

ISSN: 2349-6495(P) | 2456-1908 (O)



International Journal of Advanced Engineering Research and Science

(IJAERS)

An Open Access Peer-Reviewed International Journal



Journal DOI: [10.22161/ijaers](https://doi.org/10.22161/ijaers)

Issue DOI: [10.22161/ijaers.97](https://doi.org/10.22161/ijaers.97)

AI PUBLICATIONS

Vol.- 9 | Issue - 7 | Jul 2022
editor@ijaers.com | <http://www.ijaers.com/>

International Journal of Advanced Engineering Research and Science

(ISSN: 2349-6495(P)| 2456-1908(O))

DOI: 10.22161/ijaers

Vol-9, Issue-7

July, 2022

Editor in Chief

Dr. Swapnesh Taterh

Chief Executive Editor

S. Suman Rajest

Copyright © 2022 International Journal of Advanced Engineering Research and Science

Publisher

AI Publication

Email: editor.ijaers@gmail.com; editor@ijaers.com

Web: www.ijaers.com

International Editorial/ Reviewer Board

Editor in Chief

- **Dr. Swapnesh Taterh (Chief-Editor)**, Amity University, Jaipur, India

Chief Executive Editor

- **S. Suman Rajest**, Vels Institute of Science, Technology & Advanced Studies, India
chief-executive-editor@ijaers.com

Associate Editors

- **Dr. Ram Karan Singh**, King Khalid University, Guraiger, Abha 62529, Saudi Arabia
- **Dr. Shuai Li**, University of Cambridge, England, Great Britain

Editorial Member

- **Behrouz Takabi**, PhD, Texas A&M University, Texas, USA
- **Dr. Gamal Abd El-Nasser Ahmed Mohamed Said**, Port Training Institute (PTI), Arab Academ For Science, Technology and Maritime Transport, Egypt
- **Dr. Hou, Cheng-I**, Chung Hua University, Hsinchu Taiwan
- **Dr. Ebrahim Nohani**, Islamic Azad University, Dezful, IRAN.
- **Dr. Ahmadad Nabih Zaki Rashed**, Menoufia University, EGYPT
- **Dr. Rabindra Kayastha**, Kathmandu University, Nepal
- **Dr. Dinh Tran Ngoc Huy**, Banking and Finance, HCM, Viet Nam
- **Dr. Engin NAS**, Duzce University, Turkey
- **Dr. A. Heidari**, California South University (CSU), Irvine, California, USA
- **Dr. Uma Choudhary**, Mody University, Lakshmangarh, India
- **Dr. Varun Gupta**, National Informatic Center, Delhi, India
- **Dr. Ahmed Kadhim Hussein**, University of Babylon, Republic of Iraq
- **Dr. Vibhash Yadav**, Rajkiya Engineering College, Banda. UP, India
- **Dr. M. Kannan**, SCSVMV University, Kanchipuram, Tamil Nadu, India
- **José G. Vargas-Hernández**, University of Guadalajara Periférico Norte 799 Edif. G201-7, Núcleo Universitario Los Belenes, Zapopan, Jalisco, 45100, México
- **Dr. Sambit Kumar Mishra**, Gandhi Institute for Education and Technology, Baniatangi, Bhubaneswar, India
- **DR. C. M. Velu**, Datta Kala Group of Institutions, Pune, India
- **Dr. Deependra Pandey**, Amity University, Uttar Pradesh, India
- **Dr. K Ashok Reddy**, MLR Institute of Technology, Dundigal, Hyderabad, India
- **Dr. S.R.Boselin Prabhu**, SVS College of Engineering, Coimbatore, India
- **N. Balakumar**, Tamilnadu College of Engineering, Karumathampatti, Coimbatore, India
- **R. Poorvadevi**, SCSVMV University, Enathur, Kanchipuram, Tamil Nadu, India
- **Dr. Subha Ganguly**, Arawali Veterinary College, Sikar, India
- **Dr. P. Murali Krishna Prasad**, GVP College of Engineering for Women, Visakhapatnam, Andhra Pradesh, India
- **Anshul Singhal**, Bio Instrumentation Lab, MIT, USA
- **Mr. Lusekelo Kibona**, Ruaha Catholic University, Iringa, Tanzania
- **Sina Mahdavi**, Urmia Graduate Institute, Urmia, Iran
- **Dr. N. S. Mohan**, Manipal Institute of Technology, Manipal, India
- **Dr. Zafer Omer Ozdemir**, University of Health Sciences, Haydarpasa, Uskudar, Istanbul, TURKIYE
- **Bingxu Wang**, 2721 Patrick Henry St Apt 510, Auburn Hills, Michigan, United States
- **Dr. Jayashree Patil-Dake**, KPB Hinduja College of Commerce, Mumbai, India

- **Dr. Neel Kamal Purohit**, S.S. Jain Subodh P.G. College, Rambagh, Jaipur, India
- **Mohd Muntjir**, Taif University, Kingdom of Saudi Arabia
- **Xian Ming Meng**, China Automotive Technology & Research Center No.68, East Xianfeng Road, Dongli District, Tianjin, China
- **Herlandi de Souza Andrade**, FATEC Guaratingueta, State Center for Technological Education Paula Souza - CEETEPS
- **Dr. Payal Chadha**, University of Maryland University College Europe, Kuwait
- **Ahmed Moustafa Abd El-hamid Elmahalawy**, Menoufia University, Al Minufya, Egypt
- **Prof. Mark H. Rummeli**, University & Head of the characterisation center, Soochow Institute for Energy Materials Innovations (SIEMES), Suzhou, Jiangsu Province, China
- **Dr. Eman Yaser Daraghmi**, Ptuk, Tulkarm, Palestine
- **Holmes Rajagukguk**, State University of Medan, Lecturer in Sisingamangaraja University North Tapanuli, Indonesia
- **Dr. Menderes KAM**, Dr. Engin PAK Cumayeri Vocational School, DÜZCE UNIVERSITY (University in Turkey), Turkey
- **Dr. Jatin Goyal**, Punjabi University, Patiala, Punjab, India | International Collaborator of GEITEC / UNIR / CNPq, Brazil
- **Ahmet İPEKÇİ**, Dr. Engin PAK Cumayeri Vocational School, DÜZCE UNIVERSITY, Turkey
- **Baarimah Abdullah Omar**, Universiti Malaysia Pahang (UMP), Gambang, 26300, Malaysia
- **Sabri UZUNER**, Dr. Engin PAK Cumayeri Vocational School Cumayeri/Duzce/Turkey
- **Ümit AĞBULUT**, Düzce University, Turkey
- **Dr. Mustafa ÖZKAN**, Trakya University, Edirne/ TURKEY
- **Dr. Indrani Bhattacharyya**, Dr. B.C. Roy College of Pharmacy and Allied Health Sciences, Durgapur, West Bengal, India
- **Egnon Kouakouc**, Nutrition/Health at University Felix Houphouet Boigny Abidjan, Ivory Coast
- **Dr. Suat SARIDEMİR**, Düzce University, Faculty of Technology, Turkey
- **Dr. Manvinder Singh Pahwa**, Director, Alumni Relations at Manipal University Jaipur, India
- **Omid Habibzadeh Bigdarvish**, University of Texas at Arlington, Texas, USA
- **Professor Dr. Ho Soon Min**, INTI International University, Jln BBN 12/1, Bandar, Baru Nilai, 71800 Negeri Sembilan, Malaysia
- **Ahmed Mohammed Morsy Hassan**, South Egypt Cancer Institute, Assiut University, Assiut, Egypt
- **Xian Ming Meng (Ph.D)**, China Automotive Technology & Research Center, No.68, East Xianfeng Road, Tianjin, China
- **Ömer Erkan**, Konuralp Campus, Düzce-Turkey
- **Dr. Yousef Daradkeh**, Prince Sattam bin Abdulaziz University) PSAU), KSA
- **Peter JO**, IPB University, Indonesia
- **Nazmi Liana Binti Azmi**, Raja Perempuan Zainab II Hospital, 15586 Kota Bharu, Kelantan, Malaysia
- **Mr. Sagar Jamle**, Oriental University, Indore, India
- **Professor Grazione de Souza**, Applied Mathematics, Rio de Janeiro State University, Brazil
- **Kim Edward S. Santos**, Nueva Ecija University of Science and Technology, Philippines.


Vol-9, Issue-7, July 2022

(10.22161/ijaers.97)

Detail with DOI (CrossRef)

The applicability of active teaching-learning methodologies in health: An integrative review

Selma Kazumi da Trindade Noguchi, Andrey Silva Machado, Simone Aguiar da Silva Figueira, Jofre Jacob da Silva Freitas, Thayse Hage Gomes Machado, Marcella Mota Macedo e Machado, Leonilde Sousa dos Santos, Renato da Costa Teixeira

 DOI: [10.22161/ijaers.97.1](https://doi.org/10.22161/ijaers.97.1)

Page No: 001-006

Validation of a post-cracking law in tensile for a sustainable UHPFRC using fracture energy and finite element method

Rosangel Rojas Agüero, Jose Rafael Yopez Aguirre, Américo Campos Filho, Alexandre Rodrigues Pacheco

 DOI: [10.22161/ijaers.97.2](https://doi.org/10.22161/ijaers.97.2)

Page No: 007-017

Constitutional Hermeneutics: The role of the Judicial Power in the concretization of fundamental rights

Giselle Feliz Santiago, Olavo Bilac Quaresma de Oliveira Filho

 DOI: [10.22161/ijaers.97.3](https://doi.org/10.22161/ijaers.97.3)

Page No: 018-024

Impacts of covid-19 social distancing on the sleep of health students

Luciano Fiorentin, Marcos Freitas Cordeiro, Sirlei Favero Cetolin, Luana Patrícia Marmitt, Vilma Beltrame

 DOI: [10.22161/ijaers.97.4](https://doi.org/10.22161/ijaers.97.4)

Page No: 025-034

Astronomy as a Tool for Learning the laws of Physics: Theory of Conceptual fields by Vergnaud

Jorge Emanuel de Oliveira Irineu, Artur Justiniano Roberto Junior, Antonio José Silva Oliveira, Clóvis Bôsko Mendonça Oliveira

 DOI: [10.22161/ijaers.97.5](https://doi.org/10.22161/ijaers.97.5)

Page No: 035-060

Urban Solid Waste in Brazil: Concept, Characterization and Regulation

Veridiana Torres da Silva, Antônio Roberto Xavier, Andrea Yumi Sugishita Kanikadan, Aiala Vieira Amorim, Olienai de Ribeiro de Oliveira Pinto, Rosalina Smedo de Andrade Tavares, Karla Renata de Aguiar Muniz, Michella Rita Santos Fonseca, Maria Vandia Guedes Lima, Marcus Rodney Portela Cysne, Juliana Fernandes da Silva Queiroz, Antonio Leonardo Moreira de Aquino, Júlio César Lopes de Oliveira

 DOI: [10.22161/ijaers.97.6](https://doi.org/10.22161/ijaers.97.6)

Page No: 061-071

Analysis Design Results of Kort Nozzle on Yamaha 15 HP Outboard Motor Propulsion System Towards Increasing Ship Speed

Brampi Stefie Hendry Huka, Berbudi Wibowo, Maimun

 DOI: [10.22161/ijaers.97.7](https://doi.org/10.22161/ijaers.97.7)

Page No: 072-077

Corporate Social Responsibility with Child Education in the Sertão Pernambucano: The Case of Agrodan

Me. Eljalma Augusto Beserra, Prof. Dra. Lúcia Marisy Souza Ribeiro de Oliveira, Prof. Dra. Eva Mônica Sarmiento da Silva, Prof. Dra. Luciana Souza de Oliveira

 DOI: [10.22161/ijaers.97.8](https://doi.org/10.22161/ijaers.97.8)

Page No: 078-087

In Some Selected Districts of Bangladesh During the Covid-19 Pandemic Period, Sanitation and Health Service Facilities

Md. Rasidul Islam, Wenbin Zhao, Zekrullah Qasimi, Mehedi Hasan Sagar, Hasan Ahmed Joy

 DOI: [10.22161/ijaers.97.9](https://doi.org/10.22161/ijaers.97.9)

Page No: 088-094

Bibliometric Study on the Profile of Agroecology Research in Journals of Agrarian Sciences

Valdení Venceslau Bevenuto, Marcus Metri Corrêa, Luciano Pires de Andrade

 DOI: [10.22161/ijaers.97.10](https://doi.org/10.22161/ijaers.97.10)

Page No: 095-105

Animal protein production in aquaculture in the semi-arid northeast - challenges and perspectives for small businesses

Msc. Dajana Gabriella Nóbrega Santos da Silva, Dr. Jairton Fraga Araújo, Dr. Luciano Sergio Ventim Bomfim, Dra. Anna Cristina Freire Barbosa, Dra. Eliane Maria de Souza Nogueira

 DOI: [10.22161/ijaers.97.11](https://doi.org/10.22161/ijaers.97.11)

Page No: 106-110

Vulnerability of Environmental Components to Climate Change and Farming Strategies in the Adja-Ouere-Pobe Doublet in the South-Eastern Benin

Guy Cossi Wokou

 DOI: [10.22161/ijaers.97.12](https://doi.org/10.22161/ijaers.97.12)

Page No: 111-120

The Legal Effectiveness of the National Solid Waste Policy in Brazil Regarding Recycling Activities of Civil Construction Waste

Railson Gomes da Costa, Aldair Jône Almeida Soares, Marcus Vinicius Rivoiro, Delson Fernando Barcellos Xavier, Jéferson Araújo Sodré, Jamylle Maria Araújo Silva

 DOI: [10.22161/ijaers.97.13](https://doi.org/10.22161/ijaers.97.13)

Page No: 121-129

Design and Performance of Hybrid Solar Fish Dryer with Back Up Element Heater

M.Alfan Ansori, Berbudi Wibowo, Maimun, Gunadi Z.A

 DOI: [10.22161/ijaers.97.14](https://doi.org/10.22161/ijaers.97.14)

Page No: 130-136

Democratic Theory of Fundamental Rights as a Reference for the Inclusion of Marginalized and Invisible People

Daniela Costa Soares Mattar¹, Flávio Marcos de Oliveira Vaz

 DOI: [10.22161/ijaers.97.15](https://doi.org/10.22161/ijaers.97.15)

Page No: 137-148








Municipal councils for sustainable development and their relationship with agroecology

Samuel Cronemberger Caffé, Lucia Marisy Souza Ribeiro de Oliveira, Marcia Bento Moreira, Samuel Horácio de Oliveira, Nilo Ramos Moreira de Souza

 DOI: [10.22161/ijaers.97.16](https://doi.org/10.22161/ijaers.97.16)

Page No: 149-168

<p><i>Descriptive analysis of COVID-19 cases and deaths among traffic professionals in a Brazilian Amazon metropolis, between 2020 and 2021</i> Vanessa de Almeida Batista, Marcelo Coelho Simões, Layse Gomes Furtado, Ana Lúcia da Silva Ferreira, Natalia Kiss Nogueira da Silva, Altem Nascimento Pontes, Silvia Cristina Santos da Silva, Elzianne Pires de Souza, André Carvalho Matias, Cléa Nazaré Carneiro Bichara  DOI: 10.22161/ijaers.97.17</p>	<p>Page No: 169-175</p>
<p><i>Historical-Social and Legal Aspects of People with Disabilities (PCD): A necessary discussion</i> Giselle Feliz Santiago, Olavo Bilac Quaresma de Oliveira Filho  DOI: 10.22161/ijaers.97.18</p>	<p>Page No: 176-184</p>
<p><i>Direct Action for Unconstitutionality by Omission (ADO): In Generality</i> Giselle Feliz Santiago, Olavo Bilac Quaresma de Oliveira Filho  DOI: 10.22161/ijaers.97.19</p>	<p>Page No: 185-191</p>
<p><i>The real reasons for choosing bushing fiber (Luffa cylindrica): A bibliographic review</i> Deolinda Lucianne Ferreira, Ane Micheele Rodrigues Coelho, Cláudio Gonçalves, Edivan Neves, Darío da Silva, Andreza Bastos Mourão  DOI: 10.22161/ijaers.97.20</p>	<p>Page No: 192-200</p>
<p><i>Scientific Cooperation Network in Innovations in the use of Biopolymers in Civil Construction</i> Arlmara Abade Bandeira, Francisco Sandro Rodrigues Holanda, Carlos Eduardo Celestino de Andrade, Abimael Magno do Ouro Filho, José dos Santos Machado, Wilsonita de Melo Ubirajara  DOI: 10.22161/ijaers.97.21</p>	<p>Page No: 201-210</p>
<p><i>Contingent Valuation Method in a Pandemic Period: Diagnosis for the Search of New Directions</i> Dr. Joana D'arc Bardella Castro, Dr. Ronaldo do Nascimento Carvalho  DOI: 10.22161/ijaers.97.22</p>	<p>Page No: 211-218</p>
<p><i>Strategic Thinking on the Development of Sudan's Renewable Power Industry</i> Mohamed Gabir Ahmed Ismaail, Mintah Clement, Khalifa Dai Elnour Mohamed, Alhada Fahd Abdullah Abdulsamad Mohammed  DOI: 10.22161/ijaers.97.23</p>	<p>Page No: 219-225</p>
<p><i>COVID-19 and Takotsubo Cardiomyopathy: An integrative review</i> Luiz Mezencio Neto, Vinícius Batista Silva, Ney Ferreira de Sousa Filho, Haroldo da Silva Santana  DOI: 10.22161/ijaers.97.24</p>	<p>Page No: 226-232</p>
<p><i>The Blending of Architectural Context and Clothing Art in Set of Etiquette System</i> Yu Yao, Yuye Lu  DOI: 10.22161/ijaers.97.25</p>	<p>Page No: 233-239</p>
<p><i>Waste Management in Brazil and Implications of the Most Applied Techniques in The Management Process</i> Claudenilson dos Santos Viana, Flávio Augusto de Freitas, Edson Pablo da Silva  DOI: 10.22161/ijaers.97.26</p>	<p>Page No: 240-252</p>

<p><i>A Multi-Input Power System deployment for Enhanced Rice Production</i> Nosiri Onyebuchi Chikezie, Oyibo Uchechukwu Moses, Njoku Elvis Onyekachi, Ekechukwu Ebere Evelyn  DOI: 10.22161/ijaers.97.27</p>	<p>Page No: 253-262</p>
<p><i>Home Service Information System Design for Health Workers</i> Andi Hutami Endang, Mirandha Ariescas Riana, Mardiatul Jannah, Kamil Malik  DOI: 10.22161/ijaers.97.28</p>	<p>Page No: 263-267</p>
<p><i>Use of the Endogenous Resources of the Palestine Settlement, Cravolândia-BA: The Potentials of Quixabeira (Sideroxylon obtusifolium [Humb. ex Roem. & Schult.] T.D. Penn.)</i> James Lima Chaves, Suyare Araújo Ramalho, José Raimundo Oliveira Lima, Jéssica do Nascimento Pereira Lima, Jacqueline Araújo Castro  DOI: 10.22161/ijaers.97.29</p>	<p>Page No: 268-275</p>
<p><i>Therapeutic Approaches to Molar-Incisor Hypomineralization: An Integrative Review</i> Lucas Emmanuel Rodrigues Lima, Marcela Bezerra de Menezes Ponte, Lara Alves Meneses, Luana Beatriz Ribeiro Lima, Raissa Cardoso dos Santos, Alice Freire dos Santos, Vitória Alexandre de Moraes, José Evando da Silva Filho, Ana Catarina Tomaz Soares, Gabriel Gouveia Frota, Jose Ariston Raulino Neto, Paulo Leonardo Ponte Marques, Grace Sampaio Teles da Rocha, Anastácia Leite Jucá Ramalho, Ticiane Medeiros de Saboia Arnez  DOI: 10.22161/ijaers.97.30</p>	<p>Page No: 276-285</p>
<p><i>Reliability analysis of reinforced concrete slabs designed according to NBR 6118</i> Carlos Henrique Hernandorena Viegas, Mauro de Vasconcellos Real  DOI: 10.22161/ijaers.97.31</p>	<p>Page No: 286-297</p>
<p><i>Application of Analytical Hierarchy Process for site selection for container leasing and selling company</i> Muriel Rios Thomas, Alessandro Roberto Rocha, Fernando Nascimento Zatta, Diego Vieira dos Santos, Wellington Gonçalves  DOI: 10.22161/ijaers.97.32</p>	<p>Page No: 298-308</p>
<p><i>The prevalence of Sepsis in a public maternity hospital in the Eastern Amazon</i> Francisco Otávio Alves Cordeiro, Silvia Ferrera Nunes, Xaene Maria Fernandes Duarte Mendonça, Rubenilson Caldas Valois, Heliana Helena de Moura Nunes, Irna Carla Rosário Souza Carneiro  DOI: 10.22161/ijaers.97.33</p>	<p>Page No: 309-318</p>
<p><i>Interdisciplinarity as a Natural Strand of Scientific Knowledge</i> Sandro Dau, Sérgio Rodrigues de Souza, Vinícius da Silva Santos, Adébio de Jesus Ribeiro Lisboa  DOI: 10.22161/ijaers.97.34</p>	<p>Page No: 319-340</p>
<p><i>Farmers Affected by Hematological Neoplasms and Exposed to Pesticides: A study in southern Brazil</i> Mariana Portela de Assis, Patrik Nepomuceno, Taila Francieli da Silva, Marcela Lange, Guilherme Mocelin, Hildegard Hedwig Pohl, Suzane Beatriz Frantz Krug  DOI: 10.22161/ijaers.97.35</p>	<p>Page No: 341-357</p>

Neurological Evaluation in Quilombolas Individuals Exposed to Organophosphorus Pesticides in the Brazilian Amazon Population

Núbia Rocha Marques, Izabelle Cristine Melo de Lima, Amanda Cavalcante Lopes, Rosivaldo de Alcântara Mendes, Kleber Raimundo Freitas Faial, Antônio Marcos Mota Miranda, Fernando Paschoal-Jr

 DOI: [10.22161/ijaers.97.36](https://doi.org/10.22161/ijaers.97.36)

Page No: 358-364

Development of a Smartphone Application for Dental Biofilm Control for Adolescents undergoing Fixed Orthodontic Treatment

Ms. Cristiane Caram Borgas Alves

 DOI: [10.22161/ijaers.97.37](https://doi.org/10.22161/ijaers.97.37)

Page No: 365-372

The Use of Technology in Logistics Process Innovation in Industries

Adriana Maria Miguel Peixe, Adriana Berno, Jorge Balsan, José Simão de Paula Pinto, José Anízio Rocha de Araújo

 DOI: [10.22161/ijaers.97.38](https://doi.org/10.22161/ijaers.97.38)

Page No: 373-383

Quadratic Bounded Knapsack Problem Solving with Particle Swarm Optimization and Golden Eagle Optimization

Yona Eka Pratiwi, Firdaus Ubaidillah, Muhammad Fatekurohman

 DOI: [10.22161/ijaers.97.39](https://doi.org/10.22161/ijaers.97.39)

Page No: 384-390

Challenges, Reflections and Possibilities Experienced During the COVID-19 Pandemic Period by an Interdisciplinary Professional Doctorate Course in the State of Pernambuco, Brazil: Experience Report

Telma Lúcia de Araújo Silva, Moacyr Cunha Filho, Jorge Luiz Schirmer De Mattos

 DOI: [10.22161/ijaers.97.40](https://doi.org/10.22161/ijaers.97.40)

Page No: 391-409

Geometrical Model of bearing Capacity for a Safe Rectangular Vertically Loaded Shallow Pad Foundation on a Cohesionless (Sandy) Soil with Minimum Angle of Friction

A.G. Okeniyi, A.S. Akolade, S.A. Adefisoye, O. T. Akanbi, O.D. Okeleye

 DOI: [10.22161/ijaers.97.41](https://doi.org/10.22161/ijaers.97.41)

Page No: 410-418

Decentralization and Humanization of Public Health Services

Marlene Simões e Silva, Pamela Nery do Lago, Carolina Costa Pinto, Renata Castro Mendes, Luciana de Moraes Lisboa, Ronaldo Gomes Rodrigues, Ana Paula Caetano Pereira, Luciana Moreira Batista, Andréia Elias da Cruz Nascimento, Pablo Raphael de Freitas, Merilaine Isabel dos Santos, Carla Renata dos Santos, Karine Letícia de Araújo Costa, Marília Antônia de Paula, Danielle Cristina de Oliveira Silva Saturnino, Liene de Fátima Carvalho, Nicolle Silva de Menezes, Flávia Lima Miranda, Aline Borges Penna, Maria Emília Lúcio Duarte, Raquel Resende Cabral de Castro e Silva, Mariângela Ferraz Rodrigues Araújo, Hirlla Karla de Amorim, Kiwisunny Galvão Franzoi, Fabiana Ribeiro da Silva Braga, Ana Paula Ferreira Marques de Araújo, Hilma Keylla de Amorim, Luzimare de Matos Avelino Ventura, Darlan dos Santos Damásio Silva, Juliane Guerra Golfetto, Leticia do Nascimento, Marcelo Dangllys Duarte Fernandes, Rafaela Bezerra Gama Guimarães, Maria Ivanilde de Andrade, Leonardo Oliveira Silva, Michelly Angelina Lazzari da Silva, Diva Maria de Oliveira, Samanntha Lara da Silva Torres Anaisse, Juliana Grazielle Lobato Alexandre, Eugênio Barros Bortoluzi, Fernando Henrique da Silva Costa, Luciana Latorre Galves Oliveira, Walter Guimarães de Jesus, Gisela Pereira Xavier Albuquerque, Siomara Jesuina de Abreu Rodrigues, Cijara Leonice de Freitas, Raiane Almeida Silva, Andressa Caline Inácio Natalino Campos, Eliseu da Costa Campos, Edmilson Escalante Barboza, Liane Medeiros Kanashiro, Tatiana Alves Costa

 DOI: [10.22161/ijaers.97.42](https://doi.org/10.22161/ijaers.97.42)

Page No: 419-424

Class Actions for a Writ of Mandamus Concerning Tax Matters in Brazil: Between Law and Political Philosophy

Renato Lopes Becho, Guilherme Paes de Barros Geraldi

 DOI: [10.22161/ijaers.97.43](https://doi.org/10.22161/ijaers.97.43)

Page No: 425-435

Gender Inequality: An obstacle to sustainable development

Maria Auxiliadora Tavares da Paixão, Profa. Dra. Lucia Marisy Souza Ribeiro de Oliveira, Profa. Dra. Luciana Souza de Oliveira, Timnada Paixão Fagundes Pereira

 DOI: [10.22161/ijaers.97.44](https://doi.org/10.22161/ijaers.97.44)

Page No: 436-443

New Educational Technologies Available on the Internet as Pedagogical Support in Contingent Remote Learning

José Evandro da Silva Figuerêdo, Francisca Laudeci Martins Souza, Maria Erilúcia Cruz Macedo

 DOI: [10.22161/ijaers.97.45](https://doi.org/10.22161/ijaers.97.45)

Page No: 444-457

The applicability of active teaching-learning methodologies in health: An integrative review

Selma Kazumi da Trindade Noguchi¹, Andrey Silva Machado², Simone Aguiar da Silva Figueira³, Jofre Jacob da Silva Freitas⁴, Thayse Hage Gomes Machado⁵, Marcella Mota Macedo e Machado⁶, Leonilde Sousa dos Santos⁷, Renato da Costa Teixeira⁸

¹Physiotherapist, Master, State University of Pará, Belém/PA, Brazil. Email: kazuminoguchi32@gmail.com

²Physiotherapist, Specialist, Higher School of the Amazon, Belém/PA, Brazil. Email: andrey.silva.machado@hotmail.com

³Nurse, Master, State University of Pará, Belém/PA, Brazil. Email: simoneaguiar@uepa.br

⁴Physiotherapist, PhD, State University of Pará, Belém/PA, Brazil. Email: jofre.freitas@uepa.br

⁵Physiotherapist, Master, Higher School of the Amazon, Belém/PA, Brazil. Email: thaysehage@yahoo.com.br

⁶Physiotherapist, Specialist, Pará University Center, Belém/PA, Brazil. Email: marcellamachado@uol.com.br

⁷Physiotherapist, Master, Estácio College, Belém/PA, Brazil. Email: leonilde.fisio@gmail.com

⁸Physiotherapist, PhD, Federal University of Pará, Belém/PA, Brazil. Email: renatocteixeira@uepa.br

Received: 05 Jun 2022,

Received in revised form: 26 Jun 2022,

Accepted: 01 July 2022,

Available online: 07 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Multilayer coverage, Pressure injury, Intensive care unit.

Abstract— Objectives: to identify in the literature the applicability of active teaching-learning methodologies in health. Methodology: integrative review carried out in the Virtual Health Library using the descriptors in health sciences: Active methodologies; Health; Applicability. Results: 31,500 articles were found and, after careful reading, eleven were selected in the Virtual Health Library. The making of the patchwork quilt stood out; Digital Information and Communication Technologies; twine; thematic workshops with practical activities and previous questions for reflection and criticism were also used; patient care, analysis of real cases, role-playing (decision making and competence demonstration); documentaries and television series; mock jury; conversation wheel; movie theater with popcorn; tutorial group; constructivist spiral; flipped classroom and peer instruction, as well as its pedagogical foundations; problematization with the Arch of Charles and Magueres; Project-Based Learning; the three Pedagogical Moments; Puppet theater and musical parodies; Directed study, flipped classroom, concept map and mind map; interactive dialogued class; case studies; oral presentation of contents; kahoot; Forum; LPAM (Learning Practice Assessment Material); ESCAPE ROOM; Problem Based Learning; Video lessons; theaters and recreational activities. Final Considerations: Reflective teaching, appropriate to the context, of methodological quality has the ability to instigate an expanded and transdisciplinary vision, in addition to promoting social changes resulting from the increase of individual and collective awareness.

I. INTRODUCTION

The current world requires higher education institutions to demonstrate efficiency in the training of

students, to bring solutions to the health of the population and promote a reflective practice that collaborates to face

the challenges imposed by the moment that Brazilian health is experiencing [1].

The National Curriculum Guidelines show the indispensability of higher education aimed at the job market, which requires trained professionals to act with social responsibility, commitment to citizenship to promote the health of the population [1].

To develop this profile, several methodological approaches can be incorporated into the teaching-learning process, including adherence to active methodologies. There are varied teaching methods, from the most traditional models to the most contemporary methodologies [2].

The proposal of active methodologies is to improve the learning system that teachers use to direct the critical training of future professionals in the most varied areas [3].

Its benefits consist of student autonomy, arousing curiosity, encouraging private and global decision-making. The teacher is no longer the center of the teaching-learning process and the student becomes responsible and participant in this process, at which time he goes in search of his knowledge, acquiring professional skills that he would probably not be able to if he were experiencing a traditional way of teaching, which is carried out in a fragmented and teacher-centered way, not encouraging student autonomy in the production of knowledge [4].

The applicability of active teaching-learning methodologies is essential, which provide the formation of knowledge according to the obstacles of reality, as well as the union of indispensable and professionalizing contents, the junction between theory and practice [5].

Currently, there are numerous teaching-learning strategies that lead to satisfactory learning, such as Problem-Based Learning (PBL) or Team-Based Learning (TBL), which are the best known [5].

Furthermore, within these methodologies, several techniques can be used as work in small groups; commented readings; discuss topics; socialization; musical interpretation; film presentation; workshops; round tables; dramatizations; seminars; playful-pedagogical dynamics; plenary; critical experience report; dialogued exhibitions;

oral assessment; wallet; among others, which can also compose the active teaching-learning method [5].

From the delimitation of the theme, the present study aimed to identify in the literature the applicability of active teaching-learning methodologies in health.

II. METHODOLOGY

This is an integrative literature review, a study that focuses on synthesizing research results and showing conclusions from the corpus of literature on a given phenomenon, comprising studies related to the guiding question that guides the search for this literature.

This is an integrative literature review, developed from the need to synthesize research results and present conclusions from the corpus of literature on a given phenomenon, comprising studies related to the guiding question that guides the search for this literature [6].

For its conduction, the following steps were followed: (1) identification of the theme with elaboration of the guiding question; (2) inclusion/exclusion criteria for articles; (3) search for articles in the database; (4) evaluation of studies and critical analysis; (5) categorization of studies; (6) interpretation of findings [7].

To understand the theme, we chose the following guiding question: What is the applicability of active teaching-learning methodologies in health?

As for the inclusion criteria, they were: original and complete articles, freely available, published in Portuguese, between the years 2017 to 2021. In addition, as for the exclusion criteria, they were: repeated files, reviews, theses, congress abstracts, undefined period, unrelated to the topic studied and studies that did not answer the guiding question.

The present review was carried out in February 2022, and the following criteria were chosen for the selection of publications indexed in the Virtual Health Library (VHL): articles whose main theme were the following descriptors in health sciences: Active Methodologies, Health and Applicability, which were submitted to the simultaneous crossing with the help of the Boolean operator "AND" between them.

Table 1: Characterization of studies in terms of title, author, year of publication and objective.

N	Title	Author / Year	Objective
A1	Metodologias Ativas e Aprendizagem Significativa: Processo Educativo no Ensino em Saúde.	Pereira et al. (2021)	To analyze an educational practice, according to the theory of meaningful learning, on active methodologies in health education, carried out in the Postgraduate Program in Health Education, professional master's degree, at the State University of Mato Grosso do Sul.
A2	Metodologias ativas na educação interprofissional em saúde.	Alencar et al. (2020)	To report the experiences of using different resources of active methodologies in PET- Saúde Interprofissionalidade.
A3	Metodologias ativas de aprendizagem no ensino superior de saúde: o fazer pedagógico.	Veloso; Pequeno; Negreiros (2019)	To describe, from the point of view of higher education teachers, understandings about the new methodologies for pedagogical practice after a training course.
A4	Metodologias ativas em um curso de formação em saúde.	Ross et al. (2020)	Know the reflections of an expert on the use of active methodologies in that course.
A5	Metodologias ativas de aprendizagem: práticas no ensino da Saúde Coletiva para alunos de Medicina.	Assunção (2021)	To report teaching experiences in the development and application of active learning methodologies in the teaching of Public Health to medical students.
	Metodologias ativas de aprendizagem: caminhos possíveis para inovação no ensino em saúde.	Macedo et al. (2018)	To report the experience of professors in the discussion of active learning methodologies as a problematizing pedagogical strategy for higher education in health.
A7	Formação docente e a utilização de metodologias ativas: uma análise de teses e dissertações	Soares, Engers, Copetti, (2019)	To demonstrate, through the experience report of a group of academics from the third period of the medicine course at the Federal University of Delta do Parnaíba, the importance of playing in the teaching-learning process, as well as identifying how such learning methodologies intersect in the formation of course students.
A8	Aplicação do lúdico para o ensino de saúde na educação médica da cidade de Parnaíba, Piauí: relato de experiência.	Costa et al. (2020)	To demonstrate, through the experience report of a group of academics from the third period of the medicine course at the Federal University of Delta do Parnaíba, the importance of playing in the teaching-learning process, as well as identifying how such learning methodologies intersect in the formation of course students.
A9	Domínio das metodologias ativas por docentes de curso de graduação em Enfermagem.	Dias et al. (2020)	To analyze the training course for the acquisition of teaching skills of the nurse teacher in the application of active methodologies.
A10	A aplicação de metodologias imersivas nos cursos de metodologia híbrida da área da saúde e bem-estar na educação a distância (ead).	Moraes; Daros (2019)	To present the pedagogical model with the application of Immersive Methodologies in Health and Wellness courses, in the distance modality, as well as its benefits as a teaching methodology, for training qualified professionals to solve real problems in the globalized world, with emphasis on primordial knowledge for clinical care.
A11	Metodologias ativas no processo de ensino-aprendizagem de anatomia e neuroanatomia.	Marchior; Carneiro. (2018)	Analyze the strengths and weaknesses of active learning methods in the teaching of Anatomy and Neuroanatomy, in addition to suggesting applicable techniques.

Table 2: Applicability of active teaching-learning methodologies in health.

N	Evidence
A1	The making of the patchwork quilt rescued the knowledge, as well as provided the exchange of experiences and reflections. The problematization triggered a consensus that teaching methodologies should be strategically planned, considering the context and the actors involved. The conceptual map as an educational strategy and formative assessment showed that the master's students developed significant learning in the addressed topic. The string intonation on the theory of meaningful learning aroused the interest and attention of the students.
A2	Due to the context of the COVID-19 pandemic, it was also possible to intensify the use of Technologies and Communication, information tools for the teaching-learning process. Mind maps, concept maps and flowcharts were used; games based on reading official documents (National Curricular Guidelines for the Pharmacy Course); construction of a color entitled "The Consolidated Giant Express" redefining elements of the history of the Unified Health System and the need to strengthen it; and the production of a podcast with a thematic approach on Interprofessionality in the context of the COVID-19 pandemic. Other resources such as flipped classes, thematic workshops with practical activities and previous questions for reflection and criticism were also included; to the patient, analysis of real care, role-playing (decision making and demonstration of competence) in cases of interprofessionality; use of films, documentaries and television series.
A3	As for the development of skills, it obtained an excellent rating, standing out equally to all at 92.3% in terms of knowledge of the concepts, contributions and limitations of active methodologies and understanding of the stages of PBL, in the ability to deal with the dynamics of group work and in the attitude of dealing with conflict situations during educational activities, favoring group empathy. As for the strategies used during the workshops, the questions about content, exposure were clearly evaluated and the answers were compiled into regular, good and excellent. It was shown that the excellent concept stood out, with emphasis on the simulated jury in 84.9%; followed by the circuit, with 76.9%; and also with 69.2% for conversation circles; and handwritten. However, the cinema with popcorn and the tutorial group did not have expressive acceptance, with the good concept prevailing in 61.5% and 53.8%, respectively.
A4	The constructivist spiral, the problematizing methodology, team learning and other diversified and efficient educational actions stood out.
A5	Three methods were discussed: project design, flipped classroom and peer instruction, as well as their pedagogical foundations.
A6	The problematization with the Arch of Maguerez facilitated the understanding and applicability of active methodologies.
A7	Problematization Methodology with the Arch of Maguerez (04), Project-Based Learning (03), Problem Solving (02) and The Three Pedagogical Moments (01).
A8	Puppet theater and musical parodies, described, from the definition of the playful method, the elaboration of a presentation script and the preparation of materials, until its execution for the other students. Thus, the material and content produced were presented in the respective class of the parasitology and microbiology module.
A9	Directed study, inverted classroom, conceptual map and mind map, followed by interactive dialogued class, case studies, oral presentation of contents and kahoot.
A10	Forum techniques were used; LPAM (Learning Practice Assessment Material) and SALA ESCAPE.
A11	Techniques of practical classes were used; Problem-based teaching; Video classes; theaters and recreational activities.

III. DISCUSSION

Among the methodologies described in the results, there is the making of Patchwork, which consists of a method that rescues previous knowledge, in addition to providing an exchange of experiences and reflections. It is a device inspired by the children's book "Colcha de Retalho", by Conceil Corrêa Silva and Nye Ribeiro (2010), and by the film "Colcha de Retalhos" (How to make an American quilt, by Jocelyn Moorhouse, USA, 1995), in which case you must "weave a quilt" bringing together pieces with different stories, knowledge, desires and walks

that can transform yourself and the environment around you [8].

The problematization, which triggered a consensus that teaching methodologies should be strategically planned, considering the context and the actors involved. The conceptual map as an educational strategy and formative assessment evidenced the development of meaningful learning. The intonation of strings on the theory of meaningful learning aroused the interest and attention of the students. The educational practice generates

problematization, reflection and resignification, both in the participants and in the mediators [8].

The use of these resources is privileged to stimulate critical-reflective thinking and the consequent decision-making to solve everyday problems and develop other skills, such as communication, teamwork, leadership, collaborative practice, clarification and interaction of roles [9].

This experience allows us to verify that the use of different learning strategies is a very positive didactic resource in the knowledge construction process [9].

Pedagogical competences are centered on the need for the teacher to seek constant improvement, to adapt the methods to the new curricular requirements recommended by the National Curriculum Guidelines [10].

The current needs for professional training demanded by the job market, the profile of students enrolled in higher education, the need to comply with the National Curricular Guidelines and effective supervision by the Ministry of Education, makes Higher Education Institutions concerned about compliance with the measures imposed by government evaluators on the quality of the education offered, since there can be no compromise in the recognition of the courses or in the accreditation of the institution [10].

Another important methodology is the Constructivist Spiral, which promotes the identification of problems, the formulation of explanations and the elaboration of learning questions, through the search for new information, construction of new meanings and evaluation [11].

When using the Constructivist Spiral, the determination of problems is directly linked to previous knowledge, interpretations, sensitivities, and values brought by everyone. The problems listed by the group can be aggregated, by approximation, and present the starting point of the pedagogical process [11].

During the teaching-learning process, the coherence between the values of the current generation of students, the paradigm shifts in the provision of health services and the practices of pedagogical innovations allied to the use of Digital Information and Communication Technologies in teaching projects must be observed. The use of techniques such as the flipped classroom and peer instruction, supported by Digital Information and Communication Technologies, reshapes the classroom to make learning more meaningful [12].

Students' doubts are common, interpreted as tensions between the passivity in which they find themselves in the traditional model and the appeal for greater involvement when active learning methodologies are used. Faced with

this situation, the teacher must make the didactic transposition and overcome deficiencies in communication skills [12].

The problematization methodology is present in some methods that can support teaching, among them PBL or Problem Based Learning (PBL), Team Based Learning (TBL), Charles and Maguerez Arch and Project Based Learning (PBL). These last two differ from the others, as they work with a real Problem Situation and the study takes place to solve it [13].

Furthermore, the potential of the Problematization Methodology has been adopted in research in higher education, especially in the health area [14].

It is noteworthy that the application of the Problematization Experience Methodology provides knowledge, differentiation and reflection on active methodologies as combinations, in addition to proposing opportunities and paths for an active application of learning, in order to transform teaching practices [14].

Among the active methodologies most used today, there are the pedagogical ones of ludic teaching that have demonstrated efficiency in the process of construction of knowledge by allowing communication between different areas of human cognition, stimulating the development of language (verbal and non-verbal), personality, interpretation, and coordination [15].

Teachers need to take ownership of these work tools, they need to know them so that they feel safe to apply them, and this is largely up to higher education institutions, which should encourage the exposure of different ways of applying this innovative knowledge [16].

In the advent of virtual teaching, as well as in the hybrid model, several active methodologies have been highlighted, such as the forum, which constitutes an asynchronous activity that takes the student to the process of theoretical-practical reflection on the content covered in the discipline and allows to build knowledge collaboratively and discuss with your colleagues, tutors and teachers in training [17].

Gamification has been increasingly used, such as Escape Room, which is a form of game whose mechanics are based on solving clues, puzzles and problems to free yourself from a closed room. To escape the closed rooms and complete the proposed challenge, it is necessary to pass the tests within the deadline, which is a way to practice and evaluate the knowledge learned [17].

The Practical Learning Assessment Material (PLAM) is a differential in the application of immersive methodologies, as it refers students to an experience based on the real challenges of the profession. This comes to

provide meaningful experiences for the student to perceive the applicability of the contents [17].

Currently, Digital Information and Communication Technologies are widely disseminated, making this tool in the teaching-learning process impossible. Realistic simulation, which uses fictitious patients or mannequins, virtual learning objects (educational game software, videos, audios, web technology) has stood out among the active pedagogical practices in health education [18].

Thus, the profile of the student today is as dynamic as the technologies, as the vast majority were exposed to the internet and electronic media from a very young age. The students' difficulty does not consist in access or knowledge of the technological tool, but in the discernment, maturity and perception of the real applicability for use in the classroom. [18].

IV. FINAL CONSIDERATIONS

Through this literature review, it was possible to identify the main active methodologies that have been used in the teaching-learning process in health.

Reflective teaching, appropriate to the context, of methodological quality, can instigate an expanded and transdisciplinary vision, in addition to promoting social changes resulting from the increase of individual and collective awareness.

REFERENCES

- [1] Pascon, D. M., Otrenti, E., & Mira, V. L. (2018). Percepção e desempenho de graduandos de enfermagem em avaliação de metodologias ativas. *Acta paul. enferm.*, 31(1):61-70. <https://doi.org/10.1590/1982-0194201800010>
- [2] Urio, A., Haag, F. B., Zanettini, A., Silva Filho, C. C., Franscechi, V. L., & Souza, J. B. (2017). Desafios na utilização de estratégias para aprendizagem ativa com estudantes em uma escola pública. *Rev Enferm. UFPE on line*, 11(12):4866-4874.
- [3] Borges, T. S., & Alencar, G. (2014). Metodologias ativas na promoção da formação crítica do estudante: o uso das metodologias ativas como recurso didático na formação crítica do estudante do ensino superior. *Cairu em Rev*, 3(04):119-43.
- [4] Barros, F. F., Guedes, F., Zerbinatti, L. F., & Ribeiro, E. R. (2018). Emprego de metodologias ativas na área da saúde nos últimos cinco anos: revisão integrativa. *Espaço para a Saúde*, 19(2): 108-119. <https://doi.org/10.22421/15177130-2018v19n2p108>
- [5] Sousa, C. E. G. C. (2020). Metodologias ativas de ensino aprendizagem na área da saúde: revisão de literatura. *Facit Business and Technology Journal*, 1(21).
- [6] Crossetti, M. G. O. (2012). Revisão integrativa de pesquisa na enfermagem o rigor científico que lhe é exigido. *Rev. gaúch. Enferm*, 33(2):8-9.
- [7] Botelho, L. L. R., Cunha, C. C. A., & Macedo, M. (2011). O método da revisão integrativa nos estudos organizacionais. *Revista Eletrônica Gestão & Sociedade*, 5(11):121-36.
- [8] Pereira, J. C., et al. (2021). Metodologias Ativas e Aprendizagem Significativa: Processo Educativo no Ensino em Saúde. *Revista de Ensino, Educação e Ciências Humanas*, 22(1): 11-19.
- [9] Alencar, T. O. S., et al. (2020). Metodologias ativas na educação interprofissional em saúde. *Práticas e Cuidado: Revista de Saúde Coletiva*, 1: e12556-e12556.
- [10] Veloso, M. D., Pequeno, A. M. C., & Silva Negreiros, F. D. (2019). Metodologias ativas de aprendizagem no ensino superior de saúde: o fazer pedagógico. *Revista Ibero-Americana de Estudos em Educação*, 14(2): 354-370. <https://doi.org/10.21723/riaee.v14i2.11860>
- [11] Ross, J. R., Barros, A. C. L., Silva, J. G., Costa, J. F., Marinelli, N. P., & Rocha, J. C. X. (2020). Metodologias ativas em um curso de formação em saúde. *Revista Arquivos Científicos (IMMES)*, 3(1): 154-161. <https://doi.org/10.5935/2595-4407/rac.immes.v3n1p154-161>
- [12] Assunção, A. Á. (2021). Metodologias ativas de aprendizagem: práticas no ensino da Saúde Coletiva para alunos de Medicina. *Revista Brasileira de Educação Médica*, 45(3). <https://doi.org/10.1590/1981-5271v45.3-20210009>
- [13] Macedo, K. D. D. S., Acosta, B. S., Silva, E. B., Souza, N. S., Beck, C. L. C., & Silva, K. K. D. (2018). Metodologias ativas de aprendizagem: caminhos possíveis para inovação no ensino em saúde. *Escola Anna Nery*, 22(3). <https://doi.org/10.1590/2177-9465-EAN-2017-0435>
- [14] Soares, R. G., Engers, P. B., & Copetti, J. (2019). Formação docente e a utilização de metodologias ativas: uma análise de teses e dissertações. *Ensino & Pesquisa*, 17(3).
- [15] Costa, T. R. M., et al. (2020). Aplicação do lúdico para o ensino de saúde na educação médica da cidade de Parnaíba, Piauí: relato de experiência. *Revista Eletrônica Acervo Saúde*, 12(11): e3833-e3833. <https://doi.org/10.25248/reas.e3833.2020>
- [16] Dias, E. S., & Jesus, C. V. F. (2021). Aplicação de metodologias ativas no processo de ensino em enfermagem: revisão integrativa. *Revista Saúde e Desenvolvimento*, 2021; 15(21): 19-31.
- [17] Moraes, L. R. S., & Daros, T. M. V. (2019). A aplicação de metodologias imersivas nos cursos de metodologia híbrida da área da saúde e bem estar na educação a distância (EAD). In: Congresso Internacional ABED de Educação a Distância-CIAED.
- [18] Marchiori, N. M., & Carneiro, R. W. (2018). Metodologias ativas no processo de ensino-aprendizagem de anatomia e neuroanatomia. *Revista Faculdades do saber*, 3(5) 365-378.

Validation of a post-cracking law in tensile for a sustainable UHPFRC using fracture energy and finite element method

Rosangel Rojas Agüero¹, Jose Rafael Yopez Aguirre¹, Américo Campos Filho², Alexandre Rodrigues Pacheco²

¹Engineering School, Federal University of Rio Grande, Brazil

Email: r.rojas@furg.br, j.yopez@furg.br

² Engineering School, Federal University of Rio Grande do Sul, Brazil

Email : americo.campos.filho@gmail.com, apacheco@ufrgs.br

Received: 03 Jun 2022,

Received in revised form: 27 Jun 2022,

Accepted: 02 July 2022,

Available online: 08 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *experimental tensile test, finite element method, fracture energy, inverse analysis, UHPFRC.*

Abstract—*Ultra-high performance fiber reinforced concrete (UHPFRC) is an advanced composite material characterized by compressive and tensile strengths above 150MPa and 7MPa, respectively. Initially, an experimental procedure was used to characterize the tensile performance through bending tests, using beams with 1% and 2% content by volume of steel fibers. Three-point bending load arrangement notched prisms were used to determine the contribution of the fibers to reinforcing a cracked section. With that, the (F vs. ω) experimental curves were graphed, and from there, the analytic tensile curves (σ vs. ω) was obtained point by point by application of the inverse analysis procedure proposed by the AFGC. With the analytic curves, the fracture energy was calculated, following a procedure proposed by RILEM. Subsequently, the crack width was transformed into strain using a relationship that involves the characteristic length. The resulting analytical behavior law was used to carry out computational modeling applying the finite element method. Both the finite element method and the fracture energy were used to validate the procedures, comparing experimental and numerical results. Models and experiments showed good agreement and finally was determined the constitutive law for the UHPFRC in tension. It can be concluded from this study, therefore, that the post-cracking tensile behaviour of UHPFRC can be appropriately evaluated and validated through the applied analysis procedure in this research.*

I. INTRODUCTION

Ultra-High Performance Fiber Reinforced Concrete (UHPFRC) is an innovative material that can reach average compressive strengths at 28 days that surpass 150MPa (22ksi), with tensile strengths of 7MPa (1ksi), and 10MPa (1.5ksi) in bending. To obtain a mix with ultra-

high-strength, Camacho E. [1] observes that the water amount not chemically combined with the cement in the hydration process to be the less as possible, minimizing porosity and its connectivities, and increasing strength and durability. Schmidt and Fehling [2], additionally, have indicated that the particle packing should be optimized by

using large amounts of superplasticizers, adjusting the mix workability with the presence of fibers.

Four principles that must be met to achieve ultra-high strength and durability in concrete: (i) a very low water/cement ratio, which in our case was 0.19, resulting in a very dense and strong structure, minimizing pore capillarity and preventing the transport of toxic gases and liquids into and through the concrete; (ii) high particle packing, this requirement was not fulfilled, in our case a simple grinding process was carried out.; (iii) the use of a large amount of superplasticizer, to adjust workability; (iv) the use of fibers to increase tensile strength, flexural strength, and shear strength and to make the concrete sufficiently ductile. By keeping such general design rules, it is possible to define UHPFRC mixes for the use in beams, which should continue to have a great deal of bending strength even after cracking. During the post-cracking behavior, the fibers, subjected to tensile, have a fundamental role, since, when appropriately oriented, they tend to prevent a fragile rupture due to their bridging action that sews both sides of cracks together.

Naaman and Reinhardt [3] came up with a classification for Reinforced Concrete Fiber (FRC) that can be applied to UHPFRC. They classify FRC accordingly to the inelastic behavior: (i) tensile strain hardening, where the maximum internal force in the cracked zone is larger than the limiting elastic internal force, and (ii) tensile strain softening, where the limiting elastic force is larger than the maximum internal force. The recommendations made by the Association Française de Génie Civil AFGC [4] indicate that when UHPFRC is subjected to the tensile, it can present both behaviors just mentioned, as well as define an intermediate behavior, named as low strain hardening. In this work, UHPFRC beams with steel fiber content by volume of 1% and 2% were subjected to three-point bending tests in the lab. Their responses, in terms of load vs. deflection (F vs. δ), were recorded and showed herein graphically.

From there, the analytic tensile curves (σ vs. ω) was obtained point by point by application of the inverse analysis procedure proposed by the AFGC [4]. With the analytic curves, the fracture energy was calculated, following a procedure proposed by the International Union of Laboratories and Experts in Construction Materials, Systems and Structures, RILEM TC50 [5]. The crack width was transformed into strain using a relationship that involves the characteristic length. The resulting analytical behaviour law was used to carry out computational modeling applying the finite element method. The program ANSYS [6] was used to carry out computational modeling and obtain the analytical load vs. deflection curves. This program requires, as input data, the constitutive behavior

of the material in compression and in tensile. The former can be specified with values directly obtained from the lab experiments, while the latter can be set with the Inverse Analysis. Both the finite element method and the fracture energy were used to validate the procedures, comparing experimental and numerical results, see Fig. 1.

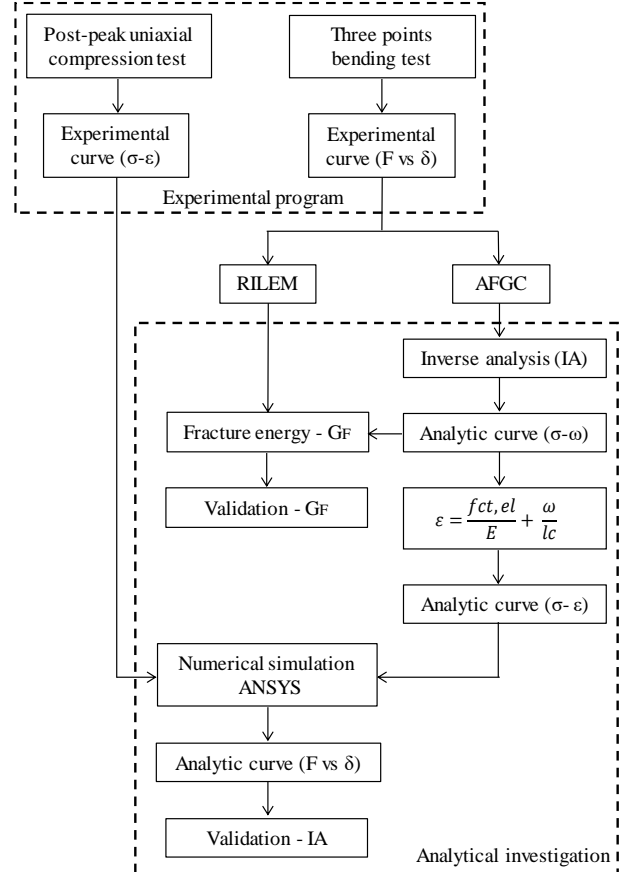


Fig. 1: Research scheme

II. EXPERIMENTAL PROGRAM

A practical strategy widely used in experimental programs to analyse the results of concrete resistance tests is the factorial arrangement, in which different treatments that are to be compared are defined. In the design of treatments, controllable factors, their levels and the combination between them are selected. The experimental design indicates the way in which the treatments are randomized and the way to control their natural variability.

The statistical tools indicated previously were used to define the UHPFRC mixture design used in this study, which was part of a series of studies carried out as support to an invention patent. It was deposited with the National Institute of Industrial Property (INPI), see Rojas et al. [7]. Also, those developments can be consulted in more detail in Rojas R. [8], it explains the extensive experimental work carried out, the end result of which is the design of the mixture indicated in TABLE 1, allowing the

production of UHPFRC with a compressive strength greater than 150 MPa.

Table 1: UHPFRC mix design.

Material	kg/m ³
Cement	955
GGBS	263
Silica Fume	119
Quartz powder	119
Fine sand	788
Superplasticizer	40
Water	185

2.1 Materials

The agglomerating materials used in the mixture are made up of:

- National cement type Portland CP V ARI with high initial resistance.
- Ground Granulated Blast Furnace Slag (GGBS) donated by the company ArcelorMittal Tubarão in the Brazilian state of Espírito Santo. In TABLE 2 we observe the chemical composition of the GGBS used in this research, including the ranges recommended in ACI 233R [9].
- Commercial silica fume (SF).
- Commercial quartz powder.

It has a single aggregate consisting of silica sand with a maximum grain size of 0.30 mm. A solution of polycarboxylate in an aqueous medium (Visco-Crete 3535) supplied by SIKA was used as a super-plasticizer additive, which adjusts the workability of the concrete and is mixed with normal water to be placed in the mix.

Table 2: Chemical composition of GGBS

Main chemical constituents	Percent by mass	Range ACI [25]
CaO	44.50%	32-45%
SiO ₂	30.22%	32-42%
Al ₂ O ₃	7.92%	7-16%
Fe ₂ O ₃	7.45%	0.1-1.5%
MnO	1.10%	0.2-1.0%
MgO	1.08%	5-15%

The fiber used is of the steel Dramix type, 13 mm long and 0.2 mm in diameter, in a volume equal to 1%. TABLE 1 shows the proportions of the mixture, in which 26% of

the cement is replaced by sustainable materials (GGBS and SF) and 8% is replaced by quartz powder. The water/cement ratio is 0.19 and the water/binder ratio is 0.13.

2.2 Manufacturing the Mixture

A sustainable UHPFRC is produced in this research. It has a simple manufacturing process, without the need for elaborated and delayed grinding processes for the packaging of particles. Two types of industrial waste are included in the mixture, silica fume and mainly GGBS, the latter with a specific granulometric distribution indicated in the invention patent.

The materials are weighed and placed in a mixer in the following order: silica fume, cement, and blast furnace slag and silica sand. The dry materials are mixed for about 5 minutes before the superplasticizer previously mixed with the water is added to the mixture. Wet materials are mixed for about 10 minutes. Initially, a dry mix is observed until small spheres of material are formed; about 1 mm in diameter, these spheres get mixed together and progressively increase in diameter until they become a wet concrete paste.

It is observed how the material separates from the bottom of the mixer, acquiring the shape and consistency of a dense plastic mass, see Fig. 2. In this state, the mixture for the UHPFRC is considered ready and it is in this moment that the steel fibers are placed, mixing for approximately 2 minutes. After fabrication, the mixture is cast into the respective moulds, to be compacted on a vibrating table for 1 minute. The specimens are stored and covered with a plastic layer for 48 hours, after which they are placed in a thermal bathroom for 24 hours at a temperature of 60 °C and then at 90 °C for another 24 hours. They are then stored in a humid room at 23 ± 3 °C until the day of the test, avoiding in all cases thermal shock on the specimens.



Fig. 2: Mixture consistency.

2.3 Post-peak uniaxial compression test

From an experimental point of view, the compilation of consistent and accurate stress vs. strain data (σ - ϵ) is difficult. During the execution of the compression test,

when the first crack forms, the lateral strain exceeds its tensile capacity and the UHPFRC specimens (with fibers) behave elastically up to approximately 80 to 90% of their compressive strength.

After reaching the maximum resistance (f_c), a progressive strain softening takes place in which the presence of fibers regulates the softening stage in a similar way as it happens in tensile, to later produce the ductile compression failure. Hassan et al. [10] found a post-peak measurement method, which consists of placing the circular rings with the LVDTs in the specimen only to measure the elastic state of the test. Additionally, two LVDTs are placed parallel to the specimen to measure the movement of the test machine head, allowing the recording of the post-peak stage. That method was used in this research to recording the post-peak behaviour of the UHPFRC subjected to uniaxial compression.

The uniaxial compression test was performed on specimens manufactured using steel moulds of 50mm diameter by 100mm height, containing a 1% fiber volume and following the criteria specified in the ABNT NBR7215 standard [11]. Twenty specimens, with 28 days of cure, were tested, applying monotonic displacement loading, using a 2000kN hydraulic machine at a rate of 0.5 mm/min. Previously, the superior and inferior face of each cylinder was levelled mechanically using a rectifier and its height is measured to verify the necessity of applying some correction factor in the resistance according to ABNT NBR5739 [12].

The values of the load vs. vertical displacement of each specimen are recorded. In the linear elastic part, the value of the strain is calculating by dividing the average displacements of the LVDTs by the initial length of measurement maintained by the circular rings. Later, with the appearance of the first crack, a multiple cracking phase occurs, in which the strain is obtained by dividing the average displacement of the external LVDTs (those that measure the displacement of the machine head) by the total height of the specimen. The stress in this stage was obtained by dividing the machine load by the cross-sectional area of the cylinder.

The characteristic compressive strength (f_{ck}) of the UHPFRC was calculated using the AFGC [4] recommendations, and the following considerations were taken into account:

- Apply the displacement control load.
- The specimen must exhibit a conical failure pattern.
- The average strength must be calculated on at least three specimens.
- The characteristic compressive strength value must be

calculated by subtracting the Student's coefficient multiplied by the standard deviation from the average strength value.

2.4 Modulus of elasticity

The modulus of elasticity was calculated by measuring directly on the linear upward branch of the UHPFRC constituent curve, recorded for each of the uniaxial compression tests performed on cylindrical specimens.

A linear approximation is used with best fit σ - ϵ results between 0 and 80 % of the peak compression strength. The value of E_{cm} is then defined as the average modulus of elasticity of the UHPFRC or the average secant modulus of elasticity, calculated as the average of the twenty individual values obtained graphically.

2.5 Three points bending test

Three-point bending load arrangement notched prisms were used to determine the contribution of the fibers to reinforcing a cracked section. With that, the (F vs. ω) experimental curves were graphed. Ten beams (four with 1% of fiber content and six with 2%), were manufactured with the mix presented in TABLE 1 and with the dimensions of 10x10x40cm. The lab tests were carried out in a hydraulic universal testing machine with a capacity of 2000kN (450kip), after 28 days of curing and by applying displacements at a speed of 0.5mm/min (0.02in./min). All of them had a notch of 30mm in depth by 4mm in width at the bottom centre of their span length made with a circular saw.

A horizontal LVDT type sensor was placed to measure the opening of the notch (ω) and two vertical LVDTs, placed on each side of the beams, were used to measure their central deflection (δ), as illustrated in Fig. 3.



Fig. 3: LVDTs to measure ω and δ .

The sensors are attached by means of tabs glued, a fast-setting glue is used. The distance between tabs must be the same from one test to the next so that the initial

measurements can be corrected by subtracting the elastic strain.

The distance between tabs should be less than 4 or 5 cm and the stroke of the sensors must be at least 2 mm.

The test variability was controlled by using materials from the same batch and the same equipment to manufacture and test the specimens. The data results were digitally recorded for each test and graphically analyzed in load vs. deflection (F vs. δ) curves, as well as in load vs. crack width (F vs. ω) curves for each of the beams.

III. EXPERIMENTAL PROGRAM

The relationship between forces and strains can be directly determined when: the internal force in a structural element is uniaxial; the cross-section is known, and it is possible to directly measure the deformation on the element under the action of a load.

Using experimental data from uniaxial compression tests, σ vs. ε curves were obtained for the UHPFRC, which were then used as a part to input data for the computational modeling.

When the forces were in bending, the determination of the nonlinear strains was not direct and alternate analytical procedures had to be used in the calculations. The procedure to determine the constitutive law for the UHPFRC in tension, including the post-cracking response, followed the methodology by AFGC [4].

The tensile curve was obtained point by point by application of the Inverse Analysis, i.e., obtaining the σ vs. ε analytic curve from the F vs. ω experimental curve.

Both curves σ vs. ε in compression and in tension were introduced as input data for the computational modeling and then the F vs. δ analytical curve was obtained. Therefore, a graphical comparison between the experimental and the analytical behaviors for each of the specimens tested were carried out.

3.1 Inverse analysis

The process starts with the definition of a new coordinate system at the point where the first crack occurs. The notch opening value at that point is turned into the new origin, with the first point coinciding with the elastic limit.

The equilibrium is easily solved to find the internal force. From the first point (step i), the next points are calculated (steps $i+1$) by solving the equilibrium of the cracked section.

A complex nonlinear equation system is generated at each step and, therefore, the free software Máxima [13] was used as a mathematical tool to solve the equations.

After solving the equation system, the force at the point is calculated, i.e., in this case, the cohesive force. The process is repeated at each $i+1$ point until the curve of cohesive force versus notch opening is built (actually, the σ_c vs. ω curve). Then, the σ_c vs. ω curve is transformed into a σ vs. ε curve, which, according to AFGC [4], can be used to define a relation between ω and ε mainly based in a determination of the characteristic length (l_c) see equation 1:

$$\varepsilon = \frac{f_{ct,el}}{E} + \frac{\omega}{l_c} \quad (1)$$

where:

$f_{ct,el}$ is the tensile strength of the concrete matrix;

E is the modulus of elasticity of the concrete matrix;

l_c is the characteristic length; and

ω is the notch opening.

The characteristic length is measured at the location where cracking occurs and in the same direction of the bottom notch opening of the beam. In the case beams are subjected to three-point bending, the AFGC [4] defines the l_c value as a function of the type of experimental behavior that is presented, i.e., the value depends upon the behavior as either of the strain softening or strain hardening types.

If the beam presents a strain softening type of behavior, the characteristic length is calculated with equation 2, while if presenting a strain hardening behavior, equation 3 is therefore used.

$$l_c = \frac{2(h-a)}{3} \quad (2)$$

$$l_c = \frac{E \cdot G_F}{fst^2} \quad (3)$$

where:

fst is the direct tension strength;

a , h are the notch depth and the beam height, respectively; and

G_F is the fracture energy.

3.2 Finite element method (FEM)

The computational analysis was carried out with software ANSYS [6] and choosing its element SOLID185 to model the concrete in 3D.

After the concrete experiences a cracking phase, the internal forces are transmitted to the fibers, which then govern the behavior of the material.

The Multilinear Material Model used in this work (CAST) can approximate behavior laws both in compression and in tension. Fig. 4 describes the boundary conditions of the beam considered in the model.

The UHPFRC was simulated as a composed material with a law in compression that was obtained from experimental data and a law in tension from an Inverse Analysis that includes the material’s post-cracking behavior.

SOLID185 is a 3D element that allows considerations to represent plasticity, hyperelasticity, large displacements, and large strains. It also allows simulations of quasi-incompressible elastoplastic materials and fully incompressible hyperelastic materials.

The element is defined by eight nodes with three degrees of freedom each (translations in x, y, and z directions), as shown in Fig. 4.

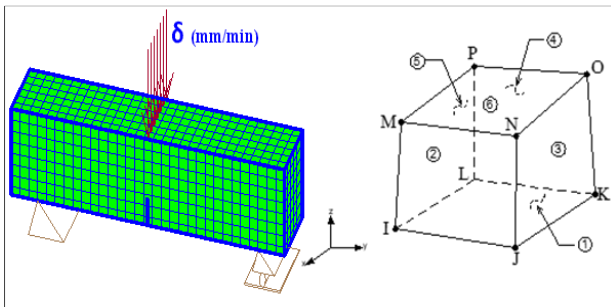


Fig. 4: Boundary element and element SOLID 185.

CAST is an elastic isotropic multilinear material with the same elastic behavior in compression and in tension, but with elastic limit and isotropic hardening behavior that can be different in each case. The behavior in tension uses the Rankine criterion, while the behavior in compression uses Von Mises.

The UHPFRC properties, such as its modulus of elasticity and its Poisson’s coefficient, had to be known for the simulations. These values were maintained constant in each specimen that was modeled.

The behavior laws in tension and in compression were different in each specimen since those behaviors were drawn from the experimental tests and the results from the Inverse Analysis.

3.3 Forces in cracked section

Fig. 5 shows the cracked cross-section of a prismatic beam subjected to bending forces, and where two different regions can be easily identified.

Firstly, there is the zone without any cracking, which is the part of the section where the force distribution corresponds to a linear elastic behavior.

Secondly, there is the cracked zone, which is the part of the section where the force distribution directly depends on the effectively of the fibers inside the concrete matrix, which can be determined via Inverse Analysis.

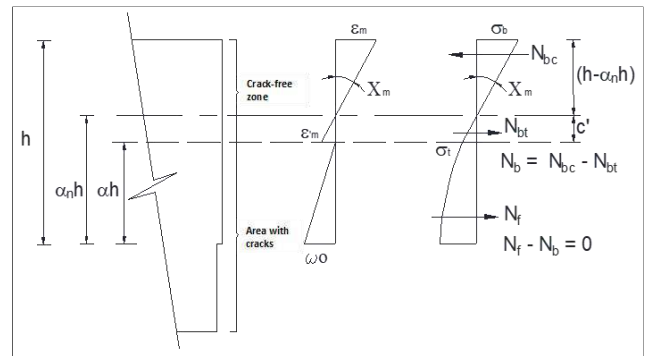


Fig. 5: Forces in the cracked section. AFGC [4] modified.

The force equilibrium in the section results in equations 4 to 8 with “b” identifying the contribution of the regions with cracks, while “f” identifies the cracked ones.

$$Nbc = \frac{1}{2} \cdot \sigma_b \cdot c \cdot b \tag{4}$$

$$Nbt = \frac{1}{2} \cdot \sigma_t \cdot c' \cdot b \tag{5}$$

$$Nb = Nbc + Nbt \tag{6}$$

$$M = Mb + Mf \tag{7}$$

$$N = Nb + Nf \tag{8}$$

The system of eight equations to solve is bound to equations 9 to 16, shown in the following.

$$Nb = \frac{1}{2} \cdot E \cdot X_m \cdot b \cdot h^2 \cdot [A^2 - B^2] \tag{9}$$

$$Nf_{i+1} = Nf_i \cdot C \cdot D + K \cdot b \cdot H \cdot (1 - D) \tag{10}$$

$$Mb = \frac{1}{3} \cdot E \cdot X_m \cdot b \cdot h^3 \cdot [A^3 - B^3] + h \cdot \alpha_n \cdot Nb \tag{11}$$

$$Mf_{i+1} = Mf_i \cdot (C \cdot D)^2 + K \cdot Nf_{i+1} \cdot O - L \cdot O^2 \cdot \sigma_{f_{i+1}} \tag{12}$$

$$N = N_{ext} = Nb + Nf \tag{13}$$

$$M = M_{ext} = Mb + Mf \tag{14}$$

$$\sigma_t = E \cdot X_m \cdot h \cdot (\alpha_n - \alpha) \tag{15}$$

$$\omega = \left[X_m + 2 \cdot \frac{M}{E \cdot I} \right] \cdot \frac{2 \cdot (\alpha \cdot h)^2}{3} \tag{16}$$

where:

$h \cdot \alpha$ is the relative length of the crack;

$h \cdot \alpha_n$ is the relative height of the neutral axis;

X_m is the curvature of the region without cracks;

b, h are the width and height of the beam cross-section, respectively;

I is the moment of inertia of the rectangular section; and the variables are:

$$A = 1 - \alpha_n; \quad B = \alpha - \alpha_n; \quad C = \frac{\alpha_{i+1}}{\alpha_i}; \quad D = \frac{\omega_i}{\omega_{i+1}}$$

$$H = \frac{\sigma f_i + \sigma f_{i+1}}{2}; \quad K = \alpha_{i+1} \cdot h; \quad L = \frac{(\alpha_{i+1} \cdot h)^2 \cdot b}{2};$$

$$O = 1 - D$$

The equation system is solved for each point of the (σ vs. ω) curve by using the known experimental points (F , ω) and the parameters calculated in the previous step.

3.4 Validation using energy fracture

The area under the analytical (σ vs. ω) curve, which is obtained via the Inverse Analysis commented in the previous section, represents the fracture energy, GF, of the material. In the same form, the area under the experimental (F vs. δ) curve gives a measure of GF, calculated according to specifications given by RILEM TC50 [5].

The Fracture Energy can be found using the load-displacement data and the equation 17. A graphical comparison is made between both behaviors and the fracture energy is then calculated for every specimen with 1% and 2% of fiber content.

$$G_F = \frac{W_f}{b \cdot (h - a)} \tag{17}$$

where:

W_f is the total area of the curve under the graphic of load versus deflection;

b is the thickness of the beam (mm);

h is the height (mm); and

a is the length of the notch made in the lower center of the beam.

3.5 Validation using finite element method

The law of behavior in compression is obtained from the experimental data, and the law of behavior in tensile is obtained by inverse analysis.

The numerical simulation of the flexural test is performed using these behavior curves as input data. An analytical load-displacement curve is obtained for each of the specimens. Then this analytical curve is compared with the response obtained experimentally, as initially indicated in Fig. 1.

The approximation between the analytical and experimental curves, indicated above, is a measure adopted in this investigation to validate the inverse analysis. With this, it is possible to verify the effectiveness of the methodology proposed by the French standard in the AFGC [4], developed from the mechanical equilibrium of Fig. 5 and by equations 4 to 16.

IV. EXPERIMENTAL AND NUMERICAL RESULTS

4.1 Compressive strength and modulus of elasticity

Twenty cylinders measuring 5cm (2in.) in diameter and 10cm (4in.) in length were used for uniaxial compressive tests for the material with 1% of fibers. The compressive strength was calculated as the average for those twenty specimens, resulting in 151MPa (22ksi), as shown in TABLE 3 (fcm=151MPa). The standard deviation was 4.3MPa (0.7ksi).

Table 3: UHPFRC compressive strength and modulus of elasticity (1MPa=145psi).

Specimen	σ (MPa)	E (MPa)
1	154	50709
2	147	44504
3	146	46104
4	158	49551
5	150	48209
6	150	46780
7	146	47503
8	152	45802
9	153	44548
10	155	46556
11	144	43768
12	159	50799
13	147	47035
14	150	49184
15	150	49129
16	150	48193
17	146	45522
18	150	49293
19	152	49595
20	158	51374
Average:	151	47708

In each test, the σ - ϵ curve is obtained and the modulus of elasticity is calculated by a linear approximation between 5% and 80% of the compressive strength, which averaged 47708MPa (6919ksi), as also shown in TABLE 3. The standard deviation was 2.2MPa (0.3ksi).

Fig. 6 shows behavior the average curve in uniaxial compression for the tested specimens. The maximum compressive stress (fcm) value occurs for a strain value equal to 0.0033. The characteristic resistance value (fck)

was 143.43MPa (20.8ksi) with a 95% probability of exceedance, obtained using the Student-fisher law.

Cylinders containing 2% of fibers were tested; in all cases, the results showed resistance values significantly lower than those manufactured with 1% of fibers and therefore were discarded. We presumed that reduction of strength was due to fiber agglomerations and the formation of internal voids.

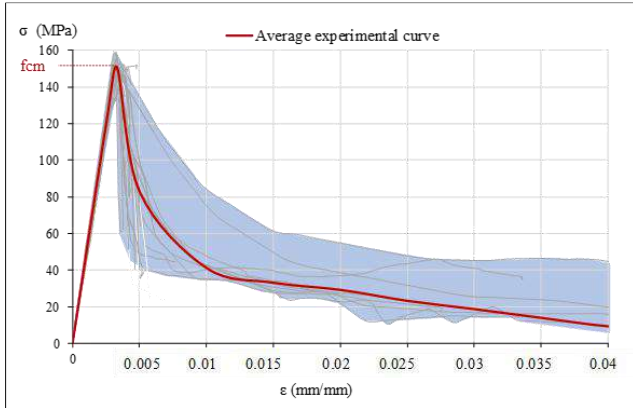


Fig. 6: UHPFRC compression constitutive behaviour.

The description in the previous paragraph meets the AFGC [4] recommendations, which proposes to characterize the compression behavior of UHPFRC according to the values of the characteristic compression strength and the modulus of elasticity.

4.2 Constitutive behaviour in tensile

Fig. 7 and Fig. 8 show (F vs. δ) curves for each of the tested beams, as well as the average curve and considering fiber content of 1% and 2%, respectively.

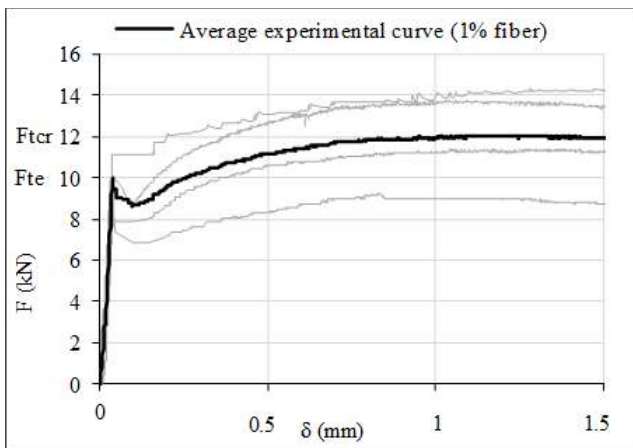


Fig. 7: Experimental curves for beams with 1% of fibers in bending (1kN=225lbf; 1mm=0,04in).

The area under each curve was calculated to determine the fracture energy according to RILEM TC50 [5].

The values of the elastic load, Fte; of the elastic strength in tension, σ; and of the deflection, δte; are presented in TABLE 4.

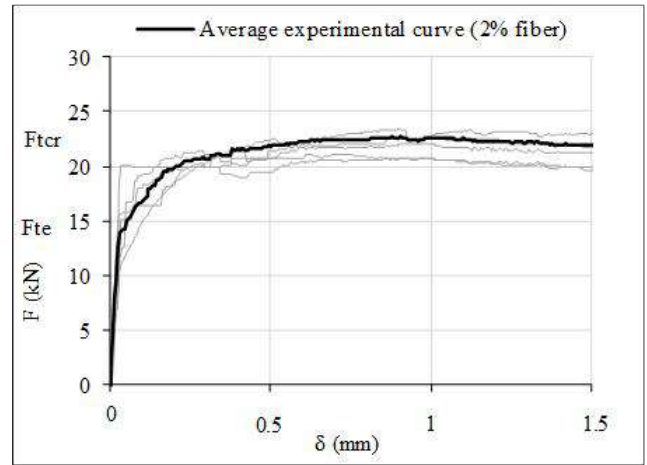


Fig. 8: Experimental curves for beams with 2% of fibers in bending (1kN=225lbf; 1mm=0,04in).

Table 4: UHPFRC elastic load and deflection, and strength in bending (1kN=225lbf; 1mm=0.04in; 1MPa=145psi)

Specimen	Fte (kN)		δte (mm)		σ (MPa)	
	1%	2%	1%	2%	1%	2%
CP-1	9.9	20.0	0.032	0.030	9.1	18.4
CP-2	10.0	15.1	0.039	0.024	9.2	18.5
CP-3	10.1	15.1	0.039	0.030	9.3	13.8
CP-4	10.6	10.3	0.037	0.020	9.7	9.5
CP-5		10.2		0.018		9.3
CP-6		10.3		0.021		9.4
Average	10.1	13.5	0.037	0.024	9.3	13.2

TABLE 5 presents the results obtained from the post-cracking behavior for the maximum load Fctr and its corresponding deflection δctr.

Table 5: UHPFRC inelastic load and deflection in bending (1kN=225lbf; 1mm=0.04in)

Specimer	Fctr (kN)		δctr (mm)	
	1%	2%	1%	2%
CP-1	9.2	21.0	0.83	0.81
CP-2	11.4	20.8	1.30	1.03
CP-3	13.8	22.5	1.04	1.08
CP-4	14.3	22.0	1.28	1.04
CP-5		23.4		0.91
CP-6		26.4		1.09
Average	12.2	22.7	1.11	0.99

Fig. 9 and Fig. 10 show (σ vs. ω) curves obtained from Inverse Analysis for each one of the beams, with fiber contents of 1% and 2%, respectively.

The area under each curve was calculated to determine the fracture energy.

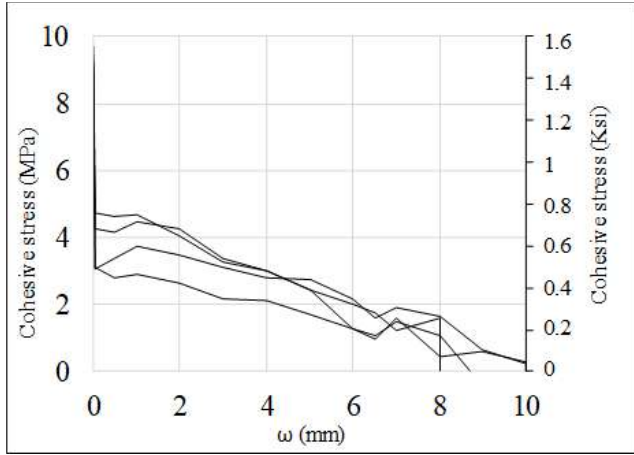


Fig. 9: Numerical (σ vs. ω) curves for beams with 1% of fibers in bending ($1\text{MPa} = 145\text{psi}$; $1\text{mm} = 0.04\text{in}$).

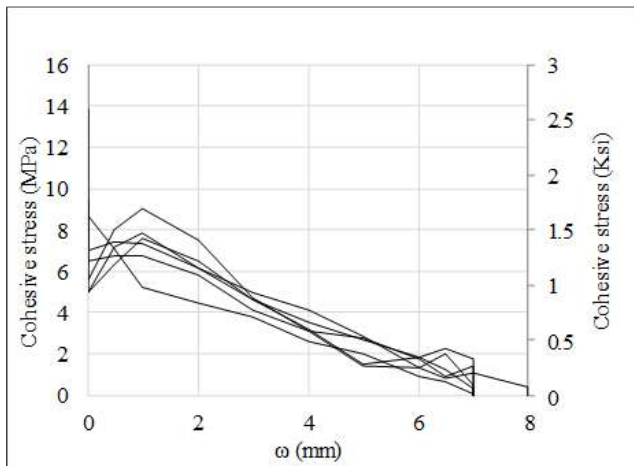


Fig. 10: Numerical (σ vs. ω) curves for beams with 2% of fibers in bending ($1\text{MPa} = 145\text{psi}$; $1\text{mm} = 0.04\text{in}$).

It was calculated from the relations (F vs. δ) and (σ vs. ω) as is showed in TABLE 6 for each one of the tested specimens, where a good fit can be observed between the two averaged results.

Table 6: Fracture Energy (GF) for UHPFRC beams with 1% and 2% of fibers ($1\text{kJ/m}^2 = 0.0006\text{BTU/in}^2$).

Fracture Energy (kJ/m^2)			
1% of fibers		2% of fibers	
Inverse Analysis	RILEM TC50-AFGC	Inverse Analysis	RILEM TC50-AFGC
	FMC		FMC

CP-1	16.91	11.66	26.53	23.76
CP-2	23.71	18.75	29.29	19.17
CP-3	23.70	15.42	29.19	23.10
CP-4	23.32	19.22	18.87	21.76
CP-5			32.49	32.40
CP-6			32.48	57.96
Average	21.91	16.26	26.67	24.04

Fig. 11 and Fig. 12 show (σ vs. ϵ) curves obtained from the transformation of ω into ϵ using equations 1 to 3, with fiber contents of 1% and 2%, respectively.

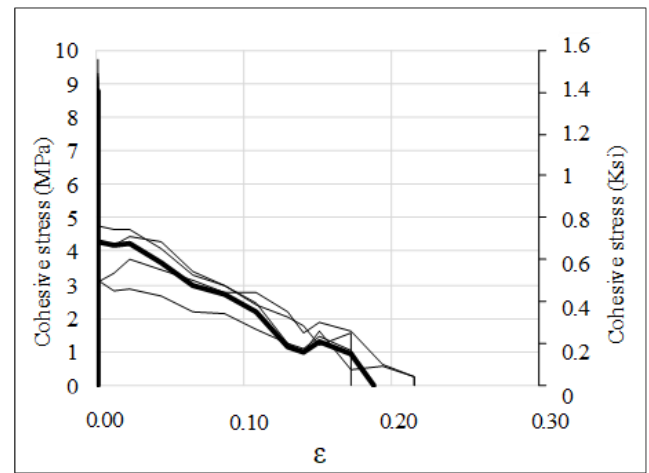


Fig. 11: Numerical σ vs. ϵ curves for beams with 1% of fibers in bending ($1\text{MPa} = 145\text{psi}$; $1\text{mm/mm} = 1\text{in/in}$).

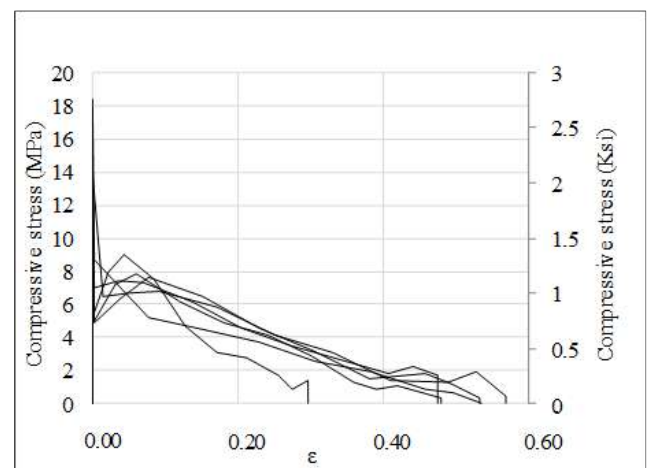


Fig. 12: Numerical σ vs. ϵ curves for beams with 2% of fibers in bending ($1\text{MPa} = 145\text{psi}$; $1\text{mm/mm} = 1\text{in/in}$).

Fig. 13 and Fig. 14 show the results of computational modeling, with fiber contents of 1% and 2%, respectively. Models and experiments showed good agreement.

The behavior analytic curves obtained in this research showed a similar trend with the curves (F vs. δ) obtained by Denairé et al. [14] using inverse analysis. Similarly, Mezquida et al. [15] carried out inverse analysis methodologies, based on the closed-form non-linear hinge model, to define the material's behavior. They obtained a similar response to this research in both cases: when the UHPFRC exhibits strain-hardening constitutive stress-strain behavior and when it exhibits strain-softening behavior.

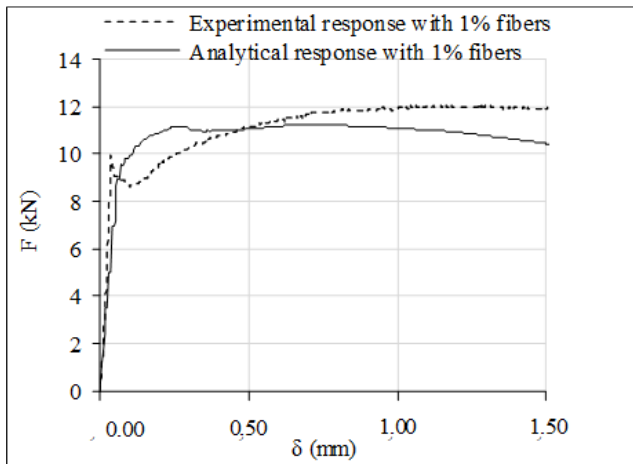


Fig. 13: Average response for 1% of fibers. Experimental vs. numerical (1kN = 225lbf; 1mm = 0.04in).

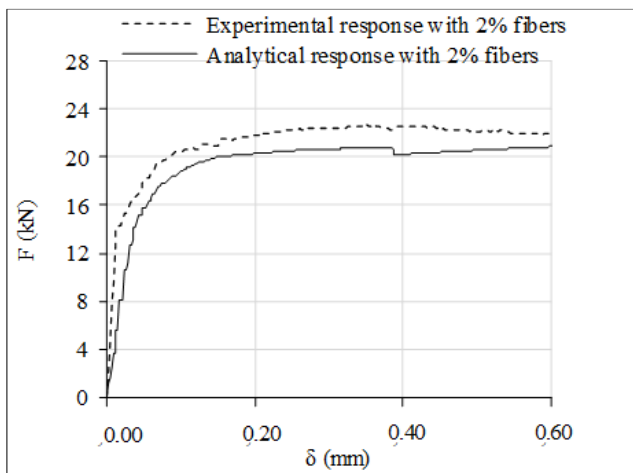


Fig. 14: Average response for 2% of fibers. Experimental vs. numerical (1kN = 225lbf; 1mm = 0.04in).

Also, Chanvillard and Rigaud [16] studied three points bend test on notched specimens and applied an inverse analysis to extract the tensile strength versus crack opening relationship. Again, the behavior curves showed a similar trend to the results in this research.

V. CONCLUSIONS

The results obtained from this investigation allow the following conclusions:

The computational modeling of UHPFRC beams can be satisfactorily carried out by considering the behavior of the composite material under a homogeneous premise. This can be accomplished with bending tests and the determination of behavior laws for the matrix with fibers in uniaxial compression and tension;

The constitutive laws for the UHPFRC material were experimentally and numerically determined for each of the beams considered. The σ vs. ϵ curves obtained in each case were considered as input data for the computational modeling carried out in Finite Elements in ANSYS. The results generated numerical F vs. δ curves that were compared with the ones experimentally obtained, showing a good fit between them;

The finite element SOLID185 used to model the matrix, together with the CAST material model used to simulate the behavior of the cracked section governed by fibers, were adequate to model the UHPFRC;

The Inverse Analysis procedure showed to be adequate to determine the behavior curve in tension of the considered beams made of UHPFRC, even considering the post-cracking response of the material;

The validation of the Inverse Analysis by means of calculating the fracture energy showed to be satisfactory for the beams with 2% of fiber content. The average value calculated from (σ vs. ω) numerical curves was 27 kJ/m² (0.017BTU/in²), while the value obtained from the experimental (F vs. δ) curves was 24 kJ/m² (0.015BTU/in²), i.e., a difference of roughly 10%.

ACKNOWLEDGMENTS

The authors acknowledge the financial support given by the Brazilian research agency CAPES as well as the personnel and equipment from the laboratories CEMACOM and LEME of the Graduate Program in Civil Engineering of UFRGS.

REFERENCES

- [1] Camacho E. (2013). Dosage optimization and bolted connections for UHPFRC ties. Ph.D. Thesis, Valencia, Spain: Universitat Politècnica de València.
- [2] Schmidt M. and Fehling E. (2005). Ultra-High-Performance Concrete: Research, Development, and Application in Europe. Digital format document: <https://www.concrete.org>

- [3] Naaman A. and Reinhardt H. (2006). Proposed classification of HPFRC composites based on their tensile response. *Journal Materials and Structures*, n. 39, p. 547-5556. <https://link.springer.com/article/10.1617/s11527-006-9103-2>
- [4] ASSOCIATION FRANÇAISE DE GENIE CIVIL. AFGC: Ultra High Performance Fiber Reinforced Concretes. Recommendations. AFGC, 2013.
- [5] THE INTERNATIONAL UNION OF LABORATORIES AND EXPERTS IN CONSTRUCTION MATERIALS, SYSTEMS AND STRUCTURES. RILEM. TC50: Determination of Fracture Energy of Mortar and Concrete by means of three-point bend tests on notched beams. *Materials and Structures Journals*, v. 106, n. 18, p. 285-290, 1985. <https://www.rilem.net/publication>
- [6] ANSYS Inc. Engineering Simulation Software. Version 19.2 Canonsburg, c2018.
- [7] Rojas R., Korzenowski C., Yopez J., Beraldin R., Campos A., Maghous S. (2020). Composição de concreto, processo de obtenção de uma composição de concreto e usos de uma composição de concreto. Depositante: Universidade Federal do Rio Grande do Sul. Depósito: BR102020024167. Protocolo: 870200017039. Instituto Nacional de Propriedade Industrial (INPI).
- [8] Rojas Aguero Rosangel. (2019) Estudio experimental y numérico de vigas usando Ultra-High Performance Reinforced Concrete-UHPFRC. PhD Thesis, Porto Alegre, RS, Brazil: Universidade Federal do Rio Grande do Sul.
- [9] AMERICAN CONCRETE INSTITUTE. ACI 233R-95: Ground granulate blast-furnace slag cementitious constituent in concrete. ACI, 1995.
- [10] Hassan A., Jones, S., Mahmud, G. (2012). Experimental test methods to determine the uniaxial tensile and compressive behavior of ultra-high performance fiber reinforced concrete (UHPFRC). *Construction and Building Materials Journal*, v. 37, p. 874-882.
- [11] ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 7215: Cimento Portland Determinação da Resistência à Compressão. Rio de Janeiro: ABNT, 1996.
- [12] ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. ABNT NBR 5739: Concreto. Ensaio de compressão de corpos de prova cilíndricos. Rio de Janeiro: ABNT, 2007.
- [13] MAXIMA FREE SOFTWARE. wxMaxima version 17.10.1
- [14] Denairé E., Sofia L., Brühwiler E. (2017). Characterization of the tensile response of strain hardening UHPFRC-Chillon Viaducts. AFGC-ACI-fib-RILEM Int. Symp. on UHPFRC, Montpellier, France.
- [15] Mezquida E.; Navarro J. and Serna P. (2019). Numerical validations Numerical validation of a simplified inverse analysis method to characterize the tensile properties in strain-softening UHPFRC. *Materials Science and Engineering*, n. 596.
- [16] Chanvillard G. and Rigaud S. (2003). Complete characterization of tensile proprieties of Ductal UHPFRC according to the french recommendations. In: HPFRCC, RILEM Proceedings Workshop, 2003, Ann Arbor, USA.

Constitutional Hermeneutics: The role of the Judicial Power in the concretization of fundamental rights

Giselle Feliz Santiago¹, Olavo Bilac Quaresma de Oliveira Filho²

¹PhD student in Law, Postgraduate Program in Master, and Doctorate in Law, UNICEUB, Brasília, Brazil

Email: giselle.santiago@sempreueub.com

²PhD of Biotechnology Applied on Agriculture, Department of Environmental Engineering, UEAP, Macapá, Brazil

Email : olavo.filho@ueap.edu.br

Received: 04 Jun 2022,

Received in revised form: 29 Jun 2022,

Accepted: 04 July 2022,

Available online: 10 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *Judicial Activism, Fundamental rights, Hermeneutics, Judicial power, Concretization*

Abstract — *Within the limits of this production, we will focus on working on a specific theme, namely, the role of the Federal Court of Justice (STF) in fulfilling the defense of fundamental constitutional principles and in the consolidation of legal certainty. To do so, we will open a theoretical discussion framework about the evolution of ideas that guide and interfere in the performance of rights operators, in a way that results in a process of realization of fundamental rights and guarantees indicated in the constitutional text. In this sense, we defend the thesis that, within certain limits, the role of the Judiciary is essential to ensure the Democratic State of Law.*

I. INTRODUCTION

In the development of this work, we will present reflections on legal hermeneutics, models of constitutional interpretation, the possibilities, and limits of the Judiciary, having as focus the controversy and theoretical debate, in the academic and legal scope, which revolves around the phenomenon very in vogue in the actuality that is judicial activism. Through this, we will seek to contribute to the analysis on the subject to try to understand the real effects of this role of the Judiciary, especially in Brazil.

In the context of this work, we will present opposing views on judicial activism, based on the analysis of several authors. In the first chapter we will confront the theoretical, philosophical, and methodological perspectives of two great schools of legal thought, namely, Formalism and the Realist School. In the second chapter, we will analyze the approaches of authors who have developed another understanding of the social and judicial role of law enforcers.

We will approach the role that the Judiciary can and should incorporate in its performance, in search of the defense and effective fulfillment of the Constitution. In this sense, the issue of judicial activism enters the order of discussions raised to collaborate with the notion that the Judiciary must work to ensure the fundamental rights provided for in the constitutional text, even if the other powers of the Republic ignore them or try to violate. Therefore, we will address the issue of judicial activism as a way for the STF to guarantee fundamental rights, of a constitutional nature, promoting the legal security of the citizens of our Democratic State of Law.

Finally, we will end with the conclusion, resuming the fundamental points addressed in the development of the work and evaluating the importance of judicial activism in the exercise of the Judiciary.

II. FORMALISM X REALIST SCHOOL

In law, from a philosophical point of view, the question that first arises is the following: how should law be interpreted? And along these lines, we start from the perspective of the so-called legal formalism, a current of thought in the field of law that is very common to be found in legal literature, and which fundamentally derives, in its systematic structuring, from the reflections of Hans Kelsen¹.

It is the line of thought that states that law is science and, in this sense, the interpreter, in the operation with the law, must act as the scientist acts with his object of analysis, having as difference only his object of study, in this case, for the jurist, to legal norms, and, for the scientist, physical and chemical phenomena. Therefore, all value judgments must be discarded.

According to this perspective, the analysis of those who dedicate themselves to the science of law is also an analysis as objective as that of the scientist, hence the idea consolidated by Formalism of separating law from morality. Not that the contents of legal norms do not have moral relevance or that they do not suffer interference from a moral dimension, even because legal norms translate moral conceptions, but the operator of law, according to this line of thought, must assume an eminently juridical, that is, the central idea is that the interpreter of the norms does not have a supra-moral protection of the positive law².

The law would have a systemic unity, and it is up to the interpreter, when applying the law, to make use of the techniques of interpretation, which are learned in universities, such as, for example, resorting to analogy, the basic syllogism of the major premise, minor premise, and the conclusion. of the law, systematic, teleological, historical, literal, authentic and doctrinal interpretation. In short, these are all the mechanisms that the law enforcer must organize the discovery of facts and say what the law is.

The final decision using this process, in principle, would not be a choice of the interpreter, but the necessary result of the exercise of logical-legal reasoning based on these interpretive mechanisms. Therefore, it is a judgment of cognition or a judgment of discovery, as opposed to a judgment of creation, or of innovation. This understanding requires as a presupposition that the legal order consists of a rational universe of doctrines and laws capable of reducing the apparent empirical diversity of law in a systemic and non-contradictory unit. Therefore, value judgments as well as political judgments should be removed³.

It can be seen that this type of interpretation supposedly has a very significant value in terms of legal certainty, since this system gives us an important level of certainty of the law put forward, as being a valid law that provides us with the certainty that judges they will interpret the law according to the basic canons of this rationality, given by a teleological method, and so that there will be no big surprises in the interpretation of the law, as well as there will be no innovations in this sense, which guarantees a certain security for the citizen.

From the 1920s onwards, Legal Formalism began to be attacked by the so-called Realist School, or School of Free Law⁴. This school fundamentally wished to introduce what they called the human element into the evolution of law, that is, instead of emphasizing “doctrinal science” and concentrating on rules as material for analysis, the Realists claimed that the truth of legal decisions it was in the social philosophies, motivations, and mental attitude of the judges. Law enforcers cannot be blind to the social reality of the law, and even if in their decisions they do not specifically refer to considerations of the social effects they will provoke, these issues must always be present as a justifying background for the decisions.

The judicial decision would thus constitute an essentially creative exercise linked to moral and political values. In other words, the conception of the Realist School is diametrically opposed to that of Legal Formalism. In this, we have an almost total freedom of the judge to create the law, based not on a dogmatic organization chart structured in the codes of laws and doctrine, but focused on social reality, the present and the problems that occur in concrete life. Therefore, in the Realist perspective, the judge himself makes the law, that is, the law would not be exactly what is contained in the Code, but what results from the interpretation and, so to speak, of the decisions of the courts⁵.

From the realistic conception, it follows that law would not be a science in the molds conceived by Legal Formalism and that value judgment is essential in the solution and application of law.

So far, we are referring, therefore, to two distinct and contradictory poles of interpretation of the law. However, between the two poles some intermediate solutions emerge, among which some of them provide recent contributions to legal philosophy and the legal theory of interpretation, which is the case of an important English philosopher named Herbert Hart (1907-1992), being considered one of the great icons of Modern Law, one of the great representatives of the so-called moderate (or tempered) positivism.

According to Hart⁶, whatever the extent of a body of rules, laws, or other regulatory mechanisms, they will never be totally immune to indeterminacy and conflicting interpretations. It is impossible for the law to not have a texture to some extent open. The author introduces an idea from the philosophy of language in which the determination of reality is conceived through its conceptual expression, that is, if there is no concept capable of expressing a given reality, it therefore does not exist. In other words, it would be the denial of metaphysical conceptions that cannot be linked to language, and it is exactly in this language that we will have the great space for disputes, due to its eminent open texture.

The author emphasizes that the open texture of language represents a kind of gray area, which is inherent to empirical concepts, and it is even impossible, given the indeterminacy, to determine its application in each case. The open texture of the laws means that the regulation of the rules of conduct must be left to the courts and authorities to strike a balance in the light of circumstances between conflicting interests, which vary from case to case.

However, it should be noted at this point that “open texture” does not mean complete indeterminacy, as most terms contain a central, fixed meaning, which provides clarity and ease in their understanding and general use. Thus, according to the considerations of Hart⁶, only when the terms present a penumbra, or an obscure region, that it becomes almost impossible to say with certainty if the term is applicable or not a legal interpretation, is that there is to be the creative exercise of the interpreter is required, at which time the discretion in the judge's decision arises.

Therefore, the judge's discretion, for Hart⁶, only arises when there is a situation of categorical indeterminacy of terms, but if this situation really takes place within a context of vagueness, of open texture of the term (or of the text). Only in the context in which this vagueness, or this penumbra of the terms dilute the guidelines of the legal norms, does the space for the judges' discretion open, in the sense of choosing between the competing interests in the concrete case. In this sense, the author even admits the exercise of the creation of the law by the interpreter (by the judge), but unlike the realists who understand the exercise of the judgment action as eminently creative, Hart limits this perspective, stating that, in principle, the judgment must be carried out according to the canons of Legal Formalism.

Furthermore, although the judge may, in a situation of indeterminacy as we have just mentioned, resort to the use of the power to create the law, he must not do so

arbitrarily, that is, the magistrate must always be invested with certain general reasons. to justify his decision and must act as a conscientious legislator, even if deciding with his own beliefs and values. It should be noted that, even so, the judge does not dispense with the legal basis and reasons that are subject to the critical judgment of those to whom it is addressed and of the community itself.

One of the great inspirers of judicial activism and neo constitutionalism, Ronald Dworkin⁷, an American legal philosopher, will deny the judge's discretion, based on a broader conception of law. According to Ronald Dworkin, Hart's view is the result of a distorted view of law common to all positivists, which asserts that law is limited to legal rules. The logical antecedent assumption of a judge's discretion is that the concept of legal rules is coextensive with the law, so that if a person's case is not open to one of the prevailing legal rules, then that case could not be decided through the “application of the law”. In other words, for Dworkin, Hart, and the positivists, they were limiting too much the power to create law, placing this law on a very narrow margin.

For Ronald Dworkin⁸, the law is not limited to the rule, and it also includes principles and values, and these are immanent to the law and are implicit in its general structure. In this way, this author understands that it is not exactly the use of discretionary power, but only the exercise of discovering the best solution or answer to be given to the concrete case, as an expression of a coherent conception of justice and equity inherent to the law itself.

This orientation affirms that between principles and rules there is a merely logical, operative difference. The rules only operate as an all or nothing, that is, they apply or not, and they can never conflict, however, if a conflict occurs, it means saying that one of them is valid and the other is not. The principles, on the other hand, do not operate within this yes/no duality, they have a dimension of weight, that is, they can be applied to a greater or lesser degree, according to the real situation of the concrete case. In addition, these principles can conflict, and the relationship between conflicting principles will also depend on the circumstances of the specific case.

Therefore, a new hermeneutic method emerges, since the interpreter will have to carry out an evaluation between the principles, and with this new interpretation techniques are born, in addition to those already known and mentioned above.

The principles integrate the essential legal interpretive universe in the same way as the rules. But if the principles are conflicting, how then can the impasse be resolved? With the judgment of weighting, judgment of proportionality, judgment of reasonableness, judgment of

maximum effectiveness, these are the main concepts that enter the mechanism of legal interpretation⁹.

The judge must then assess the relative importance of the applicable principles and try to find out, through weighting, proportionality, and reasonableness, which principle should prevail. The fact that the magistrate opts for one principle over another does not mean that the deprecated principle is denied, but rather that, in a relation of proportionality, in an assessment of the balance of interests, which determines which of the principles should prevail and which would be the most important for the resolution of the specific case^{10,11}.

Dworkin⁷ creates a guiding model for judges that he calls Hercules and, in this perspective, asserts that judges, faced with a concrete case, should develop some political theories that could serve as justifications for the set of constitutional rules that are expressly relevant to the problem.

If two or more theories seem to fit together quite well and thus point to contrasting results for the case, the judge must turn to the remaining set of practical rules and constitutional principles to create a political theory for the Constitution as a whole. The successful theory will conform to all the rules of the Constitution (or at least most of those rules), so that it represents them as a unified and cohesive set of prescriptions and rules that cover civil behavior. In other words, the judge must make decisions that apply the existing law; however, he must do it in a way that represents the law as an expression of a political theory, endowed with internal coherence, that is, the theory that best comes to be adjusted to the general coherence of society's moral and political development¹².

It is required, therefore, that the judge decides, ultimately, from a foundation of public morality. The proposal is essentially to make a moral reading of the Constitution, bringing political morality to the heart of constitutional law.

One of the great discussions of legal philosophy is this relationship between law and morality. The positivist stance seeks to eliminate morality from law as such. Not that there are no moral presuppositions in law, we are just saying that for positivists, as already mentioned, there is no superior moral protection of the applicable law¹³.

III. JUDICIAL ACTIVITY ON THE AGENDA

The great fundamental justification that Kelsen¹ will present to be operated in the legal system is the famous *pacta sunt servanda*, that is, the pacts must be fulfilled, or the laws must be fulfilled, obeyed. For natural law there is an idea of the just superior to the right, in which the just is

defined by reason, and man is understood as a rational being capable of mobilizing his capacity for rationality, the use of right reason, thus leads the law to the fair. Therefore, what governs positive law, ultimately, are the ideas, principles, or foundations that we arrive at using right reason. In the case of situations of great contradictions in the law, the right reason to solve the problem should prevail¹⁴.

In short, the legal system, under this orientation, would be supervised by the idea of fundamental reason, which, in fact, is the expression of the famous Kantian categorical imperative, which establishes the idea that actions must be manifested in the world so that can be universalized¹⁵. This notion of categorical imperative is projected in the law insofar as the conducts that can be rationally universalized establish justice. No one can kill someone, for example, because this conduct, once widespread among individuals, would cause social chaos, so criminalizing homicide. It is the categorical imperative that guides the practical notion of law.

However, Dworkin⁷ changes this perspective, asserting that justice or morality is introduced into law through the interpretation of law. This becomes the foundation of a narrative construction of political values, that is, they would no longer be in the heteronomic domain of reason, but, ultimately, in the interpretive process, in the rhetorical-argumentative production of the interpretive process of application. and law enforcement. In summary, we understand that this reading is giving rise to the adoption of solutions and interventions in Brazilian Justice by the Federal Supreme Court^{16,17}.

To illustrate this idea, we will briefly point out some decisions of the STF in this regard, namely:

a) prohibition of nepotism: the STF considered the constitutionality of the issue that it prohibited the appointment of relatives of members of the judiciary up to the third degree. The Federal Supreme Court understands that regardless of whether the law specifies the prohibition or not, this prohibition does not require a law that prohibits it, as it stems from constitutional principles of morality and impersonality, that is, the STF, in fact, with this decision, ended up positivize the principle, making it the very definition of the prohibition of nepotism, ignoring the need for an express law that asserts the prohibition of hiring in positions of trust, of someone who is related to the one who hires up to the third degree. For the STF, if the Constitution enshrines the principle of morality and impersonality, this is enough to declare a ban on nepotism.

b) the impossibility of imprisonment for debt: the STF concluded that the imprisonment of the unfaithful trustee is unconstitutional, even though this determination is

provided in the Constitution: “there shall be no civil imprisonment for debt, except for the person responsible for the voluntary and excusable breach of alimony obligation and of the unfaithful trustee” (CF 1988). To defend this position, the STF sought to base itself on a supra-legal concept by stating that the Constitution was derogated because Brazil is a signatory of the Pact of São José da Costa Rica, that is, the Pact is now assigned a derogatory status of the Constitution itself using the same mechanism as the principles.

c) suspension of the press law: the STF simply suspended the press law, declaring that all provisions are incompatible with the standard of democracy and freedom of the press conceived by the Constitution.

d) Equation of homosexual union with stable union (gay marriage): according to the STF's menu on this issue, people's sex does not serve as a factor of legal inequality; recognition of the right to sexual preference as a right emanating from the principle of human dignity; right to self-esteem in the highest point of the individual's conscience; right to pursue happiness. The concrete use of sexuality is part of people's autonomy of will. With this, we can see the political-juridical, principiological and moral construction of the Constitution promoted by the STF.

We are faced, therefore, with constructions made within a political analysis in line with Dworkin's perspective. The ministers of the Brazilian Supreme Court seek to give the Constitution an interpretation in a way that enshrines the principle as a norm, sometimes even changing the very literalness of the constitutional norm, as we have seen, for example, in the case of the unfaithful depository^{18,19,20}.

The art. 226 of the Constitution²¹ states that “the family, the basis of society, has the special protection of the State. For the purposes of State protection, the stable union between a man and a woman is recognized as a family entity, and the law must facilitate its conversion into marriage”.

The argument of principle is not established from a balancing of opposing interests, or from an attempt to distribute resources to the community, nor in the will of the majority, but, only, from the consideration of the individual as a moral subject. And the judge of the decision could not be subject to any interest or any situation of apparent conflict, otherwise he would have harmed his own perspective of analysis, since he is responsible for analyzing the essential founding moral element that lies behind the norm²².

So, Dworkin⁷ states that, in the face of the open language of the Constitution, it is necessary to recognize

the circumstance that it is not a question of applying logical or linguistic methods, but of performing a moral reading by the judge. In this sense, the judge would be open to the confrontation of arguments instead of camouflaging the moral evaluation that he performs under a technicist guise that is not supported by the constitutional text.

However, in fact, what would be being done is the separation between two different decision-making plans, namely: the democratic one, given by the majority – the political-legislative plan; and the decision plan given in a list of principles evaluation.

Jurgen Habermas²³ demonstrates that when axiological judges are mixed with normative arguments, intersubjective preferences are commonly taken as objective values, endowed with a universalizing and self-sufficient character. The great danger of this practice lies in the fact that this supposed objectification of values, treated by the courts as normative categories, is often used in the usurpation of the citizen's autonomy. At this moment, the supposedly neutral legal discourse masks the imposition of moral standards. According to the author, the use of values as reasons for deciding, removes the rationality of the process and allows the judge to act according to their conceptions of the good, which, in a pluralist society, cannot exactly be taken as consensual.

Thus, the legal norms produced by the democratic procedure would be displaced by a judicial activity of attributing meanings to the constitutional text, to some extent arbitrary, from which they emanate as values supposedly shared by the legal community²⁴.

The skepticism of Habermas²³ about the moral reading of the Constitution made by a constitutional jurisdiction is notably due to the monological aspect of the decision process. It is about reducing political morality to a single actor, the judge, who must gather an arsenal of virtues inspired by the ideal model of Judge Hercules, which allows him privileged access to truth and justice. This author will propose another mechanism, called procedural, in which he will state that what is essential for the Judiciary is to be the arbiter of the democratic game, therefore, he must verify if the channels of inclusion in the public debate were obstructed, preventing as soon as some sectors of society contributed to the formation of opinion and collective will.

For Habermas²³ the constitution of public spheres is fundamental, spaces in which the most relevant issues for society are widely debated, the wills generated communicatively in these spheres must contaminate legislative procedures, thus resulting in norms that express social pluralism. It is proposed the constitution of a model

of democracy in which the formation of the collective will is marked by the dialogic, not monological aspect of the judge. And the procedural rules become requirements of the rationality of discourse.

What is most important, therefore, is knowing how to measure, with the metric of the effectiveness of justice, the expansion of the Judiciary over the sphere of the other Powers so that excesses are not incurred, otherwise, a situation of exaggerated reduction is created. of the Legislative Power, and the values of the Judiciary Power, whose members were not elected and, therefore, are not representative of society, start to prevail over the values of the Legislative Power³.

It is also necessary to consider, despite the arguments that frame judicial activism as being counter majoritarian, that in a neo constitutional legal context, in respect of the dignity of the human person, it is necessary to preserve the existential minimum, that is, the minimum effectiveness of rights and fundamental guarantees, even if, for this to be accomplished, counter-majoritarian interference is necessary, especially because, in a highly complex society, formed by a plurality of groups, ideas, values, interests and, above all, carrying with it a whole history of social problems , racial, fundamental political issues were judicialized^{25,26}.

Controversies of great social relevance make room for the process of transferring power to the Judiciary, as the political spheres of the two other Powers of the Republic simply do not meet the interests of society, creating a kind of representation vacuum and a crisis of representation.

For the purpose of illustration and contextualization of judicialization, Cesar Britto²⁷, who has presided over the Brazilian Bar Association (2007-2010), lists some determinations of the Judiciary with a direct impact on the political field, such as, for example, when this broke the monopoly of PETROBRAS (Petróleo Brasileiro S.A.) on the oil exploration and refining process, or when it defined the indigenous question that had dragged on for centuries in Brazil, as well as the transformation of asylum into a judicially controllable act, the prohibition of the well-known and almost common practice of nepotism, the legal and ethical restrictions of electoral campaigns, party loyalty as a constitutional imposition, ceilings and floors in the remuneration of public servants, tax exemptions or the legality of taxes and a series of other issues that lead to the idea that the Judiciary, in fact, is currently constituted as the sphere of Power that has taken on the responsibility for the ratification executive action of a good part of the public policies of the federative entities^{28,29}.

The qualified performance of the STF in the realization of fundamental rights and guarantees of the citizen offers a

positive aspect of protagonist to the Judiciary, including by society itself, which is sure of the effectiveness of justice³⁰.

IV. CONCLUSION

The so-called Democratic State of Law, which implies the obligation to be governed by the Law and democratic rules, as well as implies the respect of public authorities to fundamental rights and guarantees, enshrined in article 1 of the Federal Constitution of 1988, adopted, still in its sole paragraph, the so-called democratic principle, by noting that "all power emanates from the people, who exercise it through elected representatives or directly, under the terms of the Constitution".

In this sense, we emphasize the fundamental role played by the Magna Carta. In this, the limits, and rules for the exercise of State power are found (where the "Fundamental Rights and Guarantees" are present), and, through it, the rest of the so-called "legal order" is elaborated, that is, the set of laws of a society. The democratic rule of law, therefore, cannot do without the existence of a constitution.

In this order of understanding, we consider that fundamental rights must be protected by the activism of the Judiciary against the onslaughts of the other Powers, in favor of legal security and the Democratic State of Law.

Once a right is violated, there is scope for the violation of all the others, and judicial activism can represent an important channel against the will of the State. The essence of popular sovereignty must be consolidated by the authentic, effective, and legitimate democratic participation of the people in the instruments of production and control of political decisions, and the STF, being the highest court of the Judiciary, guardian of the Constitution, must assume, in its sphere, of competence, the leadership of judicial activism.

Judicial activism, as we have seen throughout the development of this work, is a phenomenon that points to the growing role of the Judiciary, the expansion of the global power of judges, in which we perceive that this Power is increasingly trying to occupy spaces that other Powers left servants. The supposed vacuum of Power created mainly by the Legislative Power, would motivate the filling of this gap by the Judiciary, in the search for the realization of a qualified citizenship and a new meaning for democracy.

Judicial activism is involved in major controversial discussions in the legal sphere and in the academic sphere. As a new way of thinking about legal interpretation, judicial activism has to do with what used to be called the inept power of judges (or juristocracy, or dictatorship of

the judiciary), however, at the other extreme, the view is fixed that the Judiciary has a share of responsibility in the construction of democracy and active citizenship and, sometimes, some authors believe that certain movements of the Judiciary would be episodes that can be identified as the judicialization of politics.

Magistrates are elements of public administration, maximum vectors of public action and implementation of the law to satisfy our fundamental rights. The central question is to know the limits of this Judiciary action. In this reflection we think that the Judiciary is not given the right of omission. If the Legislative Power is omitted from sensitive issues, the Judiciary needs to march towards the realization of fundamental rights.

ACKNOWLEDGEMENTS

We thank UNICEUB and UEAP for the structure made available in the preparation of this article.

REFERENCES

- [1] Kelsen, H. (2006). *Teoria Pura do Direito*. 7th ed. São Paulo: Martins Fontes.
- [2] Montesquieu, C. S. (2000). *O espírito das leis*. São Paulo: Martins Fontes.
- [3] Ferreira Filho, M. G. (2012). O papel político do judiciário e suas implicações. In Francisco, J. C. (orgs.), *Neoconstitucionalismo e atividade jurisdicional: do passivismo ao ativismo judicial*. Del Rey.
- [4] Waldman, R. L. A. (2002). Teoria dos Princípios de Ronald Dworkin. *Revista Direito e Justiça*. Porto Alegre, ano 24, v. 25.
- [5] Campilongo, C. F. (2002). *Política, sistema jurídico e decisão judicial*. São Paulo: Max Limonad.
- [6] Hart, H. L. A. (2001). *O conceito de Direito*. 3th ed. Lisboa: Fundação Calouste Gulbenkin.
- [7] Dworkin, R. (2003). *O império do direito*. São Paulo: Martins Fontes.
- [8] Dworkin, R. (2001). *Uma questão de princípios*. São Paulo: Martins Fontes.
- [9] Paula, J. L. M. (2014). *Democracia e jurisdição*. 1st ed. Curitiba: JM Editora e Livraria Jurídica.
- [10] Sampaio, J. A. L. (2002). *A constituição reinventada pela jurisdição constitucional*. Belo Horizonte: Del Rey.
- [11] Sarmento, D. (2011). A dimensão objetiva dos direitos fundamentais: fragmentos de uma teoria. In: SAMPAIO, J. A. L. *Jurisdição Constitucional e Direitos Fundamentais*. Belo Horizonte: Del Rey.
- [12] Delatorre, R. (2008). *A interpretação/aplicação judicial do direito e a discricionariedade judicial: um diálogo com o pensamento de Ronald Dworkin e Hebert Hart*. Rio Grande do Sul: Porto Alegre. p. 138.
- [13] Bobbio, N. (1995). *O positivismo jurídico: lições de filosofia do direito*. São Paulo: Ícone.
- [14] Streck, L. L. (2013). *Jurisdição constitucional e decisão jurídica*. São Paulo: Revista dos Tribunais.
- [15] Cittadino, G. (2002). Poder Judiciário, Ativismo Judicial e Democracia. *Revista da Faculdade de Direito de Campos*. Campos dos Goytacazes, ano 3, n. 3.
- [16] Moraes, A. (2007). *Direito Constitucional*. 21th ed. São Paulo: Jurídico Atlas.
- [17] Tassinari, C. (2012). *Ativismo judicial: uma análise da atuação do Judiciário nas experiências brasileiras e norte-americana*. Universidade do Vale do Rio dos Sinos: São Leopoldo. pp. 44-45.
- [18] Barroso, L. R. (2009). Judicialização, ativismo judicial e legitimidade democrática. *Anuário Iberoamericano de Justicia Constitucional*, n. 13, p. 17-32, 2009. Retrieved from: <http://www.oab.org.br/oabeditora/users/revista/1235066670174218181901.pdf>
- [19] Dallari, D. A. (2010). *Constituição e Constituinte*. São Paulo: Saraiva.
- [20] Ramos, E. S. (2010). *Ativismo Judicial: parâmetros dogmáticos*. São Paulo: Saraiva.
- [21] Brasil. (2010). *Constituição da República Federativa do Brasil*. Brasília, DF: Senado, 1988: atualizada até a emenda constitucional n. 62, de 9-12-2009. São Paulo: Saraiva.
- [22] Valle, V. R. L. (2009). *Ativismo jurisdicional e o Supremo Tribunal Federal*. Curitiba: Juruá.
- [23] Habermas, J. (2003). *Direito e democracia: entre facticidade e validade*. v. 1, 2nd ed. Rio de Janeiro: Tempo Brasileiro.
- [24] Azambuja, D. (1993). *Teoria Geral do Estado*. São Paulo: Editora Globo.
- [25] Cambi, E. (2020). *Neoconstitucionalismo e Neoprocessualismo: direitos fundamentais, políticas públicas e protagonismo judiciário*. São Paulo: D'Plácido.
- [26] Branco, P. G. G. (2013). Em busca de um conceito fugidio – o ativismo judicial. In Fellet, A, Novelino, M, *Constitucionalismo e democracia*. Salvador: Juspodivm.
- [27] Britto, C. (2010). *A judicialização da política e a politização do Judiciário*. Retrieved from: <http://www.oab.org.br/noticia/19981/artigo-a-judicializacao-da-politica-e-a-politizacao-do-judiciario>
- [28] Bastos, C. R., Martins, I. G. S. (1989). *Comentários à Constituição do Brasil*. São Paulo: Saraiva.
- [29] Vianna, L. W., Carvalho, M. A. R., Melo, M. P. C., Burgos, M. B. (1999). *A judicialização da política e das relações sociais no Brasil*. Rio de Janeiro: Revan.
- [30] Carvalho netto, M. (2009). *A hermenêutica constitucional e os desafios postos aos direitos fundamentais*. In *Jurisdição Constitucional e Direitos Fundamentais*. Belo Horizonte: Del Rey.

Impacts of covid-19 social distancing on the sleep of health students

Luciano Fiorentin¹, Marcos Freitas Cordeiro², Sirlei Favero Cetolin³, Luana Patrícia Marmitt⁴, Vilma Beltrame⁵

¹Post-Graduation Program in Biosciences and Health, Universidade do Oeste de Santa Catarina (UNOESC), Brazil.
Email: fiorentinl@yahoo.com.br

² Post-Graduation Program in Biosciences and Health, Universidade do Oeste de Santa Catarina (UNOESC), Brazil.
Email : marcos.cordeiro@unoesc.edu.br

³ Post-Graduation Program in Biosciences and Health, Universidade do Oeste de Santa Catarina (UNOESC), Brazil.
Email: sirleicetolin@gmail.com

⁴ Post-Graduation Program in Biosciences and Health, Universidade do Oeste de Santa Catarina (UNOESC), Brazil.
Email : luana.marmitt@unoesc.edu.br

⁵ Post-Graduation Program in Biosciences and Health, Universidade do Oeste de Santa Catarina (UNOESC), Brazil.
Email: vilma.beltrame@unoesc.edu.br

Received: 01 Jun 2022,

Received in revised form: 26 Jun 2022,

Accepted: 05 July 2022,

Available online: 10 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Sleep Initiation and Maintenance Disorders; SARS-CoV-2; Student Health.

Abstract— Introduction: Sleep plays an important role in the balance of the human body. Its deprivation influences the development of cardiovascular, metabolic, psychological, and learning disorders. The restrictions imposed by Covid-19 on social activities affected the routine of many people, including university students, possibly impacting sleep conditions. Objective: To analyze the sleep characteristics of university students in the health area during the Covid-19 social distancing. Methodology: Cross-sectional study with 656 students from two community universities of Santa Catarina. Behavior characteristics were analyzed before and during the pandemic, relating them to sleep. Proportion analysis, crude and adjusted analyzes of the factors associated with sleep problems were performed. Results: 48.8% of the students had sleep problems. Of these, 41% were developed during social distancing. There was an increase in the difficulty to start sleep (42.4%), to stay asleep (29.4%), and dissatisfaction with sleep (36.6%). Sleep time was adequate, but insufficient to feel good for 25.6%. More sleep problems were observed among students that were older (PR=1.17; CI95%: 0.76-1.80), studied at UNOESC (PR=1.87; CI95%: 1.12-3.14), had greater use of social media (PR=2.03; CI95%: 1.21-3.39), had anxiety, sadness, and concern (PR=1.78; CI95%: 1.02-3.10), had worse eating habits (PR=1.45; CI95%: 1.01-2.07) and consumed alcohol (PR=1.59; IC95%: 0.98-2.58). Conclusion: Proper sleep time did not guarantee satisfaction with sleep. The prevalence of students with sleep problems increased with social distancing. Unhealthy eating habits, alcohol consumption, and social media use increased the risk of these problems.

I. INTRODUCTION

Sleep is the unconscious condition where sensorial activities, even though suspended, can be stimulated and return the organism to the awaken state. Among its functions, are the reestablishment of the body energy balance, restauration of the immune system, and improvement of the cognitive and psychic systems, which emphasizes the importance of the time dedicated to sleep¹⁻³. Sleep deprivation is associated with the risk of developing diverse systemic complications, such as diabetes, cardiovascular diseases, anxiety, low immunity, and learning deficits⁴.

Findings suggest that poor sleep quality may be a consequence of exposure to risky situations or behaviors, such as use of alcohol and tobacco, mental illnesses, such as chronic stress, depression, and anxiety, and excessive use of electronic devices, due to screen time and prolonged contact with social network contents⁵⁻⁷. Health science students are exposed to most, if not all, of these factors, making them vulnerable to poor quality sleep⁶.

Poor sleep quality among students of health sciences was already reported by previous studies^{5,7-9}, and the high prevalence of sleep disorders in this population shows the importance of investigating this issue in the context of the academic medium¹⁰. Sleep disorders among students are commonly observed in the transition between high school and college, because of the numerous changes in the daily routine and additional obligations¹¹.

With the COVID-19 pandemic¹², one of the prevention measures recommended by the World Health Organization was the social distancing¹³. Non-essential activities were suspended, and schools and universities were temporarily closed¹⁴. Besides the concerns regarding the disease on itself, changes in class schedules, introduction of new teaching methods, restriction of physical activities, and restricted access to some leisure activities were some of the factors that altered the daily routine of the students, having an impact in sleep quality¹⁰.

We hypothesize that students of health sciences, when experiencing all the abrupt changes related to the COVID-19 pandemic, regarding the introduction of new concerns and daily routine, had their sleep quality worsened. Thus, this study aimed to analyze the sleep characteristics of university students in the health area during the Covid-19 social distancing.

II. METHODS

This is a transversal study on university of students aging 18 years or more enrolled in the health-related programs of the Universidade do Oeste de Santa Catarina

(UNOESC) or Centro Universitário - Católica de Santa Catarina (Católica SC). The programs included were biology, biomedicine, cosmetology, medicine, nursing, nutrition, odontology, physical education, physiotherapy, psychology, veterinary medicine, and health-related post-graduation programs.

The survey was performed in July, August, and September of 2020, while the students were not having in-person classes due to the restrictive measures. Sample size calculation, considering the population of 4,700 students, confidence level of 95%, with heterogeneous distribution, resulted in a need of inclusion of at least 571 students.

Data were collected using a self-applied online questionnaire, containing questions on sociodemographic information (institution, university program, age, sex, marital status, profession, work status under the restrictive measures), and habits before and during the pandemic (duration of self-isolation, daily time in contact with social media platforms, feelings of anxiety, sadness, or concern, eating habits, and use of alcohol). The outcome consisted of sleep characteristics (difficulty to initiate sleep, difficulty in maintaining sleep, time to wake up, (in)satisfaction with current sleep quality, sleep duration, sleep hours needed to feel well, and sleep-related problems). The questionnaire was elaborated in Google Forms and an invitation was sent to the students via e-mail alongside an electronic document presenting the study and the Free and Informed Consent Form.

Data analysis was performed using Stata 13. Initially, variables were subjected to a descriptive analysis, including averages and standard deviations of numeric variables, as well as proportions of categorical variables. Raw and adjusted analysis of the factors associated with sleep problems were performed using Poisson regression with robust error variance. For this, we used three hierarchical levels to control for confounding factors. In the first level were included demographic variables (sex, age, skin color, and work); in the second level, academic information (university and course); and in the third level, behaviors during the pandemic (distancing time, daily time in social media platforms, anxiety, concern, eating habits, alcohol consumption, and physical activity). Variables were inserted in the model using backward selection, one level at a time, being maintained variables with $p < 0.20$.

III. RESULTS

In total, 723 questionnaires were answered. From these, 67 were excluded, as five refused to participate, 53 were not enrolled in health-related programs, and nine were less than 18 years old. This way, the final sample had 656 respondents.

Most participants (82.5%, n=541) studied at UNOESC, while the remaining (17.5%, n=115) studied at Católica SC. The average age was of 23.8 (±6.6) years old, 87.8%

(n=578) reported to have white skin, and 84.8% (n=556) were female (Table 1).

Table 1. Characteristics of the participants regarding sex, age, and skin color.

Variable	n	%
Sex		
Female	556	84.8
Male	100	15.2
Age (completed years)		
18 to 19	159	24.2
20 to 21	178	27.1
22 to 23	119	18.1
24 or more	200	30.5
Skin color		
White	576	87.8
Brown	69	10.5
Black	11	1.7
Total	656	100.0

Students were enrolled in 13 undergraduate and post-graduate health-related programs. Psychology was the most prevalent program (31.5%, n=207). The vast majority of the participants (97.1%, n=637) reported to have adhered to social distancing. For 67.2% (n=441) this

period lasted two months or more. Among the students, 47.9% (n=314) had a job, and 39.3% (n=258) reported to use social media platforms in an average of 3-4 hours per day, with seven hours or more being reported by 18.7% (n=123) (Table 2).

Table 2. Sample characteristics concerning undergraduate or post-graduate program, work, social distancing, and daily time using social media platforms.

Variable	n	%
Undergraduation or post-graduation program		
Biomedicine	33	5.0
Biology	11	1.7
Cosmetology	1	0.1
Physical Education	39	5.9
Nursing	73	11.1
Pharmacy	36	5.5
Physiotherapy	37	5.6
Medicine	88	13.4
Veterinary Medicine	26	4.0
Post-graduation	25	3.8
Nutrition	41	6.2
Odontology	39	5.9
Psychology	207	31.5
Work		

No	342	52.1
Yes	314	47.9
Daily use of social media platforms		
Up to 2 hours	110	16.8
3-4 hours	258	39.3
5-6 hours	165	25.2
7 hours or more	123	18.7
Total	656	100.0

When it comes to their perceptions, 83.7% (n=549) of the students reported an increase in anxiety, sadness, or concern, and 37.4% (n=245) answered that their eating habits worsened during the pandemic. To 20.9% (n=137)

of the participants the alcohol consumption decreased during this period, while it increased to 13.9% (n=91) (Table 3)

Table 3. Occurrence of self-reported anxiety, sadness, or concern, eating behavior, and alcohol consumption among students during the COVID-19 pandemic.

Variable	n	%
Increased feeling of anxiety, sadness, or concern in comparison to the pre-pandemic period		
No	107	16.3
Yes	549	83.7
Perceived changes in the quality of the eating habits in comparison to the pre-pandemic period		
Started to eat better (more fruits and vegetables, more home-made meals, etc.)	119	18.1
Started to eat worse (more caloric, industrialized, and frozen meals, more sweets, snacks, etc.)	245	37.4
No changes	292	44.5
Consumption of alcoholic beverages in comparison to the pre-pandemic period		
Does not consume alcohol	218	33.2
Alcohol consumption increased	91	13.9
Alcohol consumption decreased	137	20.9
No changes	210	32.0
Total	656	100.0

Concerning sleep-related outcomes, 42.2% (n=278) of the participants noticed a greater difficulty to initiate sleep during the pandemic, and 29.4% (n=193) reported increased difficulty maintaining sleep in this period. For 41.0% (n=269) of the students, during the pandemic it was less common to wake up early, and 36.6% (n=240) became more unsatisfied with their sleep quality. Average sleeping hours during weekdays was of 7.3 hours, increasing to 9.2

hours in the weekends. Hours of sleep were considered as ‘always sufficient’ and ‘almost always sufficient’ to 42.7% of the participants (n=280). Problems related to sleep were referred by 48.8% of the students. Of these, 28.8% (n=189) reported to already suffer from these problems prior to the pandemic, while 20.0% (n=131) developed these issues during the period (Table 4).

Table 4. Sleep characteristics of the students during the COVID-19 pandemic

Comparing to the period prior the pandemic...	Less <i>n (%)</i>	Same <i>n (%)</i>	More <i>n (%)</i>
<i>Difficulty to initiate sleep</i>	93 (14.2)	285 (43.4)	278 (42.4)
<i>Difficulty in maintaining sleep</i>	153 (23.3)	310 (47.3)	193 (29.4)
<i>Waking up earlier than usual</i>	269 (41.0)	252 (38.4)	135 (20.6)
<i>Unsatisfaction with sleep quality</i>	160 (24.4)	256 (39.0)	240 (36.6)
Duration of sleep	Time that usually goes to bed <i>Average (SD)</i>	Time that usually gets up <i>Average (SD)</i>	Duration of sleep <i>Average</i>
<i>Weekdays</i>	23.4 (1.5)	7.7 (1.7)	7.3 horas
<i>Weekends</i>	24.3 (1.7)	9.5 (1.7)	9.2 horas
Hours of sleep to feel well	Never/rarely <i>n (%)</i>	1-4 times per week <i>n (%)</i>	Almost always <i>n (%)</i>
<i>Usually sleeps the necessary number of hours to feel well</i>	168 (25.6)	208 (31.7)	280 (42.7)
Problems related to sleep	None <i>n (%)</i>	Yes, already had before <i>n (%)</i>	Yes, started during the pandemic <i>n (%)</i>
<i>Feels that has sleep-related problems</i>	336 (51.2)	189 (28.8)	131 (20.0)

The highest prevalence of sleeping problems was observed among students that increased alcohol consumption during the COVID-19 pandemic (27.5%) (Table 5). Following adjusted analysis of the factors associated with sleeping problems, the risk of developing these problems was increased for students aging 22 years or more (PR=1.17; CI95%: 0.76-1.80); UNOESC students (PR=1.87; CI95%: 1.12-3.14); that spent 7 daily hours or

more interacting with social media platforms (PR=2.03; CI95%:1.21-3.39); that reported increase in feeling anxiety, sadness, or concern during the pandemic (PR=1.78; CI95%:1.02-3.10); that developed worse eating habits (PR=1.45; CI95%: 1.01-2.07); and that increased alcohol consumption during the pandemic (PR=1.59; CI95%:0.98-2.58) (Table 5).

Table 5. Raw and adjusted analysis of the factors associated with sleep problems developed during the COVID-19 pandemic.

Level	Variable	Prevalence of sleep-related problems developed during the COVID-19 (%)	Prevalence ratios (CI95%)	
			Raw	Adjusted
1st	Sex		p=0.428	p=0.403
	Male	17.0	1.00	1.00
	Female	20.5	1.21 (0.76-1.92)	1.22 (0.77-1.92)
	Age (completed years)		p=0.009	p=0.001
	18 to 19	20.7	1.00	1.00

	20 to 21	11.2	0.54 (0.32-0.90)	0.51 (0.31-0.85)
	22 to 23	26.1	1.26 (0.82-1.93)	1.17 (0.76-1.80)
	24 or more	23.5	1.13 (0.76-1.68)	1.13 (0.76-1.67)
	Work	21.9	p=0.192	p=0.126
	No		1.00	1.00
	Yes	17.8	0.81 (0.60-1.11)	0.78 (0.57-1.07)
2nd	University		p=0.029	p=0.017
	Católica SC	12.2	1.00	1.00
	UNOESC	21.6	1.78 (1.06-2.98)	1.87 (1.12-3.14)
	Undergraduation or graduation program		p=0.326	p=0.644
	Medicine	25.0	1.29 (0.83-2.00)	1.16 (0.76-1.77)
	Nursing	23.3	1.20 (0.74-1.95)	1.19 (0.74-1.91)
	Psychology	16.4	0.85 (0.57-1.26)	0.83 (0.56-1.14)
	Post-graduation	28.0	1.44 (0.73-2.84)	0.96 (0.47-1.96)
	Other	19.4	1.00	1.00
3rd	Time practising social distancing		p=0.443	p=0.536
	Up to three weeks	23.7	1.00	1.00
	1 month	18.4	0.78 (0.44-1.36)	0.81 (0.47-1.40)
	2 months or more	19.1	0.80 (0.56-1.14)	0.82 (0.57-1.17)
	Daily use of social media platforms		p=0.197	p=0.037
	Up to 2 hours	15.5	1.00	1.00
	3 to 4 hours	21.3	1.38 (0.84-2.27)	1.52 (0.94-2.44)
	5 to 6 hours	17.0	1.10 (0.63-1.91)	1.28 (0.75-2.20)
	7 hours or more	25.2	1.63 (0.96-2.78)	2.03 (1.21-3.39)
	Feeling more anxious, sad, or concerned in comparison to the period prior to the pandemic		p=0.020	p=0.042
	No	11.2	1.00	1.00
	Yes	21.7	1.93 (1.11-3.37)	1.78 (1.02-3.10)
	Perception of the quality of the eating habits in comparison to the period prior to the pandemic		p=0.018	p=0.044
	No changes were perceived	15.4	1.00	1.00
	Started to eat better	20.2	1.31 (0.84-2.05)	1.23 (0.79-1.92)
	Started to eat worse	25.3	1.64 (1.16-2.32)	1.45 (1.01-2.07)
	Alcohol consumption in comparison to the period prior to the pandemic		p=0.037	p=0.039
	Does not consume alcohol	21.6	1.00	1.00

Unchanged	13.8	1.56 (1.02-2.38)	1.56 (1.02-2.38)
Alcohol consumption increased	27.5	1.99 (1.24-3.2)	1.59 (0.98-2.58)
Alcohol consumption decreased	21.9	1.59 (1.00-2.52)	1.38 (0.98-2.19)
Practice of physical activity		p=0.768	p=0.848
Yes	19.5	1.00	1.00
No	20.4	1.05 (0.77-1.43)	0.97 (0.72-1.31)

IV. DISCUSSION

Sleep has a singular relevance in the daily routine of university students, given its role in many health aspects and, particularly relevant in this case, intellectual activity. Good quality sleep favors better physical and cognitive conditions, such as attention, memory, and learning, so crucial in this period of life^{1,3,4,15}. However, in general, low quality sleep has high rates among university students, and these rates became even higher during the COVID-19 pandemic¹⁰.

Results from our study showed that almost half of the students had sleeping problems, and one fourth reported that these problems started with the pandemic. More than two thirds of the students stayed two or more months at home, following the restrictive measures recommended to contain the pandemic. In this period, some daily behaviors like sleeping, eating, drinking alcoholic beverages, and interacting with social media platforms, for many students, were negatively affected.

In agreement to what was observed by Du et al.¹⁶, students included in our study were emotionally affected by the pandemic, as shown by the self-reported increase in anxiety, sadness, and concerns. Similar effects were also reported by other studies including university students of health sciences during the COVID-19 pandemic¹⁷⁻¹⁹. Bashir et al.¹⁷, for example, observed the same kind of impact in the mental health of university students of health sciences, mainly in anxiety and depression levels, which can have a negative impact in sleep quality^{18,20}. This association was observed in our study, as sleeping problems were increased almost twofold among students who reported increased anxiety, sadness, or concern.

During social isolation, the perceived diet quality worsened for more than one third of the sample, and for one fourth there was an improvement. Students that reported a decrease in the perceived quality of their eating habits mentioned an increase of more caloric, industrialized, and frozen meals, more sweets, and more snacks. The ones that answered that the quality of their eating habits improved, reported an increase in the intake of fruits, vegetables, and meals prepared at home. According to Ogilvie and Patel²¹, even though there is an

association between eating habits and sleep, the relationship of causality between the two factors is not clear. Moreover, the authors conclude that experimental studies, even though small, already point towards sleeping problems and hedonic eating. Interestingly, our study showed that changes in diet, for the better or for the worse, were found to increase the risk for sleeping problems.

Staying at home influenced alcohol consumption for more than half of the sample. Use increased for 20.8% and reduced for 31.3% of the students who already drank alcohol. Cases of reduction can be explained by social drinkers, who mainly consumed alcohol during social events such as parties and gatherings in general. On the other hand, people who usually drank at home now had even more time in this environment, favoring the habit. In another study with university students made before the pandemic, hazardous alcohol use was associated with sleeping problems in 35.4% of the participants²².

Results show that an expressive number of students (48.8%) reported sleeping problems. After the start of the pandemic, a large portion of the students (42.4%) started experiencing more difficulty to initiate sleep, and 29.4% expressed more difficulty to maintain sleep. Similar findings were observed in Nursing students in Spain during the same period¹⁰. These symptoms are part of what characterizes as insomnia²³, which may have contributed with the unsatisfaction with sleep quality reported by more than one third of the participants. Insomnia may cause impairments in cognitive functions, as it increases chances of mistakes and accidents and affects quality of life²³.

During the pandemic, 29.4% of the students reported an increased difficulty maintaining sleep. A study performed before the pandemic aiming to evaluate sleeping disorders in university students in the extreme South of Brazil identified that 12.7% of the students had difficulty maintaining sleep²². It is important to highlight that, from the students that reported having sleeping problems, 41% started to notice them during social distancing. Accordingly, decreased sleeping quality in students during the pandemic were found in studies performed in China, Ireland, Malaysia, The Netherlands,

South Korea, Taiwan, and The United States of America¹⁸.

Concerning the duration of sleep, the number of slept hours considered as adequate for a young adult is of 7-9 hours 24. In a study by Tang et al. 25, The average reduction in sleeping duration was identified as the second most significant predictor for developing depression and post-traumatic stress disorder (PTSD). In the majority of the countries included in the study by Du et al. 18, less of seven hours of sleep was observed in more than 25% of the students of health-related programs during the pandemic. The average sleeping time of the participants included in our study was adequate, even though one fourth considered that did not sleep enough to feel well and more than one third reported dissatisfaction with current sleep quality.

After adjusted analysis, sex and physical activity were not identified as risk factors for sleeping problems. These findings differ from other studies performed during the same period, as Du et al. 18 identified that women were more prone to develop sleeping problems and Romero-Blanco et al. 10 found that practicing physical activities favored better sleeping quality. It is worth mentioning, however, that there is no consensus on the impact of sex and physical activity in sleeping problems among university students. Findings from a study performed in Portugal showed that even though women practiced less physical activities than men, they had better sleeping quality 26. In a study in Brazil, the probability of sleeping less than recommended was 21% less likely among physically active university students in comparison to their sedentary counterparts, and women had increased risk of daytime sleepiness and waking up at night 22.

Concerning age and university, students aging 22 to 23 years old and studying at UNOESC was associated with greater risk of developing sleep-related problems during social distancing. In the same way, significant differences were observed when considering time connected to social media. Excessive use of internet, notably of social media and before sleeping time, were consistently associated with poorer sleeping quality 27-30. Overall, the available data suggests that the more time spent exposed to social media, the greater the risk of developing sleeping problems.

Alcohol consumption during social distancing was significantly associated with sleeping problems. This association was also observed in another study, where university students that consumed alcohol had a significant decrease in sleeping quality before and during social distancing 10. It is likely that alcohol consumption interfered in the sleeping quality of students of health sciences overall, and that sleeping problems were more

prevalent among those who started drinking at home more often during the pandemic.

Despite the relevance of the subject, we cannot establish a causal relationship between the outcomes. Also, as the responses are subjective, it is not impossible that some confusion and interpretation biases are present.

V. CONCLUSION

This study showed that during social distancing, due to the COVID-19 pandemic, students of health sciences had adequate sleeping time, even though there were negative impacts in daily routine and satisfaction with sleep. Subjective dissatisfaction with sleep affected a significant part of the participants.

One fourth of the students said to have developed sleeping problems during the pandemic and reported that sleeping time was not enough to feel well. Self-reported increase of feeling anxiety, sadness, or concern, were associated with worse sleeping quality.

No associations were found between sleeping problems during the pandemic and practice of physical activity, sex, time in social distancing, work, and college program. On the other hand, eating habits, alcohol consumption, feeling anxiety, sadness, or concern, time spent using social media, university, and age had an association with sleeping problems during the COVID-19 pandemic.

REFERENCES

- [1] Krueger, J. M., Frank, M. G., Wisor, J. P., & Roy, S. (2016). Sleep function: Toward elucidating an enigma. *Sleep Medicine Reviews*, 28, 46–54. <https://doi.org/10.1016/j.smrv.2015.08.005>
- [2] Zielinski, M. R., McKenna, J. T., & McCarley, R. W. (2016). Functions and Mechanisms of Sleep. *AIMS Neuroscience*, 3(1), 67–104. <https://doi.org/10.3934/Neuroscience.2016.1.67>
- [3] Guyton, A. C., & Hall, J. E. (2017). *Tratado de Fisiologia Médica* (13a). Elsevier.
- [4] Lessa, R. T., Fonseca, L. A. N. S., Silva, V. L., Mesquita, F. B. M. de, Costa, A. J. R. da, Souza, D. J. M. de, Cesar, M. R., Ferreira, T. B., Abad, L. H. S., & Mendes, N. B. do E. S. (2020). A privação do sono e suas implicações na saúde humana: Uma revisão sistemática da literatura. *Revista Eletrônica Acervo Saúde*, 56, e3846–e3846. <https://doi.org/10.25248/reas.e3846.2020>
- [5] Bhandari, P. M., Neupane, D., Rijal, S., Thapa, K., Mishra, S. R., & Poudyal, A. K. (2017). Sleep quality, internet addiction and depressive symptoms among undergraduate students in Nepal. *BMC Psychiatry*, 17. <https://doi.org/10.1186/s12888-017-1275-5>
- [6] Galvão, A., Pinheiro, M., Gomes, M. J., & Ala, S. (2017). Ansiedade, stress e depressão relacionados com

- perturbações do sono-vigília e consumo de álcool. *Revista Portuguesa de Enfermagem de Saúde Mental*, spe5. <https://doi.org/10.19131/rpesm.0160>
- [7] Mohammadbeigi, A., Absari, R., Valizadeh, F., Saadati, M., Sharifimoghadam, S., Ahmadi, A., Mokhtari, M., & Ansari, H. (2016). Sleep Quality in Medical Students; the Impact of Over-Use of Mobile Cell-Phone and Social Networks. *Journal of Research in Health Sciences*, 16(1), 46–50.
- [8] Corrêa, C. de C., Oliveira, F. K. de, Pizzamiglio, D. S., Ortolan, E. V. P., Weber, S. A. T., Corrêa, C. de C., Oliveira, F. K. de, Pizzamiglio, D. S., Ortolan, E. V. P., & Weber, S. A. T. (2017). Sleep quality in medical students: A comparison across the various phases of the medical course. *Jornal Brasileiro de Pneumologia*, 43(4), 285–289. <https://doi.org/10.1590/s1806-37562016000000178>
- [9] Santos, T. C. de M. M. dos, Martino, M. M. F. D., Sonati, J. G., Faria, A. L. D., Nascimento, E. F. de A., Santos, T. C. de M. M. dos, Martino, M. M. F. D., Sonati, J. G., Faria, A. L. D., & Nascimento, E. F. de A. (2016). Qualidade do sono e cronotipo de estudantes de enfermagem. *Acta Paulista de Enfermagem*, 29(6), 658–663. <https://doi.org/10.1590/1982-0194201600092>
- [10] Romero-Blanco, C., Rodríguez-Almagro, J., Onieva-Zafra, M. D., Parra-Fernández, M. L., Prado-Laguna, M. del C., & Hernández-Martínez, A. (2020). Sleep Pattern Changes in Nursing Students during the COVID-19 Lockdown. *International Journal of Environmental Research and Public Health*, 17(14), 5222. <https://doi.org/10.3390/ijerph17145222>
- [11] Owens, H., Christian, B., & Polivka, B. (2017). Sleep behaviors in traditional-age college students: A state of the science review with implications for practice. *Journal of the American Association of Nurse Practitioners*, 29(11), 695–703. <https://doi.org/10.1002/2327-6924.12520>
- [12] OPAS/OMS. (2020, março 11). OMS afirma que COVID-19 é agora caracterizada como pandemia. Pan American Health Organization / World Health Organization. https://www.paho.org/bra/index.php?option=com_content&view=article&id=6120:oms-afirma-que-covid-19-e-agora-caracterizada-como-pandemia&Itemid=812
- [13] WHO. (2020, maio 18). Overview of Public Health and Social Measures in the context of COVID-19. <https://www.who.int/publications-detail-redirect/overview-of-public-health-and-social-measures-in-the-context-of-covid-19>
- [14] Silva, L. L. S. da, Lima, A. F. R., Polli, D. A., Razia, P. F. S., Pavão, L. F. A., Cavalcanti, M. A. F. de H., & Toscano, C. M. (2020). Medidas de distanciamento social para o enfrentamento da COVID-19 no Brasil: Caracterização e análise epidemiológica por estado. *Cadernos de Saúde Pública*, 36(9), e00185020. <https://doi.org/10.1590/0102-311x00185020>
- [15] Fattinger, S., Beukelaar, T. T. de, Ruddy, K. L., Volk, C., Heyse, N. C., Herbst, J. A., Hahnloser, R. H. R., Wenderoth, N., & Huber, R. (2017). Deep sleep maintains learning efficiency of the human brain. *Nature Communications*, 8(1), 1–14. <https://doi.org/10.1038/ncomms15405>
- [16] Du, C., Zan, M. C. H., Cho, M. J., Fenton, J. I., Hsiao, P. Y., Hsiao, R., Keaver, L., Lai, C.-C., Lee, H., Ludy, M.-J., Shen, W., Swee, W. C. S., Thirvikraman, J., Tseng, K.-W., Tseng, W.-C., & Tucker, R. M. (2020). Increased Resilience Weakens the Relationship between Perceived Stress and Anxiety on Sleep Quality: A Moderated Mediation Analysis of Higher Education Students from 7 Countries. *Clocks & Sleep*, 2(3), 334–353. <https://doi.org/10.3390/clockssleep2030025>
- [17] Bashir, T. F., Hassan, S., Maqsood, A., Khan, Z. A., Issrani, R., Ahmed, N., & Bashir, E. F. (2020). The Psychological Impact Analysis of Novel COVID-19 Pandemic in Health Sciences Students: A Global Survey. *European Journal of Dentistry*, 14(S 01), S91–S96. <https://doi.org/10.1055/s-0040-1721653>
- [18] Du, C., Zan, M. C. H., Cho, M. J., Fenton, J. I., Hsiao, P. Y., Hsiao, R., Keaver, L., Lai, C.-C., Lee, H., Ludy, M.-J., Shen, W., Swee, W. C. S., Thirvikraman, J., Tseng, K.-W., Tseng, W.-C., Almotwa, J., Feldpausch, C. E., Folk, S. Y. L., Gadd, S., ... Tucker, R. M. (2021). Health Behaviors of Higher Education Students from 7 Countries: Poorer Sleep Quality during the COVID-19 Pandemic Predicts Higher Dietary Risk. *Clocks & Sleep*, 3(1), 12–30. <https://doi.org/10.3390/clockssleep3010002>
- [19] Nakhostin-Ansari, A., Sherafati, A., Aghajani, F., Khonji, M., Aghajani, R., & Shahmansouri, N. (2020). Depression and Anxiety among Iranian Medical Students during COVID-19 Pandemic. *Iranian Journal of Psychiatry*, 15(3), 228–235. <https://doi.org/10.18502/ijps.v15i3.3815>
- [20] Barros, M. B. de A., Lima, M. G., Malta, D. C., Szwarcwald, C. L., Azevedo, R. C. S. de, Romero, D., Souza Júnior, P. R. B. de, Azevedo, L. O., Machado, Í. E., Damacena, G. N., Gomes, C. S., Werneck, A. de O., Silva, D. R. P. da, Pina, M. de F. de, Gracie, R., Barros, M. B. de A., Lima, M. G., Malta, D. C., Szwarcwald, C. L., ... Gracie, R. (2020). Relato de tristeza/depressão, nervosismo/ansiedade e problemas de sono na população adulta brasileira durante a pandemia de COVID-19. *Epidemiologia e Serviços de Saúde*, 29(4). <https://doi.org/10.1590/s1679-49742020000400018>
- [21] Ogilvie, R. P., & Patel, S. R. (2017). The Epidemiology of Sleep and Obesity. *Sleep health*, 3(5), 383–388. <https://doi.org/10.1016/j.sleh.2017.07.013>
- [22] Carone, C. M. de M., Silva, B. D. P. da, Rodrigues, L. T., Tavares, P. de S., Carpena, M. X., & Santos, I. S. (2020). Fatores associados a distúrbios do sono em estudantes universitários. *Cadernos de Saúde Pública*, 36, e00074919. <https://doi.org/10.1590/0102-311x00074919>
- [23] Bollu, P. C., & Kaur, H. (2019). Sleep Medicine: Insomnia and Sleep. *Missouri Medicine*, 116(1), 68–75.
- [24] Sun, Y., Shi, L., Bao, Y., Sun, Y., Shi, J., & Lu, L. (2018). The bidirectional relationship between sleep duration and depression in community-dwelling middle-aged and elderly individuals: Evidence from a longitudinal study. *Sleep Medicine*, 52, 221–229. <https://doi.org/10.1016/j.sleep.2018.03.011>
- [25] Tang, W., Hu, T., Hu, B., Jin, C., Wang, G., Xie, C., Chen, S., & Xu, J. (2020). Prevalence and correlates of PTSD and

- depressive symptoms one month after the outbreak of the COVID-19 epidemic in a sample of home-quarantined Chinese university students. *J Affect Disord*, 1–7. <https://dx.doi.org/10.1016/j.jad.2020.05.009>
- [26] Vizzotto, M. M., Jesus, S. N. de, & Martins, A. C. (2017). Saudades de casa: Indicativos de depressão, ansiedade, qualidade de vida e adaptação de estudantes universitários. *Revista Psicologia e Saúde*, 9(1), 59–73. <https://doi.org/10.20435/pssa.v9i1.469>
- [27] Freitas, C. C. M., Gozzoli, A. L. D. M., Konno, J. N., & Fuess, V. L. R. (2017). Relação entre uso do telefone celular antes de dormir, qualidade do sono e sonolência diurna. *Revista de Medicina*, 96(1), 14–20. <https://doi.org/10.11606/issn.1679-9836.v96i1p14-20>
- [28] Lin, P.-H., Lee, Y.-C., Chen, K.-L., Hsieh, P.-L., Yang, S.-Y., & Lin, Y.-L. (2019). The Relationship Between Sleep Quality and Internet Addiction Among Female College Students. *Frontiers in Neuroscience*, 13. <https://doi.org/10.3389/fnins.2019.00599>
- [29] Orzech, K. M., Grandner, M. A., Roane, B. M., & Carskadon, M. A. (2016). Digital media use in the 2 h before bedtime is associated with sleep variables in university students. *Computers in Human Behavior*, 55, 43–50. <https://doi.org/10.1016/j.chb.2015.08.049>
- [30] Yang, S.-Y., Chen, K.-L., Lin, P.-H., & Wang, P.-Y. (2019). Relationships among health-related behaviors, smartphone dependence, and sleep duration in female junior college students. *Social Health and Behavior*, 2(1), 26. https://doi.org/10.4103/SHB.SHB_44_18

Astronomy as a Tool for Learning the laws of Physics: Theory of Conceptual fields by Vergnaud

Jorge Emanuel de Oliveira Irineu¹, Artur Justiniano Roberto Junior², Antonio José Silva Oliveira³, Clóvis Bôsko Mendonça Oliveira⁴

¹Institute of Education, Science and Technology of Maranhão (IEMA) – Rio Anil Unit, São Luís – MA, Brazil

Email: jrgemanuel@gmail.com

²Department of Physics, Federal University of Alfenas, Brazil

Email: arturjustiniano@gmail.com

³Department of Physics, Federal University of Maranhão, Brazil

Email: antonio.oliveira@ufma.br

⁴Department of Electrical Engineering, Federal University of Maranhão, Brazil

Email: clovis.oliveira@ufma.br

Received: 02 Jun 2022,

Received in revised form: 27 Jun 2022,

Accepted: 04 July 2022,

Available online: 13 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Astronomy, Conceptual Fields,
Education, Physics, Investigative Teaching
Sequence.

Abstract— This work aims to present the results of the analysis of astronomy as a tool for learning the laws of physics in high school in Brazil, in the light of the Theory of Conceptual Fields (TCC)", by Gérard Vergnaud (1990), as an instrument for the planning together with the methodology of the Investigative Teaching Sequence (SEI). The present work is characterized as qualitative research and presents a new perspective on studies in this area, by enabling the configuration of new pedagogical practices, capable of bringing scientific knowledge closer to students. In the work, celestial maps were made from the location of the city of São Luís – Ma, Brazil. It was found that the use of Carta Celeste as a pedagogical tool improved the students' relationship with Exact Sciences, from the moment in which the theoretical knowledge obtained in the classroom was contextualized with field observations.

I. INTRODUCTION

Learning the discipline of Physics in High School has become a challenge for many students who appropriate this scientific knowledge in order to understand the natural phenomena present in everyday life. Generally, this discipline is seen as loaded with many calculations, and difficult to understand, motivated, many times, by the absence of a contextualized study, and, in some cases, with Astronomy content as a motivating factor for the teaching of Physics in Education. Basic.

The study of Astronomy is extremely important for the cognitive development of students in other areas of scientific knowledge, as it leads the teacher to rethink the didactics of his discipline from the moment he develops in

the student new perspectives on a certain astronomical phenomenon, when use your discipline to explain it. The objective of inserting the discipline of Astronomy back into the High School curriculum, in addition to its motivational character, is to allow the student to establish a link between celestial phenomena and their applications through the study of Physics, at the same time as allow this student to observe some of these phenomena, with the naked eye and using equipment such as a telescope, telescopes or a sky chart, overcoming the barriers of the classroom and transforming a simple transmission of content into the development of skills and abilities that will really give meaning of what is learned within the school.

Currently, the way Physics is taught in Brazil to students has become a didactic challenge for high school teachers. This is a consequence of a culture based on traditional pedagogical practices, and of the questions made by students about the absence of topics related to Astronomy that would help in the teaching-learning process, and would make the teaching of Physics more investigative and dynamic, since the study of Astronomy arouses enormous interest in students, from the moment they make physical phenomena understandable with the help of mathematical language and make it possible to understand the world through interdisciplinarity for the organization of knowledge.

In this context, this article presents a qualitative research methodology, consisting of bibliographic research and field research, where an Investigative Teaching Sequence (SEI) based on the Theory of Conceptual Fields (TCC) by Gérard Vergnaud (VERGNAUD) was applied.), as a methodological proposal for the teaching of Physics using different investigative activities, such as: open laboratory, investigative demonstration, historical texts, the Celestial Chart, problems and questions raised with the use of technological resources, such as the Stellarium astronomical simulation programme.

As a research instrument, semi-structured interviews were applied to students from the 1st and 2nd years of High School at Escola Militar 2 de Julho, from the public network of the city of São Luís, in the State of Maranhão, Brazil, involved, in two moments: at the beginning – for a diagnostic evaluation; and at the end – during the assessment of the level of concepts presented by the students after the situations experienced according to the SEI. After the diagnostic evaluation, Astronomy classes began, totaling 10 classes lasting 50 min each class, where the importance of Astronomy was worked on in the classroom and outside it, through celestial observations, in order to make these formative moments stimulating and meaningful for the student. The celestial charts were made from the coordinates where the city of São Luís - MA, Brazil is located, an unprecedented work carried out and applied as an instrument for locating the stars and constellations.

II. THE THEORY OF CONCEPTUAL FIELDS OF GÉRARD VERGNAUD IN PHYSICS TEACHING THROUGH FROM THE STUDY OF ASTRONOMY

The theoretical framework used for the development of this research and data analysis is the CBT, by Gérard Vergnaud. This theory began its development in the 1980s, with the aim of improving mathematics didactics, explaining how the process of progressive

conceptualization of additive structures, algebraic relations, multiplicative structures and number-space relations occurs.

Gérard Vergnaud, born in 1933, is a French mathematician, philosopher and psychologist whose doctoral thesis was supervised by Jean Piaget at the end of the 1960s. by Vergnaud, especially with regard to the concept of “scheme” and “operating invariant”. The author seeks to redirect the Piagetian focus from the epistemic subject to the subject-in-situation.

Vergnaud's theory points out, about the role of cognitive structures, that there are competing conceptual points between Piaget's and Vygotsky's theories, since, in Piaget, knowledge can only be assimilated if mental structures are already formed, and in Vygotskian, knowledge can only be assimilated if mental structures are already formed. the structures are being built according to the degree of assimilation of the individual. The fact that Gérard Vergnaud was a student of Piaget ends up making him inherit a part of the concepts used in his theory. He recognizes the importance of Jean Piaget's theories, highlighting the ideas of adaptation, imbalance and rebalancing for research in Science and Mathematics didactics. However, he believes that the fundamental idea in Piaget's theory was the concept of schema, and that it ended up being used also in Vergnaud's theory (MOREIRA, 2002)).

On the other hand, Vergnaud recognizes Vygotsky's contribution when considering that Piaget did not work in the classroom teaching Mathematics and Science, and Genetic Epistemology becomes incomplete in dealing with school learning problems, as he argues (MOREIRA, 2002), on p. 22.

Gérard Vergnaud's CBT is a cognitivist theory that seeks to provide a coherent scenario, and some basic principles for the study of the development and learning of complex competences (information and skills), mainly those related to science and techniques, and whose main objective is to allow the acquisition of new knowledge and ruptures between preexisting concepts in children and adolescents.

Despite its origins linked to Mathematics, CBT has been used in other areas of exact sciences. Most Basic Education students have different degrees of difficulty in learning Mathematics and Physics, due to the complexity in understanding both subjects and in the practical application of their concepts.

For Vergnaud, the interrelationship between Mathematics and Physics serves as a teaching tool that presents a wealth of concepts, and which also serves as an aid for the study of Astronomy, since knowledge is organized into conceptual fields, whose domain by part of

the student happens over a long period, through experience, maturity, and learning, through different situations lived by him. Vergnaud defines Conceptual Fields as “An informal and heterogeneous set of problems, situations, concepts, relationships, structures, contents and operations of thought, connected to each other and, probably, intertwined during the acquisition process” (BAUER, CASSETTARI, & OLIVEIRA, 2017).

The CBT has its structure based on some key concepts, such as the concept of conceptual fields, schemas, situation, operational invariant (theorem-in-action or concept-in-action), in addition to the very concept of It assumes that the core of cognitive development is conceptualization, and that it is the fundamental basis of cognition. Therefore, all attention must be focused on the conceptual aspects of the schemas and the conceptual analysis of the situations, for which it is developed the scheme of each student in or out of school (MOREIRA, 2002), page 9.

Therefore, as has been said before, mastery of a CF does not happen in a few months or years. It should be studied over several years, so that students can effectively take ownership of them. The difficulties inherent to these problems should not be circumvented, however, students must try to overcome them as they are encountered and faced, gradually (MOREIRA, 2002).

In short, Gérard Vergnaud's CBT represents a neo-Piagetian cognitivist theory that aims to provide a coherent scenario and some basic principles for the study of the development and learning of complex competences, especially those related to science and techniques, considering the contents of knowledge themselves. and the conceptual analysis of its domain.

Although Vergnaud is a researcher in the didactics of mathematics and is mainly interested in additive structures and multiplicative structures, his theory of conceptual fields is not specific to mathematics. In Astronomy, there are several conceptual fields that cannot be seen as isolated concepts, but interrelated with other fields of scientific knowledge, such as Kepler's laws of motion, Newton's gravitation, the nature of light and others.

In the studies presented by Vergnaud, the idea of concept is presented as a complex system, formed by other concepts, as it can have different meanings, according to the context in which it is inserted. These concepts are being developed as the subject begins to represent them in different situations, as he makes the connection between the parts and the whole. The need to diversify situations establishes an important role in conceptualization, as it provides a basis for students to experiment with their models, in order to make them explanatory in different contexts, improving or reformulating them, when

necessary, as indicated by Vosniadou (1994) (VERGNAUD apud CARVALHO et al, 2007).

The ideas raised by Vergnaud on the concept of Conceptual Fields (CF) led him to argue that:

"1) a concept is not formed within a single type of situation; 2) a situation cannot be analyzed with a single concept; 3) the construction and appropriation of all the properties of a concept or all the aspects of a situation is a very long process that extends over the years, sometimes a dozen years, with analogies and misunderstandings between situations, between conceptions, between procedures, between signifiers (BAUER, CASSETTARI, & OLIVEIRA, 2017) page 68."

The study of Astronomy as a didactic and motivating axis, carried out in an interdisciplinary way for the learning of Physics contents in the classroom, converges with the idea conceived by Vergnaud of speaking in conceptual fields instead of studying the use of isolated concepts. Its definition for a Conceptual Fields (CF) encompasses the complexity of the subject in face of the situations experienced. So, in order for there to be a really meaningful learning, the student cannot observe Physics from the perspective of a discipline without practical meanings and disconnected from their daily lives, but schematize situations in connection with the teacher through formal or non-formal classes of the discipline of Physics, integrated with some conceptual fields that are studied in the context of Astronomy, such as: gravitation, optics, wave and electromagnetism, in order to make sense of the situations experienced by the student.

To study the development and use of a concept during the learning process or its use, it is necessary to consider the concept as a triplet of parts of a set formed by: Situations (S), Operative Invariants (I) and Symbolic Representations (R). This set formed as the foundation of a concept is based on a set of situations (S) that make the concept significant, linked by a set of operational invariants (I), which establish the concept and structure the forms of thought organization associated with a set of symbolic representations (R), which can be used in order to represent situations and ways of working with this concept.

The first set that represents the situations is the one referring to the concept; the second represented by the operative invariants is the signifier of the concept, while the third called “symbolic representations” is the signifier. A concept is, therefore, “[...] the act of facing situations, provoking the invariants and representing the situations and

concepts involved in it, thus configuring the idea of mobility towards a foundation” (CEDRAN, 2019), p. 67).

Most students who study Physics in High School are unable to establish links between what is taught by some teachers in the classroom, due to the difficulty they have in motivating and making that knowledge addressed meaningful to students, and also because they do not manage to build effective schemes that can explain a certain class of situations generated by some concepts implicit in the study of Science in Elementary School, and that will continue to generate comprehension difficulties in the discipline of Physics in High School.

With this, the teacher, when intermediating the study of Astronomy as CF to develop some concepts of Physics, generates in the student the possibility of building their own concepts and theorems explicit, and scientifically accepted, from an implicit knowledge. However, explicit concepts and theorems are a part of conceptualization; without the implicit part formed by the operative invariants, the explicit part would have no meaning. They are, as Vergnaud suggests, just the “visible tip of the iceberg” of conceptualization, highlighting that:

"There is not necessarily a hierarchy of competences. We understand, therefore, that in several situations that give meaning to a certain concept of a simpler or more concrete order, it can be applied more effectively in the solution of a certain problem than a more complex and abstract concept, depending on the type of situation encountered. This requires, on the part of the individual, not only the joint possession of competences, but the ability to use them properly. Since they depend on teaching-learning [...] between these two processes that is the action and understanding of solutions are didactic (LIMA & MOREIRA, 2005)"

In the field of scientific learning, the integration between different conceptual fields of science, using different forms of language, develops in the student a capacity for contextualization between the sciences. When studying themes about the Universe, the teacher can make use of a connection between numerous concepts from different areas of knowledge, to make it meaningful to students through situations generated inside and outside the classroom. This opportunity created for the students, generating the students' contact with the situations, expands their cognitive development, passing it from the domain of simple situations to more complex situations, since a situation cannot be analyzed through a single concept, the which implies a more generalized view of knowledge. This

kind of vision can contribute most significantly to their learning.

Situations are an integral part of the concepts since they function as a stage where the action is performed. So, situations are responsible for the meaning attributed to concepts. For Vergnaud, the teacher's task is to provoke situations that can make students organize the produced schemas and begin to master this set of lived and schematized situations, effectively giving meaning to the concepts and procedures they learn. But, on the other hand, it is the operative invariants that mediate between theory and practice, since it is the concepts contained in the schemas, concept-in-action and theorem-in-action, that allow the perception and obtaining of information from the student. In this way, these two expressions – concept-in-action (propositions held to be true about the real), and theorem-in-action (objects, predicates, categories of thought, pertinent and relevant to the situation) – are the operative invariants that make up the schemas.

Students learn in CBT that situations are like tasks that they have to complete at a given time. The meaning that situations acquire in this theory is completely different from didactic or learning situations. Its meaning implies that the student has to be challenged in his quest to acquire knowledge, so it is important to assign tasks in the classroom that improve the process of acquiring answers. These tasks show two fundamental ideas, which, according to Vergnaud (1996), are equivalent to the meaning commonly attributed by psychologists: the subject's cognitive processes and responses are a function of the situations experienced by him/her (LIMA & MOREIRA, 2005).

For Moreira (2002), a concept becomes significant if there are many situations in which it can be understood. Giving meaning to a concept means that it becomes a relationship between the subject and situations and signifiers. Especially, when a subject recognizes the meaning of a certain task (situation) or representation (signifier), there are indications that he has elaborated schemes, that is, he has organized his behavior in the face of the situation (MOREIRA, 2002).

A schema is a universal and efficient model in any class of situations, and can generate different sequences of action, collection and control of information, depending on the individual characteristics of each situation. These invariant forms of behavior organization can be expressed by the students and recognized by the teacher through the operative invariants (concepts-in-action and theorems-in-action), which constitute the conceptual part of the schemes, that is, adequate knowledge to select information and process it.

The main function of operational invariants is to collect and select relevant information, and infer useful consequences for action, control, and subsequent information capture. It is then a function of conceptualization and inference (CEDRAN, 2019) p. 73).

In CBT, cognitive development depends directly on the specific situation and conceptualization. The situation is a task, theoretical or empirical, that must be performed by the subject.

In his work, Gérard Vergnaud, unlike Piaget, sought to relate the subject to tasks and their possible solutions, rather than building a general theory for development. For him, cognition is directly linked to the situations involved, and its core is the construction of concepts, that is, conceptualization. Conceptualization is a process that takes time and requires a set of different situations (VERGNAUD apud CARVALHO et al, 2007).

To conceptualize and solve a class of situations, the subject organizes them into representations so that they serve as a link between the schemas, that is, the actions and their organization, generated by them and their conduct. The notion of schema is, according to Vergnaud, Piaget's most important contribution, and is defined as "[...] the invariant organization of behavior for a certain class of situations" (MOREIRA, 2002), p. 12. The concept of schema was introduced by Piaget, in order to supply the forms of organization, and therefore present a fundamental position within the CBT, as they act in the complementation of the idea of situation, being essential for the understanding of the relationship between situations and intellectual development (MOREIRA, 2002), p. 12.

The knowledge contained in the schemes (concepts-in-action and theorems-in-action) can be manifested according to the situation, implicitly or explicitly. The theorem in action is a proposition considered to be true, about the real; while the concept-in-action is a category of thought considered relevant, that is, it may or may not be adequate for a given class of situations. The concept-in-action is a category of thought considered true or not, so it has the status of object and others of predicates. However, a concept-in-action, defined as an object or predicate, does not allow inference, as Vergnaud points out, because it leaves no room for questioning. In this way, relationships are possible through theorems-in-action.

Cedran and Kiouranis (2019) state that one can have concepts-in-action, such as pressure, volume and temperature, which are deemed relevant or not, however,

"[...] when the volume of a container is reduced, with constant temperature, it depends on a theorem, or even, considering a situation, a theorem-in-action" (CEDRAN, 2019), p. 74. Similarly, these concepts remain, for the most part, implicit in the actions of the subject, and can become explicit through the mediation of a teacher whose function is to make them scientific concepts.

According to Vergnaud, the relationship between theorem-in-action and concept-in-action is dialectical and inseparable:

"The relationship between theorems and concepts is obviously dialectical, insofar as there are no theorems without concepts and no concept without theorems. Metaphorically, we can say that concepts-in-action are the building blocks out of which theorems-in-action are made and that the only reason for the existence of concepts-in-action is precisely to allow the formation of theorems-in-action. (true propositions), from which the organization of the activity and the inferences are possible. Conversely, theorems are constitutive of concepts, because without true propositions, concepts would be empty of content (VERGNAUD apud CARVALHO et al, 2007), p. 8."

The construction of knowledge by the student is not based on easy and identifiable processes of acquisition. On the contrary, it is slow, and presents continuities and ruptures in some cases. Prior knowledge is crucial for the progress of acquisition of some conceptual fields, but it can also be an impediment. Therefore, to rely on some previous knowledge, the student needs to identify it in advance, so that there is a rupture or not, on the part of this student, during the process of interaction with them.

This work proposes the characterization of Astronomy as Conceptual Fields (CF), and a didactic sequence was developed with the objective of analyzing how the use of the Celeste Chart¹ and computer programs, such as the Stellarium Software², can contribute to advances in the schemes of students in, using the elaborated didactic planning as a reference, whose activities are correlated with other CF, such as the discipline of Geography, Mathematics, Chemistry and especially Physics. The teacher must consider the scientific ideas that are being formed over a long period of cognitive development by the student, through these situations to which he experiences and

¹ A Celestial Chart (CF) is a map of the sky, which can depict the entire extent of the 88 existing constellations or a part of the sky, showing how it is seen from a certain region.

² Stellarium Software is a free open-source planetarium for your computer. It shows a realistic sky in three dimensions, as you would see it with the naked eye, with binoculars or with a telescope.

evidence in his knowledge until then implicit, and that are within the Zone of Proximal Development. (ZDP) of the student.

The teaching of Astronomy must make this transformation of implicit knowledge into explicit, progressively, and without underestimating or devaluing that knowledge already formalized by the student. Students cannot be expected to master a CF such as Astronomy, much less learn another CF such as Physics from studying one or two chapters of Astronomy in a few months, but that they will develop their own schemes through each situation experienced inside and outside the classroom, and with the mediation of the teacher so that they can promote fruitful learning situations, stimulating this subject-situation interaction, and that provide and add diversification to their action schemes, that is, to their cognitive development. Therefore, the foundations of this theory for teaching Physics through the study of Astronomy aimed at High School are crucial for the proposition and evolution of new knowledge relevant to students, and for a more complete, interdisciplinary didactics focused on their reality.

Thus, teachers can also use mental models that are nothing more than representative models made of theorems-in-action to help their students in the process of assimilating new situations. As the student appropriates more scientific knowledge, their mental models will necessarily approach scientific models. However, remembering that there will be a discard as these mental models reach their desired functionality, which will not occur in the case of schemas that, as explained above, represent the invariant organization in face of a certain class of situations.

In this sense, the potential of CBT in Astronomy for teaching and learning in Physics was glimpsed, especially in the applications of significant situations, and in the understanding of the conceptual development process, through the analysis of operative invariants. Although CBT in Astronomy reveals a vast literature, especially for mathematical and physical concepts, its approach is still little used in the classroom to understand the development of cognitive processes in other areas of science.

III. THE STUDY OF ASTRONOMY AND THE INTERDISCIPLINARY CHARACTER IN THE TEACHING OF CONCEPTUAL FIELDS OF PHYSICS

In the various teaching methods that are adopted in schools, some Physics teachers transmit verbally and in writing to students the CF of each curricular series, following a still traditionalist model and plastered that does not allow the student to be the protagonist of their own learning. By becoming a protagonist, the student breaks

with old pedagogical practices from the moment that the teacher also leaves this mechanistic model of scientific knowledge transmission in the past.

Langhi justifies in his book "Education in Astronomy", about the importance of including in the Basic Education curriculum the teaching of Astronomy as a CC with motivating potential, both for students and teachers, due to its interdisciplinary character capable of generating a minimally acceptable training. in the participants of this educational scenario. The study of Astronomy is capable of deepening knowledge in several areas of knowledge, especially by diversifying Physics classes in different classroom environments (LANGHI & NARDI, 2012), p. 108.

Teaching Astronomy in an interdisciplinary way with the other sciences have motivating characteristics, as they allow the student a great aesthetic pleasure linked to science, as well as providing the pleasure of understanding a little of the Universe, with explanations through conceptual fields linked to disciplines, which, in the student's conception, did not have any link with each other. But that, like the other sciences, it must be understood as a process of knowledge production and a human, historical activity, associated with aspects of a social, economic, political, and cultural order, and not as the school presents it, namely, a set of timeless and neutral knowledge, without political and cultural ties (LANGHI & NARDI, 2012) p. 141.

With the objective in order to provide practical learning of content related to Astronomy, the PCN emphasize the need for practical activities, and prepared visits to observatories, planetariums, associations of amateur astronomers, astronomy and astronautics museums. This way of experiencing Astronomy provides a differential during your learning. The teaching of this science can be based on the great potential existing in establishments located throughout the national territory, making it different from the contents taught in school subjects, which leads to the possibility of strengthening relationships between communities: professional astronomy, amateur astronomy and school (LANGHI & NARDI, 2012). However, although the PCN recommends that Astronomy be taught in Elementary School, there is no record of any public school in Maranhão that performs this integration with other Basic Education subjects and, in particular, with Physics.

Astronomy as a science switch from the possibilities of interaction between sciences, in addition to the interdisciplinary character, the contents of Astronomy can still provide students with a less fragmented view and with an integrative function of knowledge (DIAS, 2008). In addition, it allows the student to have a real and

observational experience of concepts explained only through brushes and boards inside the classroom, which makes challenging questions and exchanges of knowledge about CC of Astronomy, which are explained through the use of formulas and concepts of Physics, Chemistry, Geography, Biology, Mathematics, among others.

As a sample of this interdisciplinarity, there is the technological evolution that the study of Astronomy provides in several areas of scientific knowledge. For example, the development of antennas, mirrors and new telescopes such as the James Webb, which replaced the Hubble telescope, has made it possible to monitor space and the Earth itself, facilitating research in the areas of space sciences, telecommunications and geosciences, in addition to assisting in some areas of medicine, such as ophthalmology (DIAS, 2008).

The thematic axis “Earth and Universe”, which covers subjects related to Astronomy, is linked to the area of Natural Sciences and its Technologies, where the objectives are related to the student's degree of maturity. In Elementary School, third cycle students already have mastery over written and spoken language, as well as the ability to create hypotheses about the natural phenomena they observe. In High School, the student is able to assimilate knowledge through the abstract, advancing in the process of acquiring new scientific knowledge, which allows the student to develop activities such as explaining the functioning of the world, solving problems, planning, evaluating human-nature interactions. and develop explanatory models for technological systems (DIAS, 2008).

The contents proposed in the National Curricular Parameters (PCN) (PCN, 1997), referring to the third and fourth cycles, which correspond to higher elementary education, address astronomy topics to which they need competences within the teaching-learning process, they are:

- History of Astronomy of ancient peoples, such as China, Babylon, and Egypt.
- More recent histories from the Greeks to Newtonian astronomy, with an emphasis on the opposition of the heliocentric and geocentric models.
- Sun-Earth System: movements of the star, eclipses, phases of the Moon, seasons of the year, tidal phenomenon, among others.
- Solar System: study of the star that compose it, evaluation of the size and distance of the planets in relation to the Sun.
- Shadow theory: study of the apparent movement of the Sun, construction of a sundial.
- Notion of Galaxies: positioning of the Sun in the Milky Way.
- Introduction to Cosmology: Big Bang Theory, the origin, expansion, and size of the observable Universe.
- In High School PCN+, it is necessary to learn Natural Sciences in the area of Physics, the structuring theme “Universe, Earth and Life”, which is composed of the following thematic units:
 - Earth and solar system:
 - Knowing the relationships between Earth movements, of the Moon and the Sun for the description of astronomical phenomena (duration of day and night, seasons, phases of the Moon, eclipses, etc).
 - Understand gravitational interactions, identifying forces and conservation relationships, to explain aspects of planetary system motion, comets, spacecraft, and satellites.
 - Universe and its origin:
 - Know the theories and models proposed for the origin, evolution, and constitution of the Universe, in addition to the current forms for its investigation and the limits of its results in the sense of expanding its vision of the world.
 - Recognize orders of magnitude of astronomical measures to locate life (and human life), temporally and spatially in the Universe and discuss the hypotheses of life outside Earth.
 - Human understanding of the Universe.
 - Know aspects of explanatory models of the origin and constitution of the Universe, according to different cultures, looking for similarities and differences in their formulations.
 - Understand aspects of the evolution of science models to explain the constitution of the Universe (matter, radiation and interactions) through time, identifying specificities of the current model.
 - Identify different ways in which explanatory models of the Universe have influenced culture and human life throughout of human history and vice versa.

According to the reform of the new High School, which is being applied as of this year in all schools, the student must be the protagonist in the process of building knowledge, having his teacher as a mediator in the process of promoting conceptualization, that is, the student must have a mastery of the concepts involved in a broader and

closer way to the scientifically accepted concepts. The current school model is based on the BNCC, which has the specific competence of the natural sciences and their technologies: to analyze and use interpretations on the dynamics of Life, Earth and the Cosmos to elaborate arguments, make predictions about the functioning and evolution of living beings and the Universe, and to support and defend ethical and responsible decisions.

In this specific competence, conceptual knowledge related to: the origin of Life; to biological evolution; to the fossil record; to exobiology; to biodiversity; the origin and extinction of species; environmental policies; to biomolecules; to cellular organization; to organs and systems; to organisms; to populations; to ecosystems; to food webs; to cellular respiration; to photosynthesis; to neuroscience; to reproduction and heredity; to Mendelian genetics; to epidemiological processes; to the electromagnetic spectrum; atomic, subatomic and cosmological models; to Astronomy; to stellar evolution; to gravitation; to Newtonian mechanics; the weather forecast; to the history and philosophy of science, among others.

This competence has as one of its skills to elaborate explanations, predictions and calculations regarding the movements of objects on Earth, in the Solar System and in the Universe based on the analysis of gravitational interactions, with or without the use of digital devices and applications. In addition to analyzing stellar evolution, associating it with the models of origin and distribution of chemical elements in the Universe, understanding their relationships with the conditions necessary for the emergence of solar and planetary systems, their structures and compositions and the possibilities for the existence of life, using representations and simulations, with or without the use of digital devices and applications (such as simulation and virtual reality software, among others) (BRAZIL, 2018)

This work becomes potentially significant by making use of Physics concepts through immersed CC in the study of astronomy. That is, the teacher encourages students to create their own concepts from new methodologies applied in the context of classes held in open environments, so that they can make astronomical observations using the Celestial Charts, and associating with CC of Physics, such as: gravity, distances, forces, and speeds. These Charts are considered celestial maps that serve to identify and locate astronomical objects in this immense laboratory called “sky”, in addition to being considered an important didactic resource to make Physics classes more meaningful.

The methodology presented in this work is of a qualitative nature. For Minayo (MINAYO, 2009), the important thing about qualitative research is objectification,

because during scientific investigation it is necessary to recognize the complexity of the object of study, critically review theories on the subject, establish relevant concepts and theories, use collection techniques of adequate data and, finally, to analyze all the material in a specific and contextualized way.

Objectification helps to ward off the excessive incursion of value judgments in research: it is the appropriate methods and techniques that allow the production of acceptable and recognized knowledge (MINAYO, 2009).

In order to obtain the data, the following collection instruments were used: semi-structured interview with closed questions, assessment carried out by the students on the elective given, construction of Celestial Charts with the students and socialization through observations using these Letters.

Therefore, this work uses the observational method, which according to Gil (2008) (GIL, 2008) the observational study only analyzes something that happens or has already happened. In this way, this research is characterized with the observational method, as it developed observations of the celestial constellations.

From the point of view of the nature of the problem, qualitative research was chosen precisely because of this critical nature, using techniques to collect the data necessary for students to start building their own Charts, and understand how to use them according to their needs. the day and time they had to adopt during the elective called “Discovering the Universe”.

The Astronomy course, the construction of the Celeste Chart and its use in formal and non-formal classes were carried out through the elective courses that at IEMA constitute the “Diversified Part” of the curriculum and have a fundamental importance in order to assist and complement CC that are part of the BNCC and cannot fail to be taught during High School. However, these electives are exposed to students at a time called “Feirão das Eletivas”, where the subjects can be chosen by each student, according to their affinity and the number of places available. Thus, only nine students enrolled in this elective course offered.

In the construction of this Celestial Chart, which was carried out in a period prior to the Astronomy course taught during the execution of that elective, the stars that make up the zodiac range were selected: Pisces, Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius, Capricornus and Aquarius. In addition to these, others constellations were chosen – to compose this work –: Orion, Fornax, Perseus, Lepus, Canis Major, Vela, Centarus, Serpens, Bootes, Octans, Hydra, Crux, and ending in a separate Celestial Charts, referring to the constellation of

the Tupinambás Indians of Maranhão, known as the “Old Man Constellation”.

It is worth mentioning that the calculation for any star is equivalent, so only the star “Beta Crux” (Mimosa) was selected, constituting the constellation known as “Southern Crux”, to perform the calculation from the latitude of São Luís. Maranhão, since for the other stars the calculations follow the same pattern, changing only the right ascension (α) and declination (δ), which are constant during some periods for each star.

Data collection, analysis and interpretation of the results of this research were carried out at the Instituto Pleno Professor Doutor João Bacelar Portela, therefore, setting up field research.

With the right ascension in hand and following the studies by (JUSTINIANO & BOTELHO, 2016), it was possible - through these equatorial coordinates - to calculate the hour angle by summing the declination with the calculated local sidereal time of each star. One of the composite stars in this Chart and concluding with the calculation of the altazimuth coordinates (azimuth and altitude).

From the result found for the horizontal coordinates for the calculated star, in this case Beta Crux, a comparison was made with the Stellarium program. where it can be observed that the values of Az and h, determined in this research, are compatible with those of the software, but with a difference of less than one degree, both for the azimuth and for the altitude. This confirms the argument that, as this simplified method does not take into account the periodic corrections of the coordinates, it is possible to build the Celestial Chart.

The values of Az e h for the Beta Crux star, found in this research, are $155.691148235^{\circ}/15.9440372936^{\circ}$, and when compared with the values obtained in the Stellarium Software literature, there is $155.4527777778^{\circ}/15.3083333333^{\circ}$, resulting in a difference of less than 1° (one) for both horizontal coordinates.

For this purpose, SEI was developed with the 1st year of high school in the form of remote and face-to-face classes, leaving the possibility of participation for students from other high school grades. This decision was thought based on the contextualizing character of Astronomy, as a CC for teaching Physics.

Both the students of Colégio Militar 2 de Julho and the students of Colégio Pro. Dr. João Bacelar Portela participated in the OBA and ONC. The OBA is held and organized annually by SAB in partnership with the Brazilian Space Agency (AEB), being an event open to the voluntary participation of students from any school

network. While the ONC is an event held by the Ministry of Science, Technology and Innovation (MCTI) of the Federal Government and is open to the participation of any student from the school network. In both events, demand from students was still small, and the results, consequently, are not expressive in Maranhão.

The application of this sequence aimed to improve student participation inside and outside the classroom when studying concepts and theories in Astronomy, which requires knowledge of Physics as a tool for the clarification of some celestial phenomena. The central idea was to bring the study of the Universe to the classroom universe, and its learning possibilities through schemes developed by the students, as well as the different situations that might or might not make sense at the moment, but that over time become scientifically constructed concepts and theorems.

In this context, what was proposed in this work is an improvement of Physics classes, making them more dynamic through the contextualization with the study of Astronomy and the pedagogical moments that are contained in SEI, such as: classes, celestial observation activities with the use of the Stellarium program, geographic orientations and use of the Celeste Chart to observe and locate stars and constellations in the sky, in addition to encouraging participation in scientific knowledge Olympics.

During the application of the SEI, methodological interventions were made in concepts such as: gravity, movements, astronomical coordinates, stellar projections in the plane, stars and constellations. The role of the teacher in this phase was fundamental to intermediate this teaching-learning process, offering situations that generate new concepts, in order to cause ruptures between knowledge based on common sense and scientific knowledge from the relationships that were obtained between different concepts. formulated during this process.

This work considered only the calculation of the stars, not taking into account the planets of the solar system, because, unlike the stars that have constant equatorial coordinates due to their relatively large distance, the stars that make up the solar system - such as the Sun, Moon and the Planets - are relatively close and, therefore, have variable equatorial coordinates over time. For the planets of the solar system, at each moment of observation these coordinates need to be recalculated through a procedure that was not described in this research.

The research is characterized as observational, as it deals with the construction and observation with a Celestial Chart in order to make Physics classes really meaningful, through the study of Astronomy. For this, active methodologies were used, which, according to Morán (2015) (MORÁN, 2015), are ways to advance further in

deep knowledge, socio-emotional skills and new practices, such as hybrid learning.

This research contributed by providing the student with a methodology that, according to Morán (2015), combined face-to-face learning during the Astronomy course, associating it with remote classes when it was not possible to be present at school, allowing students freedom to learn online. online or in the classroom with colleagues, and with the teacher as a mediator of this teaching-learning relationship.

Thus, during the development of the "Discovering the Universe" elective, we sought to encourage students to establish a dialogue about the proposed observation activities using the Celestial Charts, and on how to carry them out, since the use of technology made it possible to observe the sky even during the day, showing the need for students to have ample access to technologies, regardless of their economic situation. In other words, Morán (2015) shows that a student who is not connected, and without the digital domain, misses important opportunities to inform themselves, to access rich materials available, to communicate, to become visible to others, to publish their ideas. and to increase their possibilities through professional training in the future. We put in the appendix the unpublished figures of the letter from approx. (-2.5632, -44.3140).

3.1 APPLICATION OF THE DIDACTIC SEQUENCE

The application of the didactic sequence took place at Escola Dr. João Bacelar Portela, belonging to IEMA, located at **Rua Jorge Damus, s/nº**, in the Ivar Saldanha neighborhood, **São Luís, Maranhão, with the proper authorization to carry out the work provided by the general manager as shown in AppendixB**. This school has five classes of 1st, 2nd and 3rd scientific year with capacity for 40 students, working in the morning and afternoon shifts, in the full-time school model, and has as Pedagogical Manager Prof. Me. José Jorge de Carvalho Marvão, and General Manager Prof. Dr. Manuel dos Santos Costa.

The class chosen at this school, to participate in the Astronomy classes and use of the Celeste Chart, was formed according to the students' registration in the elective entitled "Discovering the Universe", where only 1st year students chose to participate. of this elective. It is worth mentioning that, as Astronomy has an interdisciplinary character, any student from the three grades of High School could participate in the course. However, the adhesion at the beginning was very good, however, in addition to not entering Google Meet to attend classes, for several reasons, when returning to the face-to-face model, the course had only nine students enrolled, but the teacher left it open for

anyone who wanted to participate in classes, which at first yielded a reasonable audience of students.

Image 1 – Full-Time School Dr. João Bacelar Portela (IEMA)



The choice to carry out the research with these students was motivated by being at the school as a Physics teacher of the 1st year, and by knowing that exactly this public that is starting high school has not had any contact with astronomy in elementary school.

Before starting the Astronomy course, on November 6, 2021, a semi-structured survey was carried out, still in the midst of the Covid-19 pandemic, in order to assess students' prior knowledge on topics related to Astronomy, exploring the question of movements, the number of constellations, number of planets that make up the Solar System, as well as the name of the closest star to Earth after the Sun, and if they knew how to locate themselves geographically according to the region; however, only nine responses were returned.

The collected data were analyzed through graphs and tables, showing the existing relationships in the proposed inquiries. The semi-structured interview consisted of 10 multiple-choice questions, where only one was the correct answer, and was applied remotely.

This initial assessment was essential to know the ideas that the students had on the subject, and so that the teacher could outline a direction to be followed in the next classes, because, as Zabala (2008) (ZABALA, 1988) asserts, the knowledge that each student knows, knows how to do it and how it is, it is the starting point that should allow – in relation to the objectives and learning contents foreseen –, to establish the type of activities and tasks that have to favor the learning of each student.

At the first meeting, after the basic knowledge test held on September 15, 2021, the course was presented in the form of an elective that would be taught, and its importance as a basis for learning in dialogicity, and more interdisciplinary for students. Thus, the theme "Solar System and its components" was worked on. At that moment, their formation made up of eight planets was explained, as seen in Figure 2, dozens of natural satellites, thousands of asteroids, meteors, meteorites and comets that

orbit around a star, and what keeps them trapped in these orbits. and its implications here on Earth, as well as the idea of what light-years mean as a measure of distance and what an astronomical unit means. In addition, the theory of geocentrism was very defended for years, and heliocentrism ending with the apparent movement of the stars.

On October 1, 2021, the second class was taught online, on the solstices and equinoxes, where it was explained that these two astronomical phenomena mark the beginning of the seasons, showing that they are directly related to the incidence of solar rays and the inclination of the Earth, and that due to its position in relation to the Sun, it receives these solar rays on its hemispheres differently. Therefore, the idea that students have about rotation and translation movements was evaluated, followed by a video that was transmitted to them so that they could discuss and determine the difference between them. After watching the video, they were questioned by the teacher about why the Moon always has the same face every night, regardless of the location of observation. The students did not know how to answer, denoting a total lack of knowledge about one of the most basic topics in Astronomy. Showing that the time it takes the moon to complete a revolution around the Earth is equivalent to the time it takes to complete a revolution around itself and, thus, the same face of this star will always be seen.

There was a brief conversation about how many motions the Earth has, and many responded that there are only two types of motion. The professor explained that, in fact, the Earth has 1 single type of movement that can be decomposed, according to some criteria, into more than 110 components currently observed, however, the best known are rotation, revolution and precession, explaining how long it takes every move.

Thus, the teacher can explain to the students that each night is slightly different from the night before, and only after a year will the night be exactly the same again, with the same stars in the sky rising and setting at the same time. Therefore, as the Earth performs its translation movement in 365 days and six hours, only after four years will the night be exactly the same, always considering the same observation time. Associated with each explanation, the students were asked to download the Stellarium program, which was presented to the students, where some initial features were exemplified, such as the simulation of the Earth's rotation, as seen in image 3, below.

In the third class held on October 15, 2021, still online, Kepler's Laws and their implications were worked on, such as the importance they have for alignment of planets and their influence such as the effect of tides, or even the alignment between planets that only occur over very long

periods. It was finalized with Newton's Law of Universal Gravitation, and its difference to gravity established by Albert Einstein. Added to this class was a video broadcast for better understanding of students. It was explained to the students, briefly, that in the process of building the Celestial Chart, both Kepler's Laws and Newton's Gravitation, as seen in Image 4 below, would not be important in this construction process; however, in the course of the night, over time and months, it was noticed the change of position of some constellations, and this is due to the rotation and translation of the Earth. It was explained to the students that there is a CC that is not explained in High School, and is not treated in Physics textbooks, but that has fundamental importance in the construction of the Charts that are the astronomical coordinates.

This is a failure carried throughout High School, as the teacher teaches concepts such as force, velocity, acceleration, references, but does not teach the student to understand what a celestial sphere is, astronomical coordinate systems, spherical trigonometry, and so on. Student fails to understand the concepts that are worked on in the OBA, ONC and OBF, as they are unaware of these conceptual fields of scientific knowledge.

In the fourth class, held on November 3, 2021, in the ace-to-face model, it was about Solar and Lunar Eclipses, where we had the opportunity to show students the idea about the phenomenon of the cone of shadow, self-shadow, projected shadow and penumbra, explaining why the moon is reddish during a total eclipse, and demonstrating the phases of the moon, and why you can't see its other side, as seen in Image 2, below, and why it was precisely an Eclipse that was important to prove Einstein's theory of relativity.

The students questioned a lot about the Lunar Eclipse phenomenon, where the teacher had the opportunity to explain to them that this Eclipse always happens at the full moon, as it is at this stage that the Earth is positioned between the Sun and the Moon (*Image 5*). However, emphasizing that this phenomenon does not occur throughout every month, because the Moon's orbit around the Earth is not in the same plane as the Earth's orbit around the Sun.

The phenomenon of the "Blood Moon", much admired by all, was explained to the students that this phenomenon used to disturb the indigenous peoples a lot, since in the tribe of the Tupinambás Indians there was a belief among men that they would die, and this was reason for much joy, because, in their conception, they were going to meet their ancestors, while women and children cried in fear of death. And that "Blood Moon" is just the name given to this phenomenon due to the appearance of the moon that turns reddish, when the Sun, Earth and Moon are in perfect

alignment, with the Earth at its center. The Solar Eclipse only happens when the Moon is in the new phase, because it is in this phase that the Moon is arranged between the Earth and the Sun.

Image 2 – Class on Solar and Lunar Eclipses



On December 1, 2021, the fifth class regarding the Astronomy course was taught, and the class where the teacher taught how to work with the Stellarium program was continued, as seen in Image 6, to make observations of stars, constellations, how to adopt different references for the visualization of a certain astronomical phenomenon, how to insert latitudes and longitudes of their region for an observation regarding the sky of the student's city. It is worth mentioning here that there were difficulties on the part of the students, given that, in some cases, their cell phone did not have enough space, in other cases the student did not have a cell phone and, the vast majority, did not have a computer that could work at that time. This ended up disturbing the progress of the Stellarium course a little, however, it was not a reason to stop activities.

The teacher shared with his students why some constellations are visible, and others are not in the celestial sphere, and the appearance that each of them has, in addition to the apparent movement they make in the celestial sphere throughout the night, and where they will be during the night. day using the Stellarium program. This made it easier for students to visualize some constellations, without having to wait for dusk to visualize the constellations again. It was discussed with the students that the area of the sky that corresponds to that located between the tropics of Cancer and Capricorn corresponds to the band of the zodiac, and is where, apparently, the Sun, Moon and planets move throughout the year. This apparent view of the movement of the Sun was discussed with the students, since it is the rotation of the Earth that influences the position of the Sun throughout the day, until its setting on the West side.

Students were shown how this program simulates a planetarium that is usually quite expensive for a school to purchase, and the issue of some concepts such as celestial sphere, azimuth, ecliptic, and geographic coordinates. In teaching about precession, it was shown that the ecliptic

crosses the equator, forming an angle of approximately 23.5° , and that the crossing point is known as the “Aries point”, however, due to precession, this point changes over approximately 26,000 years.

Image 3 – Class on the use of the Stellarium Program



In the sixth meeting, which started on December 15, 2021, there was talk about the constellations and how to locate them in the celestial sphere. In order to find a particular constellation, the teacher had to teach the student, first of all, to find himself geographically, and soon afterward relations of proximity were established with others already known, from Southern Crux. By obtaining this observational knowledge, the student was able to understand how ancient scholars observed the sky, establishing relationships with observations made today with the use of optical instruments or even Celestial Charts. The apparent movement of the stars in the celestial sphere was discussed.

Firstly, it was explained that, for the purpose of studies on the stars, a perfect sphere was adopted, where the Earth would be immersed within this sphere, and in which it is called the "celestial sphere", which is the place of the projections of the stars, and where one has the impression that they are all at equivalent distances from the horizontal plane.

Then, the class continued talking exactly about the impossibility of seeing stars during the day, and that this is a consequence of the strong light coming from the Sun, in addition, the dispersion of solar rays in the atmosphere, which make it impossible to see any star during the day, except for the Sun itself. Students were taught to determine the cardinal points simply by observing a few constellations, asking them to do this at home, and then looking for a constellation that always appears on the southern horizon. This class ended by showing how many planets make up the Solar System, some of their properties and their respective natural satellites – if they have one –, as seen in Image 7, below.

Image 4 – Class on the constitution of the planets of the Solar System



In the seventh meeting, held on December 16, 2021, the class started talking about the constellations, which actually represent 89 areas in the celestial sphere, and they are not just those stars that form images in the sky. There was talk about their names and their respective abbreviations, and about the body that defined, in 1930, this division of the sky into constellations, with 52 constellations in the northern sky, of which 12 are zodiacal and 36 constellations in the southern sky.

Thus, we began to teach how to find the equatorial coordinates in the Stellarium program, and the calculation for the chosen star, which in this case was Beta Crux, began. Previously, JD, S, TSS, sidereal time at Greenwich and TCL were calculated. At that moment, so that it would not be too tiring, this meeting was divided into two moments, that is, the calculations of the Charter were continued in the eighth meeting. But, before the end of the class, the Origin program was presented to the students, and it was commented that this type of graph that would be created was of the polar type, and that it needed other types of coordinates so that it could be built. It was shown how to assemble the data of a single constellation, and that it would be necessary to visualize the connection points of each star to form the image that was needed, according to the image formed by Stellarium together with the information of the constellation by the image platform of the Google.

Immediately after this action, and combining the output and arrival coordinates, each pair of coordinates to be linked in the program was always set in lines, as seen in Image 5 below, so that after forming the image of a single constellation, merged them all into a single graph. The professor explained that the Charter's function was celestial observation to understand the movement of constellations throughout the night. As this activity was not performed at night, but during the day, the students used Stellarium to advance the time and simulate the night of that specific day, or even over the months.

Image 5 – Calculation of the Celestial Chart



The calculation of the Celeste Chart in the eighth meeting was carried out on December 18, 2021. This day was a school Saturday for the students, in which the work could continue. In this part, collective work was prioritized, gathering students into groups where they could share knowledge with those who presented a little more difficulty.

The students continued the Celestial Chart calculations based on the teacher's teachings, and they find it very difficult because they are not used to working with equatorial, hourly and horizontal coordinates. In addition, many astronomical terms such as ecliptic, TSS, sidereal time, azimuth were still a barrier, which was only overcome from the Astronomy elective.

The objective of this eighth meeting was, after learning the Stellarium program, to put into practice the observations of the stars and constellations together with the use of the Celestial Chart, in order to become familiar with the 88 existing constellations, and also to make observations of the alignment of some planets, as is the case of Jupiter and Saturn, in addition to identifying the different types of objects visible in the night sky, seeking to encourage the student to bring to their universe a little of the dynamics that is appreciated when looking at the sky at night, and compare with the Celeste Letter that they helped to build in partnership with the teacher. It is logical that the time was not enough to complete the construction of the Celestial Chart in the classroom, however, the calculations of the azimuth and altitude for the star Beta Crux were completed.

The students were taught to use the Origin Software, and to enter the data in the program, however, it was not very successful at this point due to the difficulty of all having notebooks, as seen in Images 8, 9 and 10.

During the conversations, there was talk of the behavior of some stars that have variable equatorial coordinates, as is the case of the planets, however, that the Sun, unlike the other stars, also does not have, and varies from day to day. Each day the Sun moves one degree in relation to the stars. And that if it were possible to see the Sun during the day, and in this case you can through the Stellarium, you can see the Sun apparently walking through the constellations. And

that after a year, the Sun returns to the same position, in relation to the stars of the celestial sphere.

Image 6 – Construction of the Celestial Chart



Image 7 – Construction of the Celestial Chart



Image 8 – Construction of the Celestial Chart



In the ninth meeting, held on December 20, 2021, a brief review of the implications of studying the celestial sphere was carried out. The students were invited to the schoolyard and observed that for this study it is necessary to determine all the movements of the Earth previously taught, as seen in Image 9, below. It is possible to determine the coordinates of each place and, therefore, make a survey of terrestrial maps, today with the aid of GPS. Another implication would be to determine the measure of time that is needed to determine the passage of the constellations in that time interval. And it could be shown that, with the help of Stellarium, it is possible to calculate the distance of the closest stars or any other, simulating the appropriate moment that one would like to calculate.

It was shown, with the help of Stellarium, the apparent path that the Sun makes called “ecliptic through the celestial sphere and the point”, where it and the equator meet called “equinoctial points” or “equinoxes”. At one point it was shown that the point at which the Sun passes from the Southern Hemisphere to the North is known as the “spring

equinox” or “ γ point” (gamma), and that the other, diametrically opposite, is known as the “autumn equinox”, or “ Ω point” (omega). The students had the notion that the first is the starting point for counting angles when it is necessary to determine the positions of planets or stars in the sky, and that the points of the ecliptic that are furthest from the equator are known as solstices (summer and winter). Therefore, they are the points where the Sun is more to the South or to the North.

At the tenth meeting, held on December 21, 2021, it was a matter of putting into practice, outside the classroom, everything that was studied in the classroom, and which generated moments of intense debate, especially on the movement of the celestial constellations. These apparent movements were still unknown to the students, as they had always heard of Earth movement. They ended up alluding to the motion of the stars as equivalents. However, despite knowing that the stars have movement, like everything else in the Universe, these movements are neglected due to the distance they are from Earth.

Image 9 – Non-formal meeting for observation using the Charts and Stellarium



It was explained to the students that this apparent diurnal movement of the constellations is due to the rotation of the Earth, that is, rising in the East, moving until it disappears in the West, and that every two hours a constellation is born in the place where the first one was born. Just as it is due to the translation that when observing with the Celestial Charts for the same region of the Earth (North, South, East or West), one has the vision of different constellations throughout the months of the year if observed at the same time. , and that because of the Earth's translation, the Sun, with respect to the stars, seems to move from West to East, and that because of the Moon's translation around the Earth, the Moon, with respect to the stars, appears to move from West to East, because the Earth's motion rotates towards the right hand, while the celestial sphere rotates towards the left hand.

In addition to all this study on the stars, observations were made concomitant with the use of Celestial Charts, observations of indigenous constellations (especially that of the Old Man), and the use of the Stellarium software, in

order to familiarize them with this important product. educational, which served as a motivator for discussions and learning about Astronomy using Physics, and for explanations of some celestial phenomena, as seen in Images 12 and 13.

Image 10 – Discussions and learning about Astronomy using Physics to explain some phenomena



entitled “Discovering the Universe”, the last semi-structured research was carried out, to evaluate what the students were able to assimilate and learn, in a way that serves the educational development of each of them, and that they can apply this learning throughout their school years and during the scientific olympiads.

IV. PRESENTATION AND ANALYSIS OF RESULTS

This section aims to present the results obtained during the Astronomy course through the elective entitled “Discovering the Universe”. This didactic sequence was designed for 12 classes, where the first and the last are semi-structured research, with the purpose of evaluating previous knowledge and those acquired by the Astronomy course. The initial semi-structured research evaluated the students' previous knowledge about the CC addressed in each question, while the final questionnaire evaluated the students' evolution when using these astronomy concepts to structure their scientific knowledge and reformulate in an interdisciplinary way with the Physics discipline.

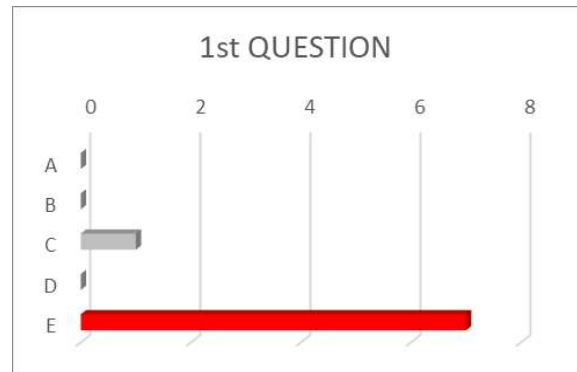
4.1 Results of the Semi-Structured Diagnostic Survey

The semi-structured survey included a diagnostic assessment consisting of 10 basic questions as shown in Appendix C, and a final assessment at a slightly more elaborate level also consisting of 10 Astronomy questions as shown in Appendix D. The answers will be presented in the form of a bar graph, where the green bar represents the correct alternative. In both surveys, only eight students participated, which made the research universe a little more restricted, however, it shows the need for urgent changes in the training curriculum of Elementary and High School, as shown in the graphs below.

1 Which science is responsible for studying the universe, stars and celestial bodies, in order to explain their origin and movement?

- a) Physics
- b) Chemistry
- c) Astrology
- d) Philosophy
- e) Astronomy

Graph 1 – Answers to the 1st question

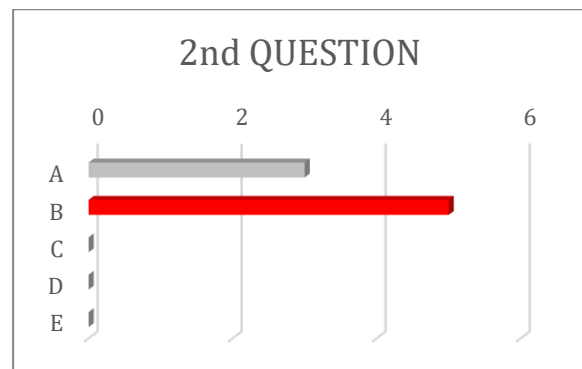


In this first question it can be seen that even today some students confuse Astronomy with Astrology. Currently, modern science does not define Astrology as a science, although it has been widely used in the past by the kings of the time to justify some astronomical phenomena. This kind of conceptual misconception would be easily eradicated if high school teachers had some continuing education in Astronomy.

2 What is the equivalent of what the Earth describes around the Sun, that is, its orbit?

- a) Rotation
- b) Revolution
- c) Precession
- d) Revolution
- e) Nutation

Graph 2 – Answers to the 2nd question

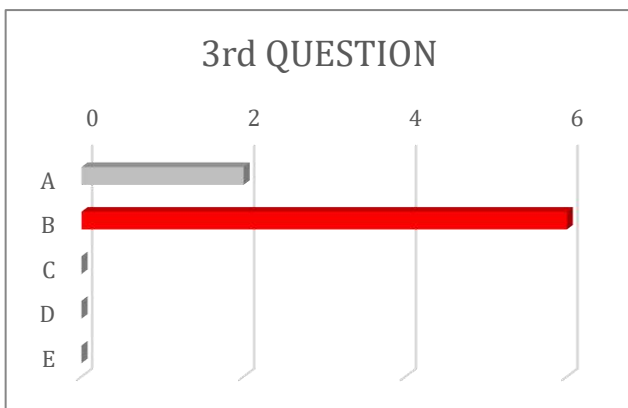


It can be seen, in this second question, that many students still confuse translation (which is the movement of the Earth around the Sun) and rotation (which is the movement of the Earth around the Sun of its own axis). This implies a serious conceptual error, because if they cannot discern about these two concepts, they will consequently have difficulties in understanding the movement of stars and constellations, or even could not understand why different constellations appear in the place where the Sun sets along of months.

3 *Astronomical phenomenon that occurs whenever the Earth is between the Sun and the Moon, exactly on the line of intersection of its orbit with that of the Moon, the so-called "line of nodes", and whenever the Moon is in the full phase, it is known as?*

- a) Solar Eclipse
- b) Lunar Eclipse**
- c) Southern Eclipse
- d) Eclipse Space
- e) Eclipse Stellar

Graphic 3 – Answers to the 3rd question



In this third question, the graphical analysis shows that there is a methodological deficit in the teaching of Physics, because even today students cannot understand the Lunar Eclipse phenomenon, and that through computer programs, such as Solar System Scope or even Stellarium, students will be able to more easily understand the Physics behind the phenomenon, such as the astronomical event shown here by Figure 39.

Figure 39 – Lunar Eclipse of the 15th of December May 2022

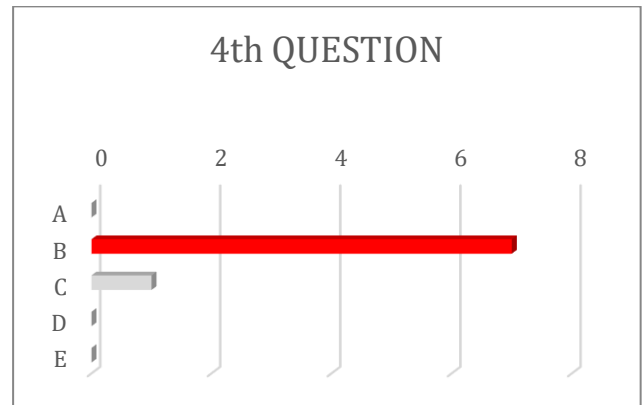


Source: Solar System Scope Program (2022)

4 *Why does the moon have a different phase (appearance) each night?*

- a) Because the Earth revolves around the Moon
- b) Because the Moon revolves around the Earth**
- c) Because the Moon passes in the Earth's shadow
- d) Because the Sun revolves around the Moon
- e) None of the previous answers

Graph 4 – Answers to the 4th question



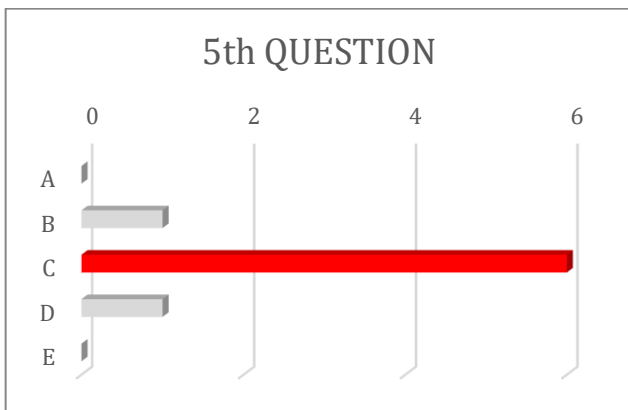
This fourth question demonstrates that even with most having got the answer right, it is necessary to reinforce contextualized classes with astronomy themes, so that the few students who got it wrong can understand that the Moon maintains a translational movement around the Earth, and the Earth around the Sun, and during these movements there will be a moment when the Earth will be placed between the Sun and the Moon, which will consequently cause the Lunar Eclipse, which is nothing more than the shadow of the Earth projected on the Moon.

5 *Planets in the Solar System can be classified according to their composition. Based on this classification, it can be said that we have:*

- a) 5 rocky (Mercury, Pluto, Mars, Ceres, Neptune) and 3 gas (Uranus, Saturn and Earth)
- b) 3 rocky (Pluto, Ceres and Earth) and 4 gas (Mars, Uranus, Neptune and Mercury)
- c) 4 rocky (Mercury, Venus, Earth and Mars) and 4 gas (Jupiter, Saturn, Uranus and Neptune)
- d) 6 rocky (Pluto, Mars, Ceres, Neptune, Venus and Moon) and 2 gas (Mercury) and Saturn)
- e) None of the previous answers

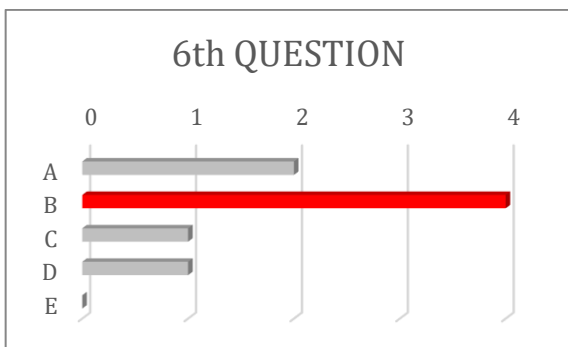
In this fifth question, the intention was to analyze the students' knowledge about the quantity and constitution of the planets currently known, which orbit the Sun. It can be seen that there are still students who do not know the correct number and tend to confuse some of them with stars when observed with the naked eye, because they know absolutely nothing about the Solar System, and even less about the stars outside it.

Graph 5 – Answers to the 5th question



- 6 How many constellations geometrically divide the celestial vault, apparently being a sphere?
- a) 87 constellations
 - b) 88 constellations
 - c) 86 constellations
 - d) 85 constellations
 - e) 84 constellations

Graph 6 – Answers to the 6th question

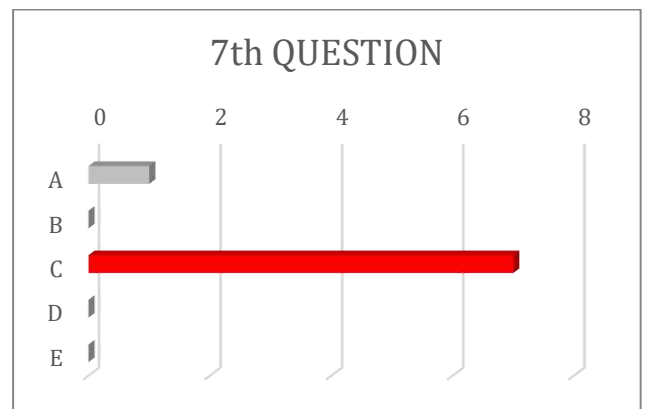


In the sixth question, the subject highlighted was the number of known constellations, and if the students knew the exact number. And it became clear that half of them did not know how many constellations there are currently, which requires more studies on stars and constellations, and why images are formed with the joining of some of them.

- 7 A sky map, which can depict the full extent of existing constellations or a part of the sky, showing how it is seen from a certain region, is known as?

- a) Geographic map
- b) Educational
- c) Celestial Chart
- d) Chart Western Map
- e) Solar

Graph 7 – Answers to the 7th question

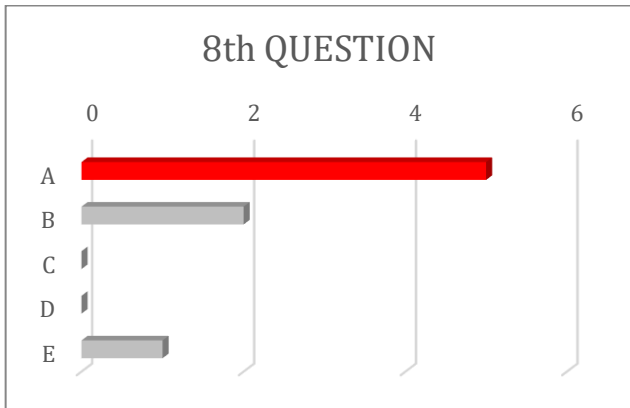


About the main theme of this work, in the seventh question the question is whether the students knew a Celestial Chart, and their answer was evidenced showing that, currently, they still there are high school students who don't know what a map of the sky is, let alone what these maps are for. This demonstrates the importance of taking Astronomy courses.

- 8 Why do we always observe the same face of the Moon?
- a) Because the time it takes for the Moon to rotate around its own axis is equal to the time it takes for it to rotate around the Earth
 - b) Because the time it takes for the Moon to rotate around its own axis is different from the time it takes for it to rotate around the Earth
 - c) Because the time it takes for the Moon to rotate around its own axis is different from the time it takes for it to rotate around the Sun
 - d) Because the time for the Moon to rotate around its own axis is equal to the time it takes it takes to revolve around the Sun

e) Because the time it takes for the Sun to rotate around its own axis is equal to the time it takes to revolve around the Earth

Graph 8 – Answers to the 8th question

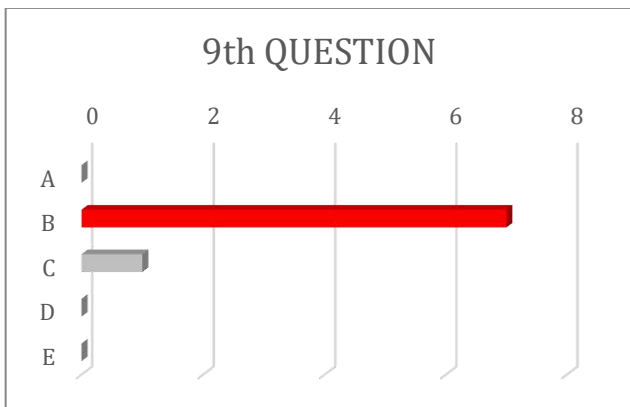


When analyzing the answers to this eighth question, which deals exactly with the process of observing a star, it is clear that there are still gaps unfilled in the process of assimilation of knowledge by the students, or the teacher deprived of continuing education that allows him to establish a link between the phenomenon and the acquisition of knowledge about this phenomenon on the part of the student, in a scientific way.

9 How many planets make up the Solar System, and what are they?

- a) 7 – Mercury, Earth, Mars, Saturn, Pluto, Jupiter and Aldebaran
- b) 8 – Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune
- c) 9 – Saturn, Uranus, Jupiter, Mars, Earth, Pluto, Andromeda, Neptune and Io
- d) 10 – Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto and Io
- e) 11 – Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto, Io and Callisto

Graph 9 – Responses to 9th question

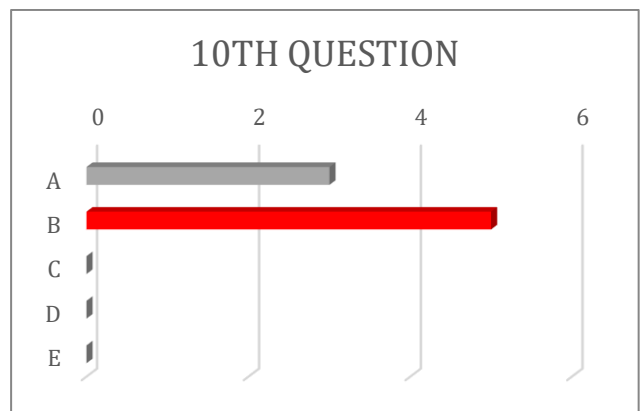


This ninth question is similar to the fifth, however, it still shows a lack of knowledge of some students about the number of planets in the Solar System, and that through computer applications, Physics classes could be improved in teaching methodological processes. learning.

10 What is the name of the closest star to Earth after the Sun?

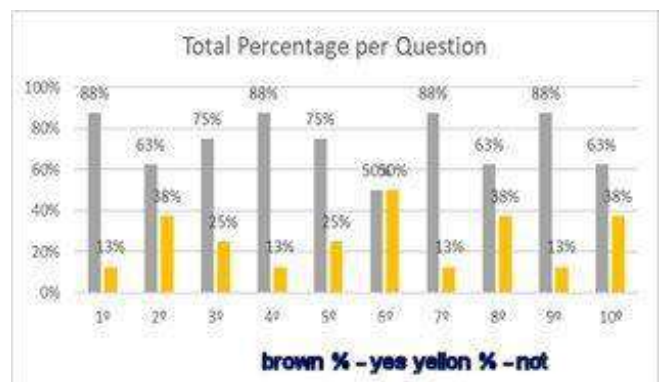
- a) Andromeda
- b) Proxima Centauri
- c) Mintaka
- d) Alnilam
- e) Betelgeuse

Graph 10 – Answers to the 10th question



In the tenth question, it can be seen that when it comes to stars outside the Solar System, the ignorance of the students is more evident, for not having the habit of reading about the Universe and their constitutions. Here, about 50% were not aware of this star, and do not know any of the others that made up the answer table for this question. Below is an overview of the diagnostic evaluation.

Graph 11 - Total percentage due to diagnostic evaluation



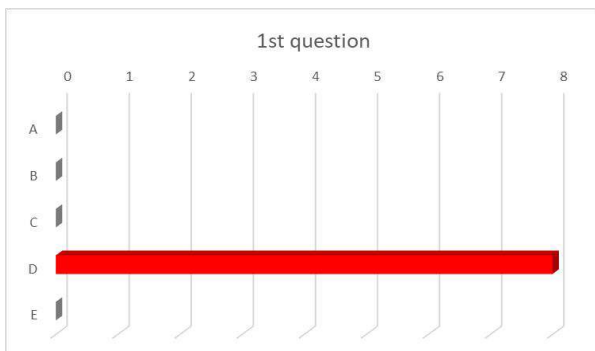
- SEMI-STRUCTURED RESEARCH AFTER THE ASTRONOMY COURSE

At this moment, the students were evaluated after the elective course entitled "Discovering the Universe", and after the classes inside and outside the classroom, they were observed what were the schemes they created, in order to understand the concepts studied and apply their theorems and concepts in action at more elaborate levels, going on to confirm some concepts as really significant, or to refute those that were theoretically outside the scientifically proven concepts. Some questions in this survey were purposely repeated to see if students still remembered and other questions were modified to a higher level.

1 In space, what is a group of stars relatively close to each other called?

- Solar System
- Black Hole
- Planetoid
- Constellation**
- Comet

Graph 12 – Answers to the 1st question

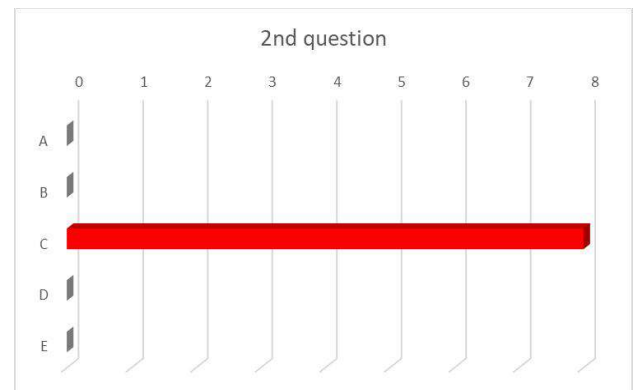


In this first question of the final research, it is noticed that everyone has knowledge about constellations, however, in a wrong way, because it is learned in textbooks that a constellation is a set of stars linked together. This is a didactic mistake, because, in reality, they are not associated star systems. In general, they are very distant from each other, within the Galaxy.

2 Which planets are visible to the naked eye from Earth?

- Eta Carinae
- Jupiter and Pluto
- Mars, Jupiter, Venus and Mercury**
- Uranus and Venus
- Ceres

Graph 13 – Answers to the 2nd question

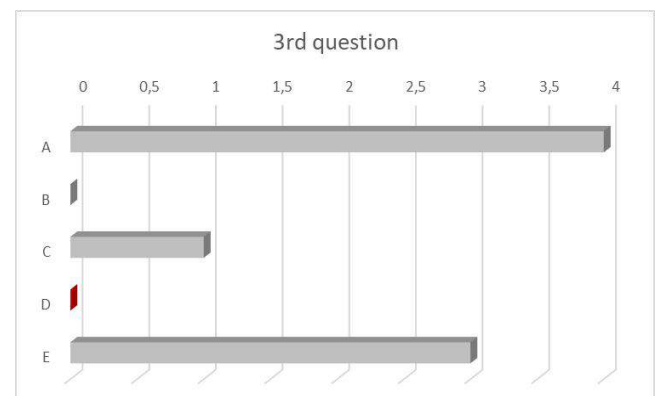


In this second question, the students proved to be knowledgeable about the planets that are visible throughout the night, however, it was unknown to them that these planets occupy the band of the zodiac, which is nothing more than an imaginary band, centered on the ecliptic, through the celestial sphere, and about 16° in width, where the Sun, the Moon and the planets Mercury, Venus, Jupiter and Saturn are always located. That was interesting, because it represented a certain amazement, as if they were discovering something really new.

3 The Moon completes one revolution around the celestial sphere every 27.321662 days. This period, measured relative to the fixed stars, is known as?

- Month Austral
- Lunar Day
- Sidereal Time
- Sidereal Month**
- Lunar Year

Graph 14 – Answers to the 3rd question



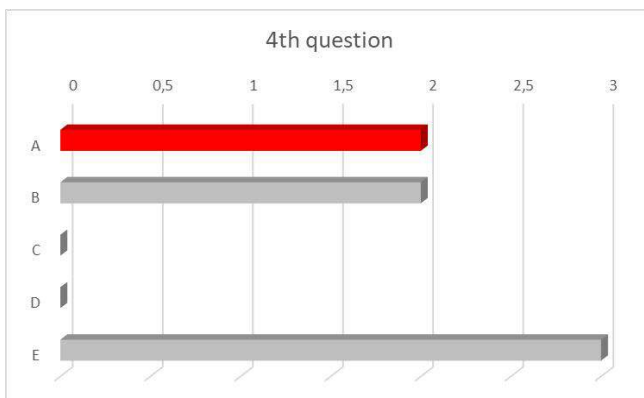
In this third question, it can be seen that although it was shown in the classroom, the students did not assimilate it properly, so that none of them managed to answer satisfactorily. In the classroom it was explained to them that

the sidereal month is the period of translation of the Moon in relation to a fixed reference. Its difference from the synodic month³ is explained by the fact that it depends on a composition of the movements of the Earth and the Moon. As the sidereal month is exactly the same as the Lunar day, the same face of the Moon is always seen.

4 *Band of the celestial sphere along the ecliptic, about 18° wide, through which the Sun, Moon and planets transit is known as?*

- a) *Zodiac*
- b) *Range*
- c) *Ecliptic*
- d) *Transition Space*
- e) *Revolution Zone*

Graph 15 – Answers to the 4th question

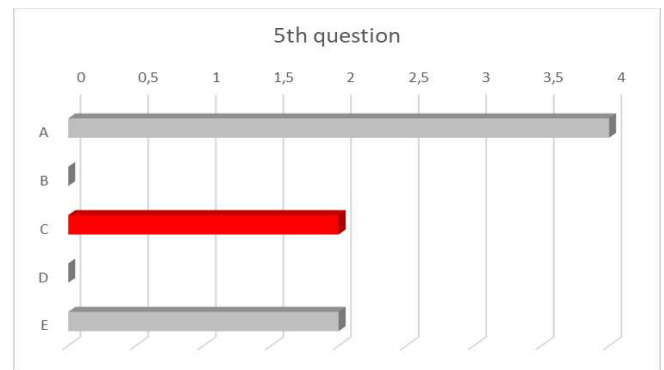


As already discussed in previous questions, we return to talking about the zodiac that represents a band. The constellations that form the Zodiac (circle of animals, or path, from Sanskrit Sodi), a band of 18° around the ecliptic, were defined around 500 BC by the Babylonians, dividing the ecliptic into 12 equal subdivisions of 30° each. They can be related by the mnemonic *ArtaGeCa LeViLiSco SaCAquaPi*, as they are: *Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius, Capricornus, Aquarius and Pisces*.

5 *The projection on the celestial sphere of the apparent trajectory of the Sun, observed from the Earth, is called:*

- a) *Plane Solar*
- b) *Plane Spatial*
- c) *Ecliptic*
- d) *Celestial Sphere*
- e) *Celestial Pole*

Graph 16 – Answers to the 5th question

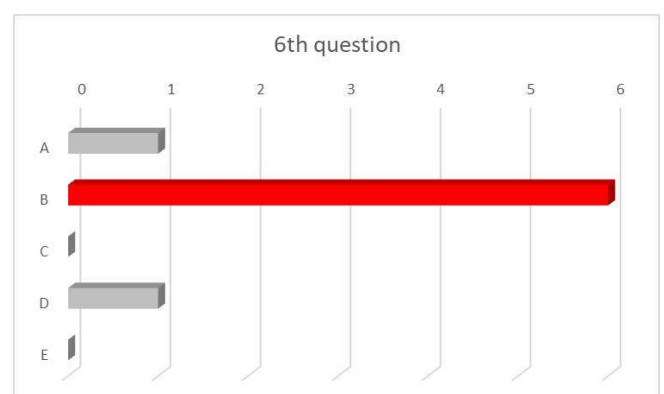


In this fifth question, it was exactly the meaning of the ecliptic in Astronomy, and it was explained to students that it represents the plane of the Earth's orbit around the Sun. From the perspective of an observer on Earth, the movement of the Sun around the celestial sphere over the course of a year traces a path along the ecliptic against the background of the stars. This path, which joins all the daily positions of the Sun on the celestial sphere throughout the year, is called the ecliptic. According to the heliocentric referential (view from outside the Earth), the ecliptic is the plane of the Earth's orbit around the Sun (LANGHI, 2016).

6 *How many constellations geometrically divide the celestial vault, apparently being a sphere?*

- a) *87 constellations*
- b) *88 constellations*
- c) *86 constellations*
- d) *85 constellations*
- e) *84 constellations*

Graph 17 – Answers to the 6th question



This sixth question repeated the previous research to see if there was any improvement in learning, and the

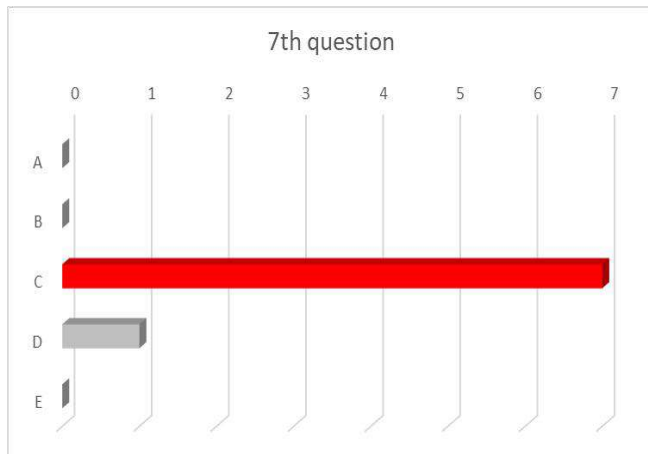
³ The synodic month or lunation is the average time interval between two consecutive equal moon phases.

question shows exactly the expected result. In the previous survey, 50% of the students got it right, while in this survey 75% of the students got the question right. Knowing how to define the number of constellations, which are the zodiacal ones and their respective abbreviations is important for students who want to follow this line of research in Position Astronomy, or just learn to calculate a Celestial Chart.

7 *A sky map, which can depict the full extent of existing constellations or a part of the sky, showing how it is seen from a certain region, is known as?*

- a) Geographical Map
- b) Educational
- c) Celestial Chart
- d) Chart Western
- e) Solar Map

Graph 18 – Answers to the 7th question



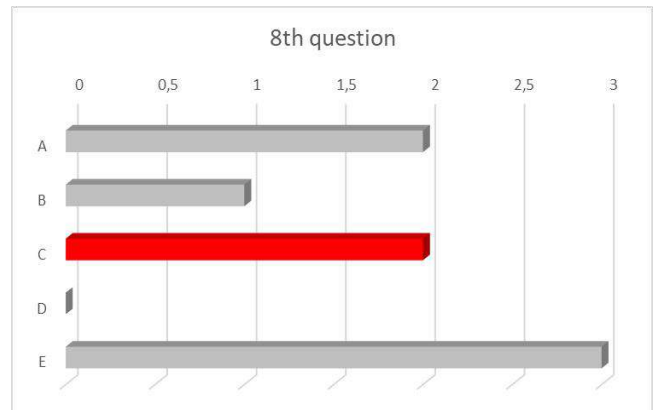
On this seventh question, there were no changes, as there was still a student who showed a lack of knowledge about the object used to map the sky, and which also makes it possible to understand about the movement of constellations throughout the nights and months of the year. This celestial map also makes it possible to understand, in the case of the Sun, the change in constellations that can be observed when looking in different directions of the sky due to the translation of the Earth around the Sun. This celestial phenomenon was duly worked with students outside the classroom with the Celestial Letters produced in this scientific research.

8 *Can we identify a Total Eclipse of the Moon when it completely passes through the region called the?*

- a) Penumbra
- b) Shadow
- c) Umbra
- d) Darkened Region Eclipse

e) Zone

Graph 19 – Answers to the 8th question

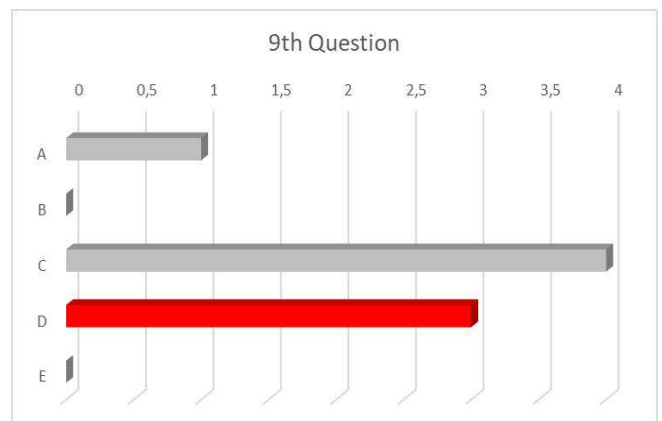


In this eighth question, it is noted how important Astronomy classes are in Elementary and High School, given that this subject is addressed in the 2nd year at the Optical CC Geometric, and it can be seen, through Graph 19, that only two students or 25% of the class got this question right, while the other students do not have the schema formed in their ideas of how the Lunar Eclipse phenomenon happens. Understanding the movement of the stars is also important so that we can understand some phenomena here on Earth, such as, for example, the syzygy tide.

9 *Is the altitude of any star at the zenith in degrees a?*

- a) 360°
- b) 270°
- c) 180°
- d) 90°
- e) 45°

Graph 20 – Answers to the 9th question



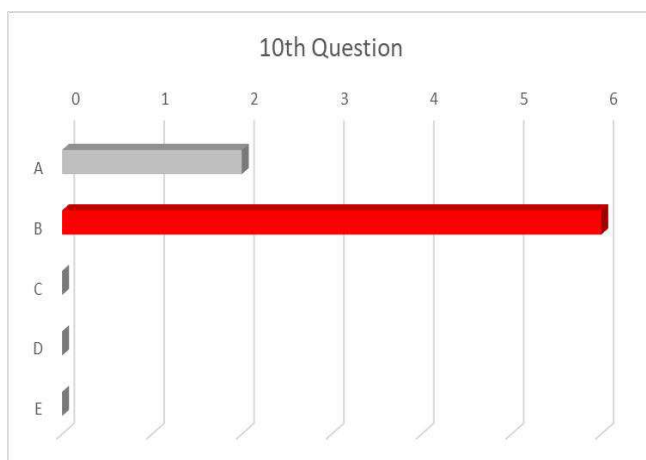
In the ninth question, only 37.5% of the students got it right, which demonstrates a lack of knowledge or even a lack of a discipline like Astronomy that approaches the CC of science in an interdisciplinary way. This result reflects the low rates of approved and medalists in the OBA and

ONC at the Bacelar Portela school, and through this result it can be extended as a reflection to other schools in Maranhão, especially the private ones, whose focus is only on the entrance exam.

10 What is the name of the closest star to Earth after the Sun?

- a) Andromeda
- b) Proxima Centauri
- c) Mintaka
- d) Alnilam
- e) Betelgeuse

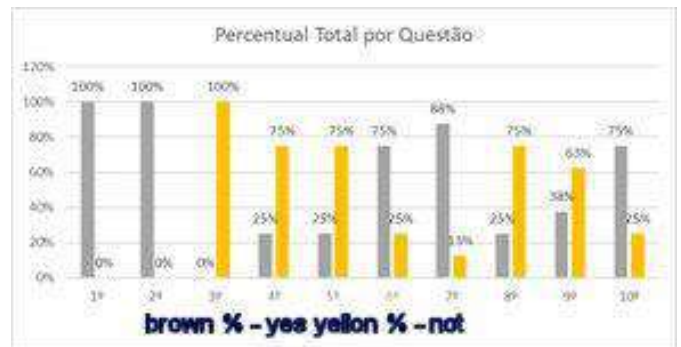
Graph 21 – Answers to the 10th question



In this tenth question, which was also purposely repeated, it was noticed that after the course, there was an evolution of the participating students, as now there were 75% of correct answers, and how the evolution was small, it is believed that only through an extensive course in Astronomy, focusing on observations, practices inside and outside the classroom, will a more effective result be obtained, calling for more girls to engage in science, research and innovation. Students' knowledge about the best-known stars is still very small in public schools in Maranhão. Perhaps, with more courses being held in the form of electives at IEMA, more candidates will emerge for researchers who can help develop the scientific and technological hub, helping to improve the Human Development Index (HDI) through education aimed at community development in the region. from maranhão.

In summary, we have, in general, the analysis of this second moment of the classes, in which there were advances in CC of Astronomy.

Graph 22 – Total Number of Students who responded to the final survey



● FORMATIVE ASSESSMENT (QUALITATIVE ASPECTS)

The other part of the survey corresponded to listening to the students, knowing how they received the course and what they thought of this new experience, how this elective would influence the life of these students, in order to bring improvements in their learning. What did you think of the experience of learning to build and use a Celeste Letter in open school environments, and using the Stellarium program as a helper, given that the timetable was daytime? How was the experience of understanding the movement of constellations using coordinate systems still unknown to these students? Next, the students summarized all their criticisms, whether constructive or not. The teacher asked them to be extremely sincere, so that teaching practices could be further improved.

The speeches of the students referring to the Astronomy course, and the practices of observation and discussion of the topics covered, it was even proposed a more lasting course in another opportunity, given the great interest of this team that was during this elective at the school. João Bacelar Portela. Working with Astronomy, using the conceptual tools of Physics, developed in them a more critical and argumentative posture when carrying out observations using Celestial Charts and Stellarium as a guide in celestial observations.

V. CONCLUSION

The choice of the object of study and the investigation technique used in this research was carried out during the Master's activities, given that there are few bibliographic references that would allow the professor to develop the work, and due to the lack of continuing education in Astronomy that would allow the even to do more solid and scientifically correct work. This absence of continuing education for the training of teachers and disciplines - which can show students that it is possible to work in an interdisciplinary CC of Astronomy with the other sciences -

still represents a very strong obstacle in Maranhão, in addition to the rates of approved students. and science Olympiad medalists are extremely low in public and private schools. And it was exactly after the realization of these facts, and so that the students could acquire greater interest in Astronomy, that the student decided to develop the first Celeste Chart of São Luís do Maranhão.

In this research, students' cognitive difficulties regarding the assimilation of questions related to basic Astronomy were found, which can be explained through the teaching of Physics. However, there is a need for innovative pedagogical methodologies that give a new meaning to the studied conceptual fields and allow the student to establish relationships between celestial and terrestrial events.

The elaboration of Celestial Charts required a knowledge of Astronomy that was well above those imagined at the beginning. Some of this knowledge was not possessed, not even by the teacher, due to the lack of disciplines focused on Astronomy in Higher Education, or even of continuing education in Astronomy for the development and improvement of teaching practices.

Developing in the student the ability to generate conceptual schemes, so that they could understand what a celestial sphere is, consists of enabling them to achieve the following knowledge: associating the movement of the celestial sphere as a result of the Earth's rotation around its axis of rotation in the range of a sidereal day, not a solar day; notions of astronomical and geographic latitude; notions of altazimuth coordinates, in order to represent the sky visible at a location, at a specific date and time; familiarization with hourly and equatorial coordinate systems; notions of time scales, since there was a need to transform universal hours into time zones and true solar hours, in order to obtain true sidereal time, data that are essential to relate equatorial and time systems; knowledge of spherical trigonometry to relate hour systems with altazimuths; knowledge of computer applications that allowed the efficient calculation of the necessary mathematical transformations; knowledge of computer applications that generate graphics from numerical data in a spreadsheet; in addition to the knowledge of the movement of the celestial sphere, in order to extrapolate 12 punctual Celestial Cards so that they could be used throughout the year. These learning phases have become a methodological challenge in the midst of a completely adverse scenario.

Another difficulty presented during the course is that not all students had notebooks to carry out the work, so only the Letters were used together with the cell phone, for the elaboration of the activities of observation of the sky.

As the topic has always aroused everyone's curiosity, the observations with the Celestial Letters and the use of the

Stellarium in outdoor environments allowed debates on Astronomy and Physics, promoting an educational and motivating role, both for students and for teachers, as triggered numerous questions on the part of everyone involved about the movement of stars, position of stars in space, coordinate systems involved, in addition to the idea of time involved in celestial phenomena.

As a result of the semi-structured surveys, the students ended up having an improvement in some questions, however, they did not perform well after the course in most of the questions presented. This is due to several factors, such as: excessive time without school activity due to the pandemic, lack of continuing education in Astronomy for Basic Education teachers, lack of Astronomy discipline that can work the contents required by the BNCC (BRASIL, 2018), in addition to technological equipment that can help the teacher in the development of these classes, inside and outside the classroom, such as notebooks, tablets and data show.

Even so, it was found that the use of this pedagogical tool (celestial letter) improved the students' relationship with the Exact Sciences, from the moment it contextualized the theoretical knowledge obtained in the classroom with field observations.

It was proposed, in this research, a specific discipline of Astronomy that can work contextualized with the other sciences, with the use of Celestial Charts in formative moments outside the classroom, so that the students can become familiar with other types of coordinates not seen. in Basic Education, in addition to more visits to planetariums or lectures in schools by teachers who work on topics related to the study of Astronomy and the dissemination of science in Brazil and, in particular, in Maranhão.

Finally, it is proposed, in future studies, a greater development of studies on the Celestial Letters from São Luís do Maranhão, mainly taking into account the brightness of the stars, in the development of the Letters, which is of fundamental importance for the study of Position Astronomy. This theme was not highlighted in this research, due to the impossibility of working in schools, due to the pandemic for a certain period, and the lack of time after the release of school activities. However, it serves as an important CC to be developed in future works, where, from this research, new works for the Maranhão region may emerge.

ACKNOWLEDGEMENTS

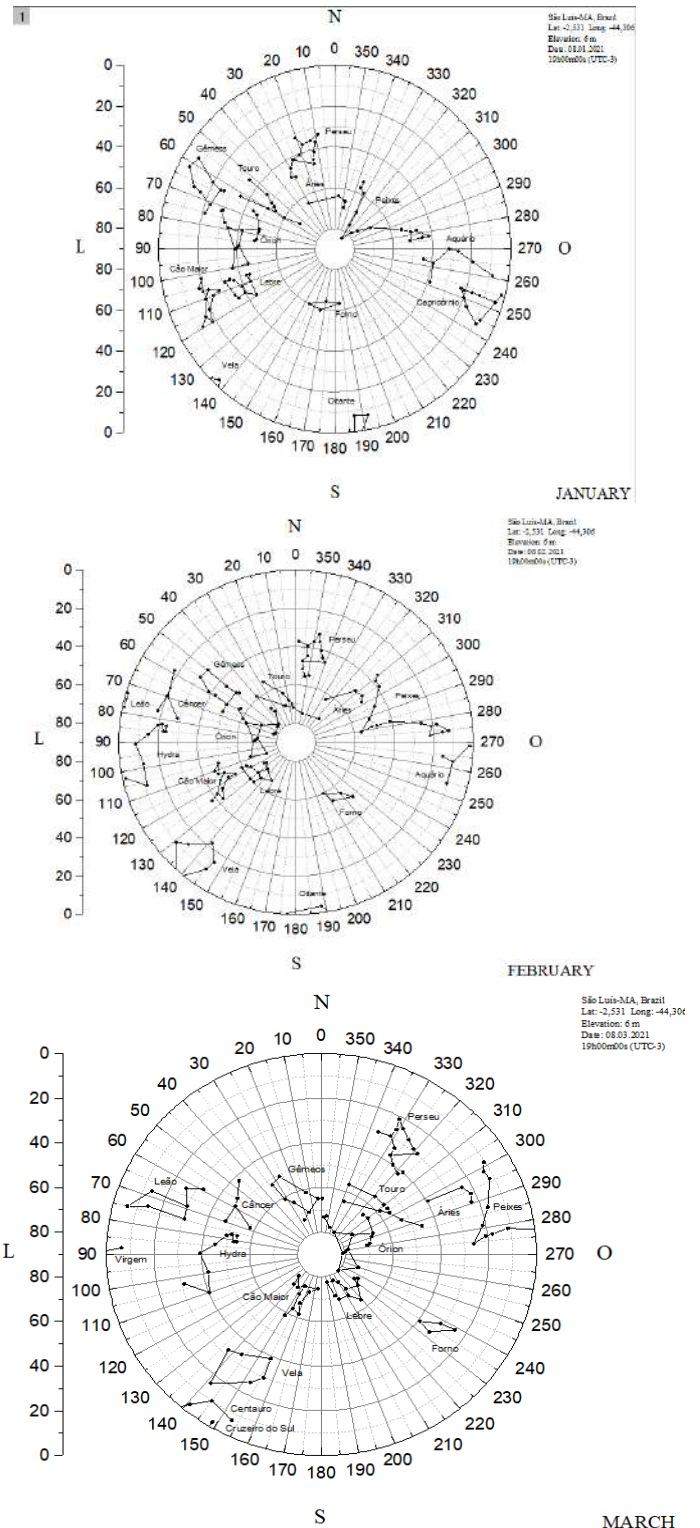
The autor Jorge Emanuel de Oliveira Irineu thanks to the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), code 001, for promoting this research.

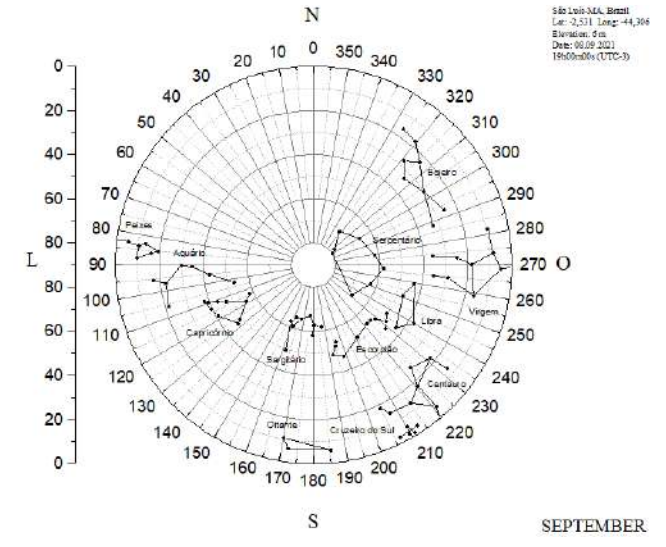
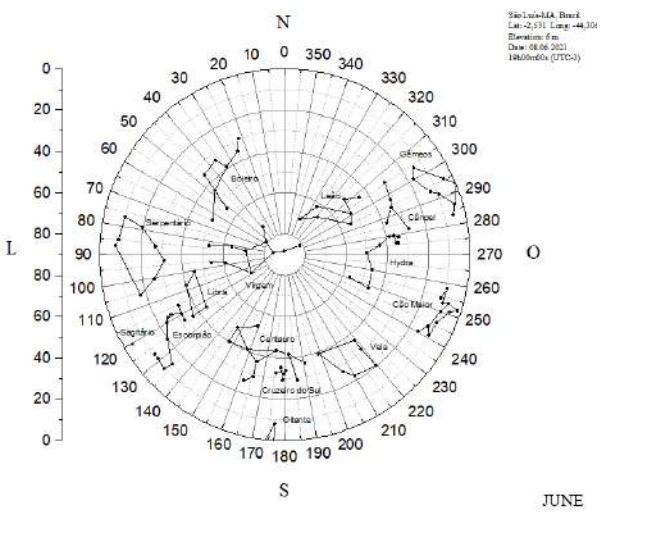
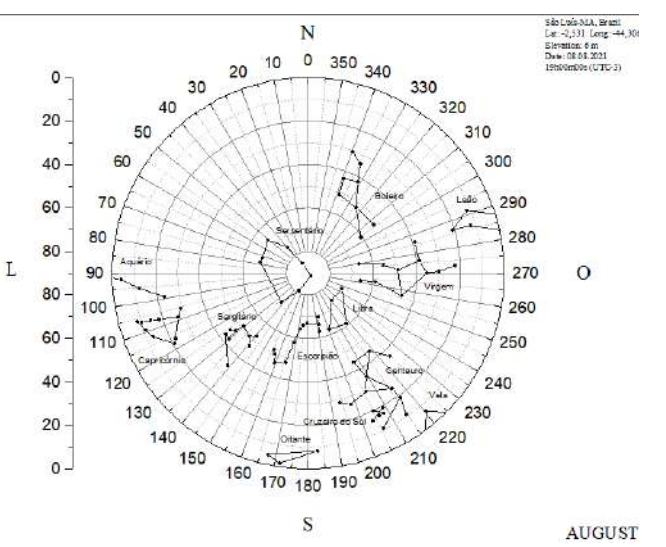
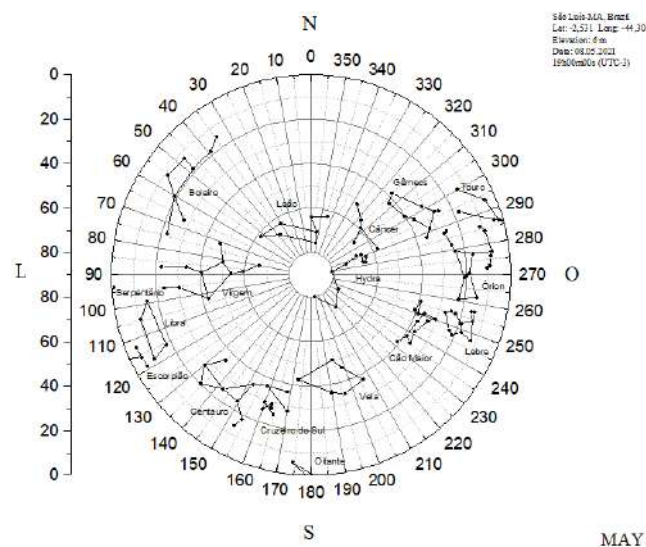
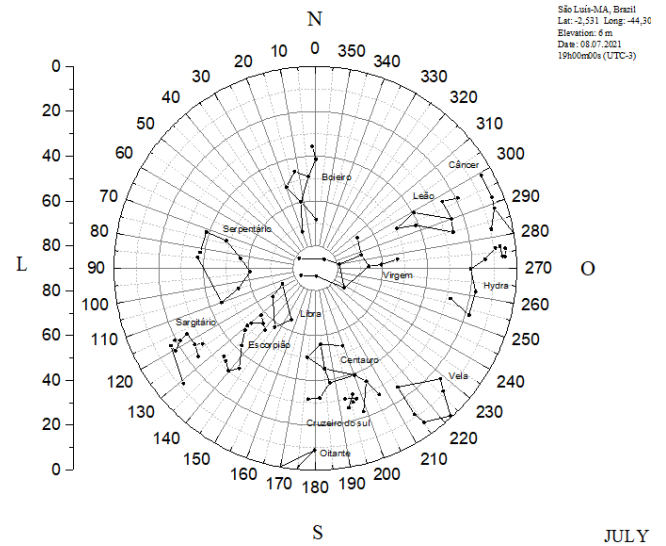
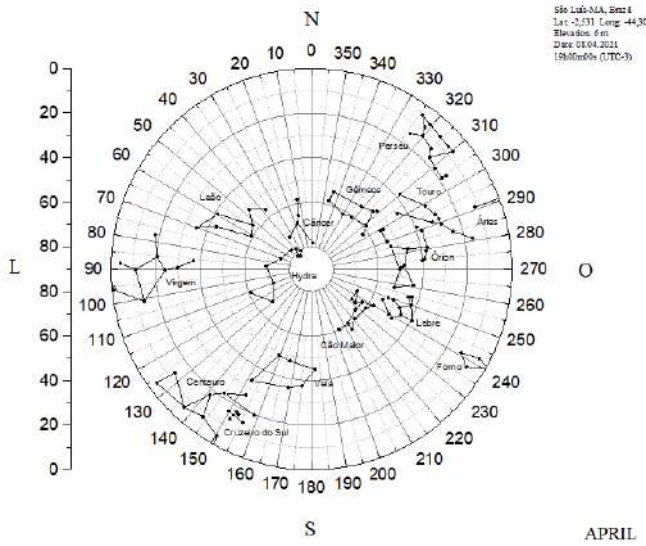
REFERENCES

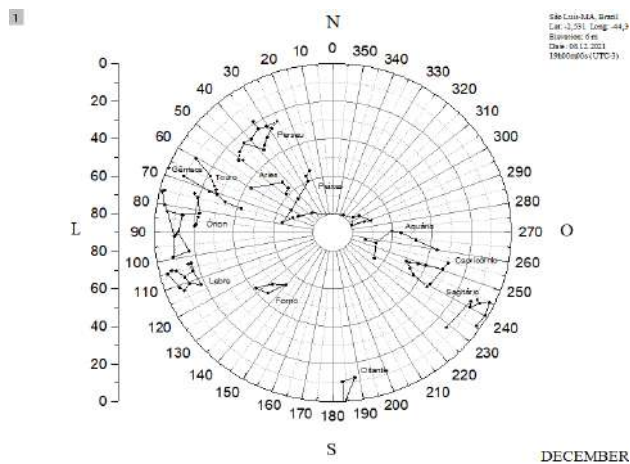
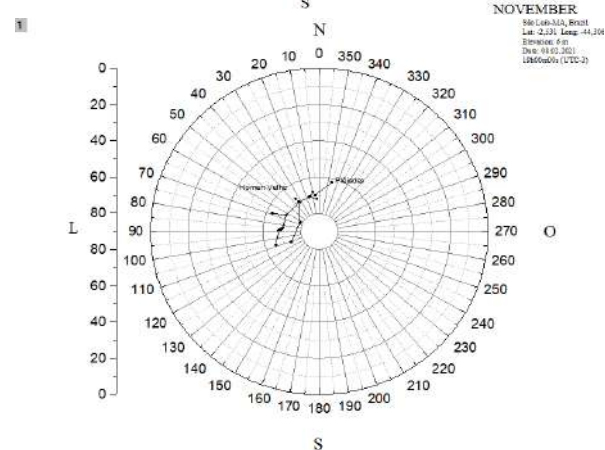
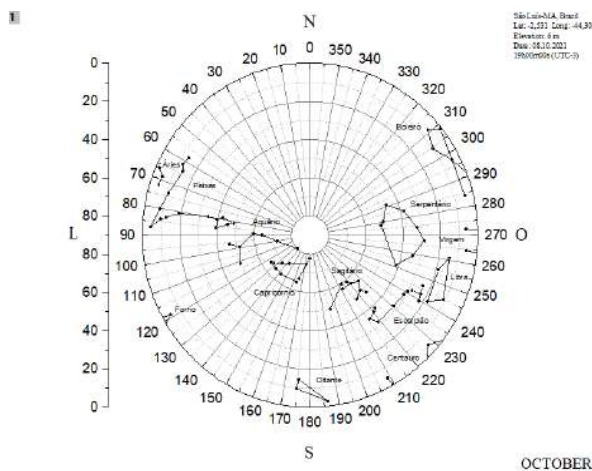
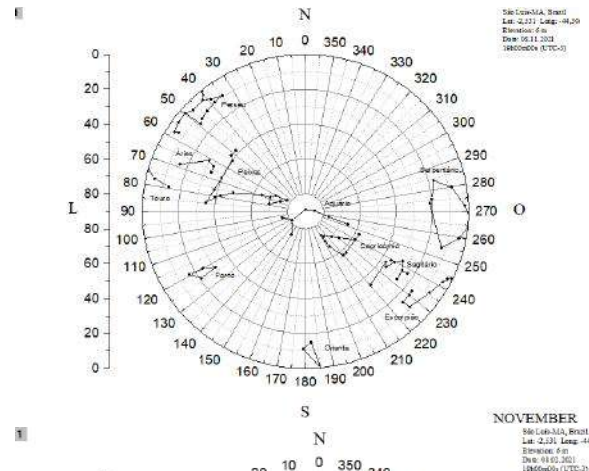
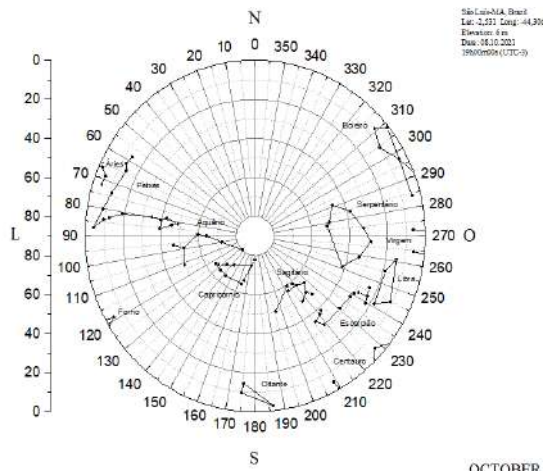
- [1] BAUER, A., CASSETTARI, N., & OLIVEIRA, RP (2017). Teaching policies and quality of education: a literature review and policy indications. *Essay: Evaluation and Public Policies in Education*, v. 25, p. 943-970, 2017. (pp. v. 25, p. 943-970). Porto Alegre: RS.
- [2] Boczko, R. (nd). *Astronomer. The Sun by the zodiac constellations*. Institute of Astronomy, Geophysics and Atmospheric Sciences at the University of São Paulo, São Paulo.
- [3] BRAZIL. (2018). *Common National Curriculum Base for the High School Stage*. Brasília: MEC.
- [4] CEDRAN, K. 2. (June 23, 2019). *Conceptual field theory: visiting its main foundations and perspectives for science teaching*. *ACTIO : science teaching*, pp. 1-8.
- [5] DAYS, CA (2008). Insertion of astronomy as a curricular subject in High School. *Latin American Journal of Astronomy Education*, 5-65.
- [6] GIL, AC (2008). *How to design research projects*. Sao Paulo: Atlas.
- [7] JUSTINIANO, A., & BOTELHO, RR-1. (2016). Construction of a celestial chart: A didactic resource for teaching Astronomy in Physics classes. *Brazilian Journal of Physics Teaching*, 1-11.
- [8] LANGHI, R., & NARDI, R. (2012). *Education in Astronomy: rethinking teacher education*. São Paulo: Writing Publisher.
- [9] LIMA, FP, & MOREIRA, I. d. (2005). Tupinambá astronomical traditions in the vision of Claude D'Abbeville. *Journal of the Brazilian Society for the History of Science*, v. 3, no. 1, p. 4-19, 2005. . *Journal of the Brazilian Society for the History of Science*., P. 4-19.
- [10] MINAYO, MC (2009). *Social research: theory, method and creativity*. Petropolis: URGs.
- [11] MORAN, J. (2015). *Changing education with active methodologies*. . Contemporary media collection. Media convergences, education and citizenship: youth approaches, v. 2, no. 1, p. 15-33., v.2 n 1 pag 15-33.
- [12] MOREIRA (2002). MOREIRA, MA Vergnaud's Conceptual Fields Theory, science teaching and research in this area. *Magazine Porto Alegre, RS*, v. 7, no. 1, p. 7-29, 2002. Available at: <https://www.lume.ufrgs.br/handle/10183/141212>. *Research Journal in Science Teaching*, v. 7, no. 1, p. 7-29.
- [13] NCP (1997). *National Curriculum Parameters*. Brasília: MEC.
- [14] VERGNAUD apud CARVALHO et al, 2. (2007). GERMANO, ASM and CARVALHO, JC *Astronomia*. 1st ed. Natal - RN: EDUFERN, Christmas: EDUFERN.
- [15] VERGNAUD, I. (1990). Vergnaud. G. (1990). *La theorie des champs conceptuels*. *Searches in Didactic des*.
- [16] ZABALA, A. (1988). *Educational practice: how to teach*. trans. by Ernani F. da F. Rosa. Porto Alegre: Artmed.

APPENDIX

CELESTE LETTERS YEAR 2022 FROM THE CITY OF SÃO LUÍS – MA – BRAZIL.







CELESTE INDIGENOUS CHARTS YEAR 2022
 FROM THE CITY OF SÃO LUÍS – MA – BRAZIL. -
 OLD MAN COSTELLATION

The Celestial Chart was prepared containing the “Old Man Constellation”, of the Indians Tupinambás of Maranhão. Only this constellation was built in this work due to the difficult construction of the other constellations because it is the union of different constellations, which makes its construction difficult. Therefore, it would be necessary to look for the right ascension (α) and declination (δ) of each star that made up this constellation, assemble the original constellation and, finally, visualize the connection that the corresponding stars made, to then build with the coordinates correct for each in the Origin.

Urban Solid Waste in Brazil: Concept, Characterization and Regulation

Veridiana Torres da Silva¹, Antônio Roberto Xavier², Andrea Yumi Sugishita Kanikadan³, Aiala Vieira Amorim⁴, Olienai de Oliveira Pinto⁵, Rosalina Smedo de Andrade Tavares⁶, Karla Renata de Aguiar Muniz⁷, Michella Rita Santos Fonseca⁸, Maria Vandia Guedes Lima⁹, Marcus Rodney Portela Cysne¹⁰, Juliana Fernandes da Silva Queiroz¹¹, Antonio Leonardo Moreira de Aquino¹², Júlio César Lopes de Oliveira¹³

¹Specialization in Science Teaching, Department of Education of Baturité, CE, Brazil. E-mail: torresveridiana2016@gmail.com. Orcid: <https://orcid.org/0000-0002-3679-4477>.

²Post-Doctor and Doctor in Education, Post-Graduate Program in Sociobiodiversity and Sustainable Technologies, Redenção, CE, Brazil. E-mail: roberto@unilab.edu.br. Orcid: <https://orcid.org/0000-0002-3018-2058>.

³PhD in Applied Ecology by the Inter-Unit Graduate Program in Applied Ecology by ESALQ/USP, Brazil. E-mail: akanikadan@unilab.edu.br. Orcid: <https://orcid.org/0000-0001-5057-4801>.

⁴PhD in Agronomy (Phytotechnics), University of International Integration of Afro-Brazilian Lusophony/Institute of Rural Development, Redenção, CE, Brazil. email: aialaamorim@unilab.edu.br. Orcid: <https://orcid.org/0000-0003-4222-3459>.

⁵PhD in Agronomy (Phytotechnics). Postdoctoral internship - PDPG/SEMI-ARID - CAPES/FUNCAP Scholarship, Academic Master's Degree in Sociobiodiversity and Sustainable Technologies, University of International Integration of Afro-Brazilian Lusophony, Redenção, CE, Brazil. E-mail: agron.olienaide@gmail.com. Orcid: <https://orcid.org/0000-0002-8333-3665>.

⁶PhD in Administration, Institute of Applied Social Sciences, University of International Integration of Afro-Brazilian Lusophony. Redenção, Ceará, Brazil. E-mail: rosalina@unilab.edu.br. Orcid: <https://orcid.org/0000-0003-3592-5559>.

⁷Master's student in Sociobiodiversity and Sustainable Technologies at the University of International Integration of Afro-Brazilian Lusophony, Redenção, CE, Brazil. E-mail: karlla.renata@hotmail.com/ORCID: <https://orcid.org/0000-0003-4007-2482>.

⁸Master in Teaching and Teacher Training, Municipal Department of Education of the Municipality of Caucaia, CE, Brazil. E-mail: michellafonseca@yahoo.com.br/ORCID: <https://orcid.org/0000-0003-3258-965X>

⁹Master in Educational Sciences, State University of Ceará, Brazil. E-mail: profavandieguedes@gmail.com/ORCID: <https://orcid.org/0000-0003-3258-965X>

¹⁰Master's Degree in Applied Linguistics, Federal Institute of Education, Science and Technology of Ceará, Fortaleza, CE, Brazil. E-mail: maruscysne@hotmail.com/ORCID: <https://orcid.org/0000-0003-3905-8763>

¹¹Master's student in Sociobiodiversity and Sustainable Technologies at the University of International Integration of Afro-Brazilian Lusophony. E-mail: 3jhulyfernandes@gmail.com. ORCID: <https://orcid.org/0000-0002-3393-0541>.

¹²Specialization in Gender, Diversity and Human Rights. E-mail: quinomleonardo@gmail.com/ORCID: <https://orcid.org/0000-0001-7325-1247>.

¹³Specialization in Gender, Diversity and Human Rights, Municipal Department of Education of the Municipality of Baturité, CE, Brazil. E-mail: juliolopes1110@gmail.com/ORCID: <https://orcid.org/0000-0001-8749-5306>

Received: 09 Jun 2022,

Received in revised form: 30 Jun 2022,

Accepted: 07 July 2022,

Available online: 13 July 2022

Abstract— *The study's main objective was to discuss the concept, characterization and other norms that govern and regulate Urban Solid Waste in Brazil. Methodologically, this is a theoretical-empirical study by means of a bibliographical procedural method, exploratory as to the objectives and of a basic nature with a qualitative approach. As for data collection techniques, research was*

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Sleep Initiation and Maintenance Disorders; SARS-CoV-2; Student Health.

carried out in secondary sources such as books, scientific articles, legislation, guidelines, and norms that define and regulate solid urban waste in Brazil. As for the analysis techniques, we used content analysis and narrative socio-historical contextual discourse. As conclusive results, the study allowed us to verify that two needs to be fulfilled by the public power and Brazilian society are evident: a) the fulfillment of the norms, legislation, and guidelines in relation to Urban Solid Waste, and 2) the putting into practice of a public policy of integrating and integrating environmental awareness that is efficient, effective and disseminated within society on a national, regional and local level.

I. INTRODUCTION

This research deals with the concept, definitions, classification, and regulation of urban solid waste in Brazil in contrast to Environmental Education (EE). To this end, the research focused on theoretical and empirical sources by analyzing and interpreting scientific writings, legislation, technical standards, and other relevant guidelines.

The National Congress after twenty-one years of discussions on the National Solid Waste Plan (PNRS), approved it in 2010, turning it into Law No. 12.305 [1]. This law involves the three federative entities - Union, States and Municipalities; the productive sector and society in general, in an institutional articulation that aims to seek solutions to the problems in the management of Municipal Solid Waste (MSW's), which compromise the quality of life of all Brazilians. With the approval of the PNRS, the discussion on the theme in question was requalified and given new directions [2].

Since August 2010, based on the concept of shared responsibility among the federated entities, the society as a whole - citizens, governments, private sector and organized civil society - became responsible for the environmentally adequate management of solid waste [3].

Today, citizens must be responsible not only for the correct disposal of the waste they generate, but also for rethinking and analyzing their role as consumers. The private sector is responsible for the environmentally correct management of waste solid waste, by their performance in the production chain and by product innovations that bring social and environmental benefits. It is the responsibility of the public authorities - at the federal, state, and municipal levels - to prepare and implement solid waste management plans [4].

Therefore, society has been pressured to make changes in habits, related to unbridled consumption due to a high socioeconomic and environmental cost caused by the generation of SUW's, forcing one to seek sustainable alternatives that diminish impacts. One of the alternatives

that can help minimize these impacts is to separate the recyclable materials and send them to artisans, collectors, entities, or companies that will reuse or recycle the material [5].

According to the Ministry of Environment, RS's acquire commercial value, if properly managed, and can be used in the form of new raw materials or new inputs. Therefore, it is necessary to implement a management plan that will bring positive social, environmental, and economic results, because the intention is to reduce the consumption of natural resources at the source and provide the opportunity for income generation, leading to social inclusion and reduction of environmental impacts caused by the improper disposal of this waste.

The definition of urban waste involves multiple variables because its origin and formation are associated with various factors: seasonality, climate, habits and customs, economy, floating population, among others. Thus, the identification and quantification of these factors require study and in-depth work for a long period [6].

[7] states that it is common to define solid waste as all residues that result from man's daily activities in society. The WHO, on the other hand, defines SUW as "anything that the owner no longer wants, at a certain point in time, and that has no commercial, current or perceived value" [8]. This concept may be considered outdated given that SUW possesses great economic potential and income generation for populations.

[9] differentiate between garbage and MSW's, because there is an understanding that separated materials, which can be recycled or reused, are treated as solid waste, while mixed and agglomerated materials have more of a garbage connotation.

According to [10] 0004/2004, RS's constitute the solid or semi-solid remains from human activities or not, that despite not presenting a utility where they were generated, can be transformed into inputs for other activities. It is notorious to know that the waste generated at homes, at

work, at school, etc. They are collected periodically by the collection service of the cities, as well as the sweeping of squares and public places, which may include tree leaves, branches, and pruning residues.

II. THEORETICAL AND METHODOLOGICAL FOUNDATIONS

Law 6938/81, which deals with the techniques for the destination of SUW's, establishes principles and outlined objectives in relation to the environment. The law deliberates all responsibility to the municipalities in the management of the SUWs produced within their jurisdiction, except for industrial waste, in which the generator is responsible for the handling and destination of its waste - the polluter pays principle [11].

In Brazil, there are important parametric documents that regulate solid waste, including the Brazilian Standard 10004/2004 and Law No. 12,305 of August 2, 2010 [10].

According to the ABNT-10004/2004 standard, the concept adopted for waste is:

Waste in solid and semi-solid states, resulting from industrial, domestic, hospital, commercial, agricultural, service and sweeping activities. Included in this definition are sludges from water treatment systems, those generated in pollution control equipment and installations, as well as certain liquids whose characteristics make it unfeasible to discharge them into the public sewage system or bodies of water or require technical and economically unfeasible solutions in view of the best available technology.

Law 12.305/2010 presents the definition of waste as being:

[...] discarded material, substance, object, or asset resulting from human activities in society, to whose destination is proceeded, proposed to proceed, or is obliged to proceed, in solid or semi-solid states, as well as gases contained in containers and liquids whose characteristics make it unfeasible to discharge them into the public sewage system or bodies of water, or require solutions that are technically or economically unfeasible

in view of the best available technology.

[12] considers that these two legal instruments conceptualize solid waste in similar ways. The definitions present the waste with no commercial value and utility, but this concept has acquired new conceptions nowadays, because most of the materials can be used for some other purpose, even acquiring an economic value, either directly, such as the laminated packaging chips discarded by industries, being used in the making of boards and plywood; or indirectly, such as the use of fuel to generate energy used in various processes.

However, the states and municipalities' environmental control agency must interfere in the problem in a supplementary manner, by means of inspection, demanding adequate handling, storage, transportation, and final disposal of such residues. Thus, urban cleaning management in the cities can occur in three ways: directly by the municipality, by a specific public company or even by a mixed economy company created for this purpose [13].

According to regulatory documents, the legal form to adequately dispose of SUWs is that of landfills, with appropriate final disposal methods, whether these are: sanitary, controlled, with shredded or compacted waste. The processes classified as destination; recycling, composting, and incineration plants constitute waste treatment or improvement processes, and not final disposal [13].

Thus, the [4] discusses the best-known forms of final disposal of solid waste which are: sanitary landfill, controlled landfill, and open-air dumpsite.

a) From the landfill

It is considered an engineering technique used for the final disposal of MSW on the ground, through confinement in layers, covered with inert material, usually soil, having drainage systems for gases and leachate, produced [14].

The landfill is a storage space in which MSW from households, industries, and construction and demolition are discarded. In Brazil, the organization of the final disposal of MSW considered environmentally appropriate has specific legislation, with the landfill as the most correct form of final disposal [3].

[15] conceptualizes landfills as processes used for the disposal of waste on the ground, particularly household waste, based on engineering criteria and specific operational standards, in a safe manner according to environmental pollution control and safety standards.

[16] states that this system should be designed to receive and treat the waste produced by the populations, avoiding harmful consequences to the natural environment.

Thus, the construction of a sanitary landfill must be based on studies of the environmental conditions of engineering, to reduce the impacts caused to the environment and public health.

According to what [17] points out, the disposal of SR's in landfills entails several risks, such as the production of leachate and its leakage, which can contaminate water and the soil surface; the fact that the waste is toxic and pollutes the air.

The author concludes, when referring to disposal in landfills, that "garbage dump and landfill" would have the same meaning, considering synonymous expressions, being these second more accepted, for "sounding better". Thus, he defines dumpsite and landfill as "a hole full of garbage that stinks and spews out liquids", because the purpose of a landfill "is to bury the garbage so that it is isolated from the water table and kept dry without contact with air. When this occurs, the waste slows its decomposition, and is considered the "sanitary" part of the process [17].

b) Controlled Landfill

It consists of the place of disposal of MSW's on the ground, with partial control of compaction, coverage, effluent treatment, gas drains, waterproofing, being an activity not allowed in accordance with the current legislation [18].

[15], a controlled landfill is a variable of the open-air dump, in which the waste receives a daily covering of inert material, being handled in a random manner. However, this does not solve the pollution problems generated by the waste, because it generates liquids and gases.

[19] say that controlled landfill is considered an intermediate solution between the dump and the landfill. For it is an attempt to transform dumps into landfill, since these sites are built chimneys to release the gases and try to capture the leachate by pumping, returning it back on top of the pile of garbage; to reduce the contamination of groundwater. In other words, the controlled landfill is also considered an inadequate disposal since it has no collection and treatment of the leachate and gases.

c) Dump site

This is when USW's from houses, industries, hospitals, and others, are thrown on the ground, without any coverage, forming ramps, causing serious problems to the environment and public health, affecting mainly the collectors and residents of the vicinity.

[15] calls *lixão* "common landfills", which is characterized by the discharge of garbage without treatment, also called: dumps or empties. He considers this disposal technique "the most harmful to man and the environment", however, the most used in developing countries, such as

Brazil.

According to [20], landfills are the oldest and most precarious method of waste disposal and disposal of SW. These are places where SW are discarded in the open, without care as to the negative impacts caused, to groundwater, waterways, soil, and vegetation, attracting flies, cockroaches, and poisonous animals.

[16] states that, "*lixão* is the same as "open air" disposal, being considered inadequate and illegal according to Brazilian legislation. He considers as the most appropriate way for the disposal of urban waste the sanitary landfill because it aims at minimizing environmental impacts.

However, the final disposal of SUW's is a challenge for public administrations to comply with the current legislation with selective collection, reducing the volume of waste in landfills, managing all the necessary actions for its destination, and offering strategies to enable changes in the population's habits, regarding conscious consumption and the adequate disposal of the waste produced.

In as much as the environmental impacts caused by SUW's are concerned, [16] discusses waste, showing that its production has a wide variation, according to factors that justify the increase of domestic waste in Brazil, being composed of 50% organic matter. First, there are climatic factors such as when there is a lot of rain, increasing the moisture content. In the fall, there are many leaves; in the summer and during special seasons, people consume more drinks, increasing the volume of packaging. Another factor that produces an increase in waste is demographic, because the larger the urban population, the higher the *per capita* production of waste.

Another factor that centralizes this theme: are the socioeconomic ones, because the higher the cultural, educational, and acquisitive level, the higher the incidence of recyclable material and the lower the incidence of organic matter.

[12] says that SR's cause impacts that interactively affect the physical environment: water, air and soil; the biotic environment: fauna and flora; and the anthropic environment: the man and his socioeconomic and cultural relationships. The impacts on the physical environment are due to the release of gases during the decomposition of waste and from the burning of waste, whether intentional or accidental.

Thus, environmental impact according to the art. 1 of [21] is "any change in the physical, chemical and biological properties of the environment, caused by any form of matter or energy resulting from human activities

directly or indirectly. According to [22] the impacts generated by the absence of SUW management are diverse and include sanitary, environmental, economic, and social aspects.

[6] also state that sanitary impacts are those that most affect the population, causing various public health diseases. The garbage produced itself is not a cause of disease but acts as a focus for the infestation of biological vectors such as rats, cockroaches, flies, mosquitoes, insects in general that are transmitters of bacteria, viruses, protozoa, and pathogenic fungi that cause morbidity and mortality.

[23] adds that the inappropriate accumulation of waste in dumps creates a public health problem because it favors the multiplication of disease vector animals such as rats, which transmit leptospirosis and bubonic plague, and flies, which carry in their legs thousands of bacteria that are harmful to man, as well as the proliferation of microorganisms that are dangerous to health.

Thus, the excess organic matter present in urban garbage - food leftovers, fruit, and vegetable scraps from street markets, among others, constitutes the ideal habitat for the proliferation of vectors, which allied to the high rate of malnutrition of the country's lower-income population, produces serious diseases, with greater emphasis on childhood.

For [6] the environmental impacts are reflected in the pollution of the soil and surface and underground water bodies, caused by leached liquids.

The economic impacts, on the other hand, are easily detectable when one considers the health expenses with the needy population. The effort becomes innocuous because the population continues to be contaminated by garbage close to their homes. There are still high costs for the deactivation of dumps and areas of clandestine disposal of urban waste.

Another impact considered secondary is the financial loss of families and society, by the fall in productivity at work, caused by diseases and their recurrence. In addition, there is the real estate devaluation of the areas near the dumps, resulting in low investment in this area [6].

About the social impacts, [6] show the practice of waste picking in streets, avenues, markets, fairs, and dumps, done by men, women, and children, who live in contact with dangerous and contaminating materials such as medical and toxic waste.

The text "The limits of growth", which addresses reflections on the limits of human development, was published in 1968, in Rome, through the contributions of several authors on environmental issues. In this period, there

were problems that, at that time, already raised concerns among the peoples of the world, such as the extension of poverty, the increasing rejection of values; the destruction of the environment, among others [24].

Since then, several social movements have arisen, which have discussed human relations with the environment. These movements have increasingly instigated some segments of the world society to those concerns, resulting in the First World Conference in Stockholm, in 1972, in Sweden, which addressed issues on Environment and Human Development.

Once the Stockholm Declaration was elaborated, values and concepts that all countries should rescue in the use of the environment in an ecological and rational way were inserted in the international agenda. The highlight of this declaration is that, besides allowing the beginning of a possible dialogue between industrialized and developing countries, it was to promote ecological practices to review how economic growth should happen, highlighting the pollution of global goods such as air, water, and soil [24].

In "The limits of growth", the observation that the world, if seen "from the outside", to analyze its limits, environmental capacity and reserves, man would recognize nature and its importance, but not the possibility of this relationship in an indifferent way [25] stands out.

The WHO, based in Geneva, contests this "outside" view in 1987 in Brundtand's "Our Common Future", brought in the form of a report, with a call for a broadening of the vision of how the world develops and for future planning not to negatively affect natural resources [24].

The International Conference on Development and Environment has made this appeal authentic. Rio-92, as it became known, is considered the most important in the history of environmental issues, held in 1992 in the city of Rio de Janeiro, were present, heads of state and government, with the design to develop discussions on sustainable actions, in order to draw up an action plan aimed at combating the negative results that economic growth has generated to the environment [26].

At Rio-92, positions were advocated that would represent significant changes to the social reading that was being formed, including problems presented by productions involving the consumption and exploitation of the global goods, the modification of spaces, and an education of future generations [26].

These reflections and discussions on the subject have resulted in the emergence of a new language, which gradually came off the paper and started to show up in practice. O man began to point out his role in society in relation to the natural elements, seeking the existing link

between man-nature and the relations of men among themselves [24].

This may or may not mean a fine-tuned orchestration of curricular practices. Many educators, concerned with the environmentalist problematic, agree that environmental education is the realization of activities aimed at the formation of a strict environmentalist, conservationist and/or preservationist conscience [24].

In this way, it is necessary for society to have knowledge about environmental issues, because it is of utmost importance for "the subjects" to build and develop an awareness that favors the development of curricular approaches related to the environment.

Methodologically, this is a theoretical-empirical study by means of a bibliographical procedural method, exploratory as to the objectives, of a basic nature, and with a qualitative approach for analyzing a social issue seeking to understand the social subjects and their behavior in relation to the phenomenon studied [27]; [28].

The data collection techniques were carried out through research in secondary sources such as books, scientific articles, legislation, guidelines, standards that define and regulate the urban solid waste in Brazil. As for the analysis techniques, it was used the content analysis and the narrative socio-historical contextual discourse [28]); [29]; [30].

The study brought to light the most fertile debate on the concept, characterization, and other norms that govern and regulate Urban Solid Waste in Brazil, the actions and performance of the public power, and on the responsibility that each person in Brazilian society must have in relation to environmental issues and causes.

III. RESULTS AND DISCUSSION

The study we adopted focuses on the classification of municipal solid waste according to its origin, based on Law 12.305/2010. There are several classifications for solid waste and criteria to divide it. However, one should follow those based on the legislation. Brazilian Standard 10004/2004 presents the classification of solid waste in two classes: Class I and Class II, A and B:

Table 1: Waste classification

Class I Residues - Dangerous	They are those that present danger - risk to public health or the environment - or one of the characteristics of: inflammability, corrosivity, reactivity, toxicity, pathogenicity, or are listed in Annexes A or B of the standard.
Class II A waste - Non inert	They are those that do not fit into the class I waste classifications, Dangerous, or Class II B waste class, inert. Class II A waste may have properties such as biodegradability, combustibility, or water solubility.
Class II B waste - Inert	They are any residues that do not have any of their constituents solubilized at concentrations above the water potability standards, except for appearance, color, turbidity, hardness, and flavor, as per annex G, of the referred standard [10].

Source: Compiled by the authors

In corroboration with the above demonstration, [12] makes a comparative analysis of the Brazilian Standard and Law No. 12,305/2010. The first classifies solid waste into two groups: Hazardous (class I) and NonHazardous (class II), while the Law 12.305/2010 classifies them according to their origin, counting eleven distinct groups, and, as to hazard in two classes Hazardous and NonHazardous. It emphasizes that by the Norm,

[...] the waste classification process involves identifying the process or activity that gave rise to it and its constituents and comparing these constituents with listings of waste and substances whose impact on health and the environment is known [12].

The author concludes that the concept of hazardous waste adopted by the Standard is more restricted than that adopted by Law 12.305/2010. Both consider as hazardous waste those with hazardous, flammability, reactivity, and toxicity. The law expands this concept, adding to the waste characteristics of pathogenicity, carcinogenicity, teratogenicity, and mutagenicity, warning that they cause risk to public health and environmental quality.

Table 2: Classification of waste by origin.

Urban Solid Waste	Description	Material Type
Household waste	They are those resulting from domestic activities in households, usually consisting of food leftovers, decomposing products.	Paper, cardboard, plastic, glass, nonferrous metal, disposable diapers, polyethylene terephthalate/pet packaging, ferrous metal, tree trimmings, animal feces, among other items.
Urban Cleaning Waste	This is the waste that comes from public places.	Waste from streets, squares, parks, public sweeping weeding, scraping demolition material /debris from construction sites, among others, as well as old furniture, large branches, ceramic appliances, and materials that are useless for use.
Urban solid waste	It is the name used to refer to all the types of waste generated in the cities and collected by the municipal service.	Household waste, sweeping waste, commercial waste and, in some cases, rubble), that is, it is all the household and urban cleaning waste produced by the population [19].
Waste from commercial establishments and service providers	They are residues generated in the urban and/or rural areas, originated from commercial activities and services service.	They are waste from supermarkets, restaurants, squares, and other services (BRASIL, 2010).
Waste from public sanitation services	They are residues from fluvial drainage, cleaning of culverts	Glassware, bags, debris generation, decomposing animals, among others are found [3].
Industrial waste: waste generated in production processes and industrial facilities	Among them are residues considered as dangerous: products out of specification.	They are paints, raw materials, and intermediary products such as solvents; oily dregs from refining processes; electrodes; decanter box residues; contaminated PPE among others [3].
Health service waste	These residues, from hospitals - hospital waste - drugstores, medical and dental offices, clinical analysis laboratories, veterinary clinics, among other establishments that provide services like these.	These are syringes, needles, dressings, and other materials that may present some type of contamination by disease-causing pathogens" [19].
Construction waste	This includes construction and demolition materials; pavement and building renovations and repairs.	They are ceramic components - bricks, blocks, tiles, coating plates, among others; mortar and concrete; and from other infrastructure work including soil - blocks, pipes, curbs generated in the construction sites from earthworks; from the manufacturing process and/or demolition of precast concrete parts.
Argo-forestry residues	They are residues from agricultural and cattle raising activities. They are all the residues that can be generated in agricultural and cattle raising activities; forestry, including those related to inputs used in these activities (BRAZIL, 2010).	These are waste oils, plant protection product packaging veterinary medicine packaging and labeling, pesticide packaging, and plastics, among others.

Transport residues	Transport service residues are those that originate at ports, airports, customs , road and rail terminals, and border crossings.	The waste collected at these sites is treated as "septic waste", because it can contain disease-causing agents brought from other countries. It may contain pathological agents and spread diseases between cities, states, and countries, mainly through food leftovers, food products and personal use.
Mining waste	Mining waste is generated in the drilling activity,	These are tailings generated from iron, limestone, titanium,

Source: Prepared by the authors

All these materials, properly separated, can generate beneficial impacts both environmentally and economically; contributing to the generation of income in communities where selective collection of waste is practiced at its origin and its recycling can be another possibility of income generation for communities. This would avoid health problems caused by the proliferation of infectious and parasitic disease vectors.

There is a worldwide concern in relation to the final disposal of SUW's produced by the populations, intensified from the conferences organized by the United Nations, from Stockholm and Vancouver, in the 1970's, resulting in the search for measures of lesser impact on the environment, contributing to its balance and socio-environmental sustainability. One of them are the treatment techniques that allow energy to be obtained through its recovery, which significantly reduce the impact that waste causes to the environment.

There are several methods of urban waste treatment. The option for one or a combination of two or more of them will depend on the composition of the garbage and the public policy adopted by each state.

In Brazil, the regulatory framework for the environmentally adequate final disposal of SUW's is supported by Law No. 12.305/2010 in art. 3, item VII, which provides for the RSU's including its reuse, recycling, composting, recovery and energy recovery or other purposes, obeying the specific operational rules of the regulatory agencies: National Environmental System - SISNAMA, National Health Surveillance System - SNVS and Unified Agricultural Health Care System - SUASA; in order to avoid public health and safety problems, as well as aiming to reduce environmental impacts.

As for the types of destination of Urban Solid Waste emphasized in Law No. 12,305/2010, they are:

Table 3: Types of waste destination.

Waste destination	Description
Reuse	Reuse is defined as "the process of using solid waste without its biological, physical or physical chemical transformation. Thus, the reuse of waste means extending the useful life of objects and or giving them a new function, for example, plastic ice cream and margarine jars can be reused to pack other foods or to store utensils, besides being possible to use it as a plant pot, among others.
Recycling	Recycling means "the process of transforming solid waste that involve the alteration of their physical, physicochemical, or biological properties, with a view to transformation into inputs or new products".
Composting	is a simple measure that occurs through the biological process of decomposition and recycling of organic matter contained in animal or plant remains, forming a rich fertilizer for the soil. It provides an appropriate destination for organic waste, reducing its

	accumulation in landfills and repairing the soil. This technique promotes an adequate destination for organic agricultural residues, industrial and domestic. This organic compost can be applied directly to the soil to improve its characteristics, without causing risks to the natural environment.
Recovery and energy use	It is a technology that transforms waste into electrical and thermal energy using its calorific power as fuel; energy recovery is provided for in the provisions of the PNRS. The energy recovery of MSW can occur through the gases derived from landfills or by thermal treatment processes. An example of biogas generation in a landfill is started a few months after the waste landfill started and will continue for about 15 years after it is closed.

Source: Prepared by the authors

According to the types of destination of waste, it should be understood in this definition, that there can only be destination for waste that was "generated". Once generated, the waste can take several paths, whether they are an open-air dump, or environmentally appropriate if they are for reuse, recycling, composting, and recovery and energy use of this waste.

The current situation in Brazil shows unemployment and underemployment, aggravated by the lack of job openings and the low educational levels of the population, forcing them to perform unhealthy labor activities, such as the collection of garbage and the housing of families in the garbage dump.

In the dumps, the people who work there are subject to conditions that are inadequate to the human being. [31] state that in informal jobs it is common the absence of both environmental and individual protection equipment, and that the insufficient training of workers is added to the risk factors to the specific health of the activities that are developed in these places.

Thus, actions are required to implement mechanisms that minimize the environmental impacts caused by man, through compliance with the obligations of goals and objectives of the public authorities, since it is their responsibility to provide the urban infrastructure as well as the mobilization of the population for the planning and sharing of actions on how it will be destined RSU's, observing the resources and investments available. The environmental issue related to the proper disposal of SUW's has been a constant concern of governments and of society in general, which must take on shared responsibility

Based on this premise, law 12.305/10, which established the PNRS, provides the principles, objectives, and instruments (Article 4) for its implementation, as well as guidelines on integrated management and solid waste management, including hazardous waste, the responsibilities of generators and the government and economic instruments applied. Thus, the law contains important tools to enable the

confrontation of the social, economic, and environmental consequences of the adequate management of the waste produced by the population with technical planning.

In addition, the law guides a proposal that institutes the prevention and reduction of waste generation. It encourages the practice of sustainable consumption habits and provides a set of tools to increase the recycling and reuse of waste, valuing the material that has economic value and can be reused or recycled. Therefore, it ensures that the disposal of waste that cannot be reused or even recycled minimizes negative environmental impacts.

The National Policy for Solid Waste (PNRS), based on Law No. 12.305/2010, outlines guidelines for its integrated management. The Law announces that the municipalities need to plan the correct operation for the selective collection and disposal of waste produced by the population.

In this way, the Law enables the creation of important goals that will contribute to the elimination of open-air dumps and indicates planning tools at the national, state, and municipal levels, as well as at the micro, regional, inter-municipal, and metropolitan levels; in addition to establishing that private parties must prepare their Solid Waste Management Plans.

IV. CONCLUDING REMARKS

After conducting this study, some judgments can be declined about Urban Solid Waste and Environmental Education (EE) or lack thereof in the Brazilian context and / or Ceará. Starting with the lack of compliance with the rules and legislation and the absence and practice of a public policy of efficient, effective, and widespread environmental education in the educational environment at national and regional levels. This has hindered any action that rethinks a strategy to reduce the waste that is produced. Although this has not been the object of this research, it seemed to us that this assertion is applicable to those municipalities of the space use agreement, already mentioned here.

The way in which the public authorities in their different

spheres manage SUW's is inadequate, especially when it comes to transportation, such as buckets or even trucks with small bodies, with sheets of plywood on the sides, to pack more garbage, making it impossible not to lose the garbage collected during transportation, as is evidenced on the roads and/or places where they pass.

It is possible to see that an integrated and integrating public policy of the public power in the different spheres from municipal to national for the final disposal of SUW's is of extreme importance, so that in each "generator environment", no longer of garbage, but of residues, the sorting by selective collection would be done, that is, in the domestic, commercial, hospital, and industrial environments, this is the action of each citizen, this for the so-called dry residues. The humid or organic ones, in a responsible public policy, would be destined to composting. Thus, the population would have several benefits generated by the selective collection and composting, because in this way "the waste", properly separated, would generate more income, adding value to the worker who lives from the collection.

Therefore, it is necessary to change the actions and actions of the government and to change the habits of the population through a more effective environmental education regarding "their garbage". This problem must be seen in an integrated way in its multiple dimensions.

REFERENCES

- [1] BRAZIL. Law no. 12.305, of August 2, 2010. Instituting a Política Nacional de Resíduos Sólidos; altera a Lei no 9.605, de 12 de fevereiro de 1998; e ad outrops Providencia's.
- [2] PRS. Solid Waste Portal: Legal Aspects, Waste Management Plans. 11/05/2013. Available at: <<http://www.portalresiduossolidos.com/plano-nacional-de-residuos-solidos/>> Accessed: 16 nov 2016.
- [3] BRAZIL. Official Diary of the Federative Republic of Brazil: Legislative Power, Brasília, DF, 2010. Available at: <http://www.mma.gov.br/port/conama/legiabre.cfm?codlegi=636>.
- [4] PNRS. National Plan for Solid Waste. Brasília: MMA, 2012. Disponível em: http://www.sinir.gov.br/documents/10180/12308/PNRS_Revisao_Decreto_280812.pdf/e183f0e7-5255-4544-b9fd-15fc779a3657.
- [5] BRAZIL. Ministry of Education. Education manual for sustainable consumption. Brasília: MEC/MMA/IDEC, 2005. Available at: <<http://portal.mec.gov.br/dmdocuments/publicacao8.pdf>>
- [6] BASTOS, R. de H. et al; Cap:8, Management of Solid Waste in the Municipality of Guaramiranga-Ceará. In _____ . Serra de Baturité: an integrated view of environmental issues/ABNER, M. N. N. C. et al. (Org) BASTOS. F. H.: Fortaleza: Expression Grafica e Editor, 2011.
- [7] LIMA, J. D. Urban Solid Waste Management in Brazil. 1 Ed. ABES. Campina Grande - PB, 2001, 267p.
- [8] BIDONE, F. R. A.; POVINELLI, J. Conceptus Basics de Residues Solidus. EESC- USP/Escola de Engenharia de São Carlos - Universidad de São Paulo. São Carlos: 2001,120p.
- [9] NAIME, R; SANTOS, K, L. Diagnosis of solid waste management in the municipality of Campo Bom - RS. Engenharia Ambiental - Espírito Santo do Pinhal, v. 6, n. 3, p. 563-576, sep/dec 2009.
- [10] ABNT- Brazilian Association of Technical Standards. NBR 10004. Rio de Janeiro, 2004. 71p. Available at: <<http://www.ebah.com.br/content/ABAAAFRNMAb/nbr-10004-residuos-solidos-classificacao>>
- [11] BRAZIL. Law No. 6.938 of 1981: Provides on the National Environmental Policy Environment, 1981. Available at: http://www.planalto.gov.br/ccivil_03/Leis/L6938.htm Accessed: apr. 2018.
- [12] SANTOS, G. O. Solid waste, and sanitary landfills: in search of a new look/Gemmelle Oliveira Santos; preface Suetônio Mota. - Recife: Imprima, 2016.
- [13] IBAM. Manual for Integrated Solid Waste Management. Brazilian Institute of Municipal Administration. Rio de Janeiro, 2001. José Henrique Penido Monteiro ... [et al.]; technical coordination Victor Zular Zveibil. Rio de Janeiro: IBAM, 2001. Available at: <<http://www.resol.com.br/cartilha4/manual.pdf>> Accessed 10 Jun 2017.
- [14] OLIVEIRA, M. C. Qualitative survey of the situation of RSU's: Escudo de Caso no municipia de Barreira - Ce. Unilab. 2016. Available at: <<http://repositorio.unilab.edu.br:8080/jspui/bitstream/123456789/558/1/Marlytana%20Costa%20de%20Oliveira.pdf>>
- [15] FERNANDES, J. U. J. Garbage: urban public cleaning: solid waste management from the perspective of administrative law. Belo Horizonte: Del Rey, 2001.
- [16] MARQUES, R, F, P, V. Environmental impacts of urban solid waste disposal on soil and surface water in three municipalities of Minas Gerais /Rosângela Francisca de Paula Vitor Marques. - Lavras: UFLA, 2011. 95 p.
- [17] LEONARD, Annie. The history of things: from nature to trash, what happens to everything we consume. Technical revision André Piani Besserman Vianna. Translation Heloísa Mourão. Rio de Janeiro: Zahar, 2011.
- [18] FEPAM - Technical Guideline for the Environmental Licensing of the activity of Final Disposal De RSU's. Available at: <<http://www.fepam.rs.gov.br/CENTRAL/DIRETRIZES/DT-004-2017.PDF>>
- [19] NASCIMENTO. M. N et al. (Org.) Solid Waste Booklet: Sustainable Technologies Program; Projeto "No Clima da Caatinga". Org.: Associação Caatinga. Publication May 2015. Available at: https://issuu.com/climadacaatinga/docs/cartilha_2_small_1aab8f949a9ce4
- [20] COPOLA, G. The National Solid Waste Policy: Lei federal nº 12.305, de 2 de agosto de 2010: os aterros sanitários de rejeitos e os municípios. Fórum de Direito Urbano e Ambiental, Belo Horizonte, v. 10, n. 58, 2011.

- [21] CONAMA. National Council of the Environment. RESOLUTION No. 001, of January 23,1986. Available at: <<http://www.mma.gov.br/port/conama/res/res86/res0186.html>>
- [22] PEREIRA NETO, J.T. Solid Waste Management in Small Municipalities. Science and Environment Magazine, number 18, Santa Maria - RS, 1999. 42-52p.
- [23] SARIEGO, J. C. environmental education: as ameaças ao planeta azul. São Paulo: Scipione,2002.
- [24] CASCINO, Fabio. Environmental Education: principles, history, teacher training. 02.ed. São Paulo: SENAC, 2000.
- [25] OLIVEIRA, G. C. S; TONIOSSO, J. Environmental education: pedagogical practices in early childhood education. Cadernos de Educação: Ensino e Sociedade, Bebedouro-SP, 1 (1):30-43, 2014.
- [26] MILHORANCE, Flavia. What was Rio 92. O Globo. 30 May 2012. Available at: <<http://www.oglobo.com.br/>> Accessed on: 25 May 2013.
- [27] XAVIER, A. R. et al. Research in Education: historical and theoretical-methodological aspects. EDUCA. Multidisciplinary Journal in Education, [S.l.], v. 8, p. 1-19, jan. 2021. Available at: <https://www.periodicos.unir.br/index.php/EDUCA/article/view/4627/3815>>.
- [28] GIL, A. C. Methods, and techniques of social research - 6th ed.
- [29] SEVERINO, Antônio Joaquim. Scientific Work Methodology. 26. ed. - São Paulo:Cortez, 2013.
- [30] CHIZZOTTI, Antonio. Research in humanities and social sciences. 4 ed. São Paulo:Vozes, 2011.
- [31] MENDES, R.; CAMPOS, A. C. C. Health and safety in informal work: challenges and opportunities for the Brazilian industry. Brazilian Journal of Occupational Medicine, Belo Horizonte, v. 2, n. 3, p. 209-223, jul./set. 2004.

Analysis Design Results of Kort Nozzle on Yamaha 15 HP Outboard Motor Propulsion System Towards Increasing Ship Speed

Brampi Stefie Hendry Huka, Berbudi Wibowo, Maimun

Fisheries Resources Utilization Study Program, Jakarta Technical University of Fisheries Indonesia AUP Politechnic graduate program, Indonesia

Received: 03 Jun 2022,

Received in revised form: 01 Jul 2022,

Accepted: 08 July 2022,

Available online: 14 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Kort Nozzle, Propulsion, Yamaha Outboard Motor.

Abstract— Use of Yamaha outboard motors There are very many small farmers (tuna fishermen) with a capacity of 1.5 GT in the Leahari country, South Leitimur sub-district, Ambon city. Apart from being used for fishing, it should also be used to sell the catch to the receiving company, but in reality the sales process to the company uses a rental motorcycle taxi. One of the factors that need to be considered in the process of planning and building a ship is a good propulsion system, the propulsion system itself is Propeller design planning. Propeller is one aspect that must be planned properly in order to achieve the purpose of the ship's function in terms of speed. Propeller that uses a kort nozzle is called a ducted propeller. The phenomenon that occurs in propeller enclosed in a tube (kort nozzle) is that the velocity of the water flow inside the tube is faster than the flow of water outside the tube resulting in lower pressure inside the tube than the pressure outside the tube. . This pressure difference results in an additional thrust (thrust). In this study, the method used is experimental and statistical tests in which the author will examine the use of a kort nozzle on the Yamaha 15 HP outboard motor propulsion system which is expected to increase the speed of the ship so that fishermen can use vessel to sell their tuna catches to receiving companies.

I. INTRODUCTION

The use of a Yamaha 15 HP outboard motor on small fishing vessel (tuna fishermen) with a capacity of 1.5 GT (Leaharicountry, South Leitimur sub-district, Ambon city) is very much in meet. Apart from being used for fishing, it should also be used to sell the catch to the receiving company, but in reality, because the location of the company is quite far away, the sales process to the company uses a rental motorcycle taxi.

In the process of planning and building a ship, several factors need to be considered in order to achieve shipbuilding goals. Important factors in order to achieve the desired maximum speed of the ship are hull planning,

engine systems, safety systems, and good propulsion systems.⁵

The propulsion system it self is the propeller design plan. Propeller is one aspect that must be planned properly in order to achieve the purpose of the ship's function in terms of speed. The speed of the ship is inseparable from a good propeller design in order to get the thrust generated by the propeller motion.⁷

Propellers that use a nozzle nozzle are called ducted propellers. kort nozzle wrapper propeller in the form of a foil-shaped plate.¹

High thrust loads provide low efficiency, whereas low thrust loads provide high efficiency. Thus, the efficiency

of the propeller can be increased, which means an increase in the propulsive quality of the ship, by reducing the thrust load.⁵

Phenomenon that occurs in propeller enclosed in the tube (kort nozzle) is the speed of water flow inside the tube faster than the flow of water outside the tube resulting in lower pressure inside the tube than outside the tube. This pressure difference results in an additional thrust (thrust), with the installation of a nozzle nozzle on the propeller, there can be an increase in thrust or thrust.⁶

In this study, the author will examine the use of the nozzle nozzle outboard motor propulsion system Yamaha which is expected to increase the speed of the ship so that fishermen can use the ship to sell their tuna catch to receiving companies.

II. RESEARCH METHODS

The method used in this research is field testing or experiments conducted on 10 -12 May 2022 in Negeri Leahari country, South Leitimur sub-district, Ambon city, Maluku province. The tests carried out include speed testing and thrust testing on a Yamaha 15 HP engine that uses a kort nozzle and does not use a kort nozzle.

Tools and materials used in this study include:

Tools :

- Tuna Boat (1.5 GT)
- Yamaha Outboard Motor 15 HP
- Kort Nozzle
- Stop Watch
- Weights and Buoys
- Digital hanging scales and load belts
- "L" wrench
- Ples screwdriver
- Mines screwdriver
- Field Roll Meter (100 Meters)
- Digital Tachometer

Material :

- 12" Nylon rope
- Fuel
- 2T Mediterane Oil
- Majun

III. RESULTS AND DISCUSSION

Propulsion

System The propulsion system on ships is generally divided into 3 main components, namely : the main engine, the transmission system and the propulsor (movement equipment). These three main components are an integral part of the planning process that cannot be reviewed separately. Errors in the design, will have very large consequences for the following conditions:

1. Not achieving the planned service speed of the ship
2. Fuel oil consumption is not efficient
3. The economic value of the ship decreases
4. Influence on the level of vibration that occurs on the hull.

The way the ship propulsion system works is the main engine as the main power provider which then provides power to the transmission system. The amount of power received by the transmission system depends on the efficiency of the main engine. The power that enters the transmission system will be forwarded again to the propulsor, so that the propulsor which functions as a ship propulsion device will move due to the Effective Horse Power received from the transmission system.

Vessel and Engine

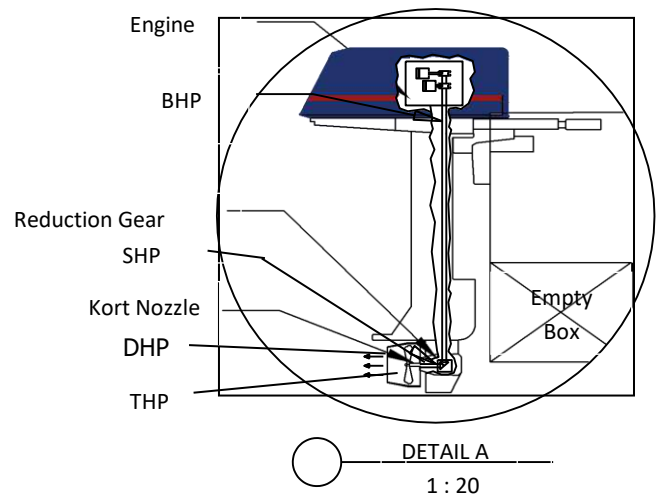


Figure 1. Ship Propulsion System

Engine Data

Brand	: YAMAHA
Type	: FMH
Power	: 15 HP
Output Power	: 11 KW
Weight	: 36 – 38 Kg
Diameter x Step	: 56.0 mm x 50.0 mm

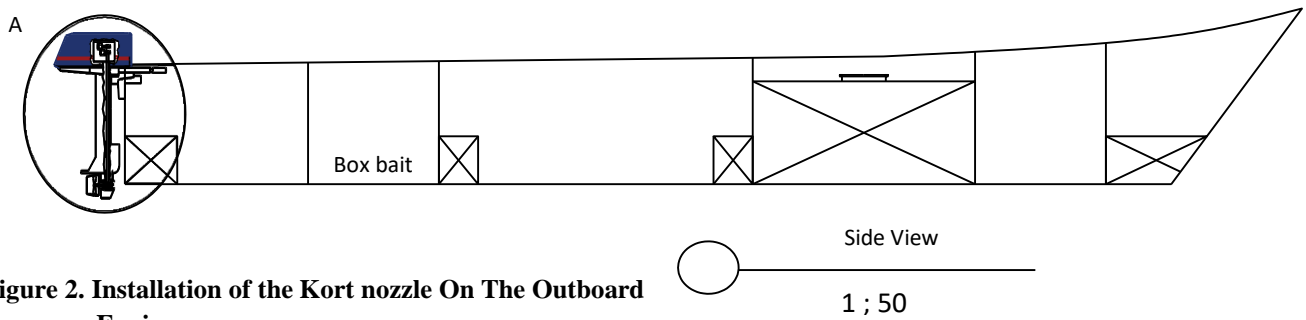


Figure 2. Installation of the Kort nozzle On The Outboard Engine

Data Vessel Data

Length (LOA)	: 09.00 m
Waterline Length (LWL)	: 08.55 m
Overall Width (B)	: 01.25 m
Deck Height (H)	: 00.75 m Draft
Height (T)	: 00.60 m
Gross Weight (GT)	: 01.50

Power Calculation – Power on Ship Propulsion System

a. EHP (Effective Horse Power)

Effective Horse Power or effective thrust of the ship can be calculated by the formula⁶ as follows:

$$EHP = R_T \times V_S \text{ (HP)}$$

Where :

- EHP = Effective power
- R_T = Total Resistance, (Kg)
- V = Vessel service speed, (m/s)

b. THP (Thrust Horse Power)

thrust *propeller* can be calculated by the formula⁶ as follows :

$$THP = T \times VA \text{ (HP)}$$

Where :

- THP = Thrust
- T = Thrust
- VA = Advance velocity of fluid flow in the *propeller* disc (m/sec).

c. DHP (Delivered Horse Power)

Delivered Horse Power or power delivered to the *propeller*, can be calculated by the formula⁶ as follows :

$$DHP = EHP/PC, \text{ (HP)}$$

Where : PC = efficiency *Propulsive*,

which can be calculated by the following formula :

$$PC = \eta_O \cdot \eta_H$$

Where :

- O = *Propeller efficiency*
- H = rotative efficiency, the value is taken from 1.

Relative = Efficiency of the hull which can be calculated by the formula:

$$H = (1-t)/(1-w)$$

d. SHP (Shaft Horse Power)

Shaft Horse Power (SHP) is the power measured up to the area in front of the *stern tube* bearing of the ship propulsion shaft system. *Shaft Horse Power* (SHP) can be calculated by the formula⁶ as follows:

$$SHP = DHP/\eta_S, \text{ (HP)}$$

Where :

- DHP = Power supplied to the *propeller*, (HP)
- S = Efficiency on the *propeller* shaft

e. BHP (Brake Horse Power)

BHP or brake power measured at the flange between the *gearbox* and *thrust* bearing is calculated by the formula⁶ as follows:

$$BHP = DHP/(\eta_S \cdot \eta_{gear}), \text{ (HP)}$$

Where :

- S = Efficiency on *propeller* shaft
- gear = Efficiency of reduction gear

f. Speed of Advance (V_A)

Speed of Advance or advance speed can be calculated by the formula⁶ as follows:

$$V_A = V(1-w), \text{ (m/sec)}$$

Where : V = Vessel Speed, (m/s)
 W = current fraction with

g. T (Thrust)

A ship with a good thrust value can make a ship run better in terms of speed when compared to a bad thrust value under the same conditions of horse power and rpm.⁴

Thrust or propeller can be calculated by the formula⁶ as follows:

$$T = R_T / 1 - t, (Kg)$$

Where : R_T = Total ship resistance, (Kg)
 t = thrust fraction

Test Results and Statistical Analysis

Paired t-test (paired t -test) is a method of testing the hypothesis where the data used is not independent (in pairs). The characteristics that are most often found in paired cases are that one individual (object of research) gets 2 different treatments. Even though using the same individual, the researcher still obtained 2 kinds of sample data, namely data from the first treatment and data from the second treatment.³

This method was also used by the author in testing hypotheses on the sample data obtained. Both for speed and thrust.

The Trust

Table 1. Result of Trust Tes Without Kort Nozzle

No	Machine RPM (RPM)	Trust Result (Kg)/Repeat			
		1	2	3	4
1	2000	42,3	42.1	42.4	42.3
2	2500	51.5	51.4	51.6	51.4
3	3000	73.2	73.3	72.9	73.5
4	3500	111	111, 2	111	111. 3

Table 2. Result of Trust Tes Kort Nozzle

No	Machine RPM (RPM)	Trust Result (Kg)/Repeat			
		1	2	3	4
1	2000	45,5	45.4	45.2	45.2
2	2500	54.5	56,6	54.6	55

3	3000	77.5	77.3	77.4	77.6
4	3500	115. 6	115. 8	115. 4	115. 5

The results of the statistical analysis of Paired T test are as follows :

Sig 0.00

: T statistic (20.515) > t table (2.11991)

Speed Test

Table 4. Speed Test Result Without Using Kort Nozzle

No	Machine RPM (RPM)	DISTANC E	Time			
			1	2	3	4
1	2000	100	0.4979	0.4982	0.4977	0.4983
		200	1.3687	1.3691	1.3689	1.3701
		300	2.2537	2.2539	2.2536	2.254
2	2500	100	0.4100	0.4102	0.4101	0.4102
		200	1.2218	1.2220	1.2218	1.2221
		300	2.0179	2.0177	2.018	2.0179
3	3000	100	0.3384	0.3385	0.3383	0.3385
		200	1.0513	1.0512	1.0514	1.0517
		300	1.3778	1.3777	1.3780	1.3780
4	3500	100	0.284	0.2843	0.2846	0.2842
		200	0.5519	0.5521	0.5518	0.5516
		300	1.2247	1.2248	1.225	1.2248

Table 4. Speed Test Result using Kort Nozzle

No	Machine RPM (RPM)	DISTANC E	Time			
			1	2	3	4
1	2000	100	0.4591	0.4589	0.4591	0.459
		200	1.3013	1.301	1.301	1.3012
		300	2.1985	2.1984	2.1985	2.1985
2	2500	100	0.3991	0.3992	0.399	0.399
		200	1.1594	1.1594	1.1593	1.1593
		300	1.5419	1.542	1.5419	1.5418
3	3000	100	0,306	0.3058	0.3059	0.306
		200	1.0303	1.0301	1.0303	1.0302
		300	1.3534	1.3533	1.3534	1.3534

4	3500	100	0.2625	0.2625	0.2524	0.2522
		200	0.5171	0.517	0.5169	0.5168
		300	1.2025	1.2024	1.2024	1.2022

Results Statistical analysis of Paired T test as follows

Sig : 0.00

Calculation (4,071) > t table (2.01174)

Calculation of Speed and Thrust Addition of Ships Using Nozzle Kort and Not Using Nozzle Kort

Based on the experimental results and the results of statistical tests, it can be calculated the increase in speed and *thrust* for ships using *kort. nozzle* when compared with ships that do not use *a nozzle* as follows :

Increase in Speed

Known ;

a. = Average speed of ships using *kort nozzle* = 9771.00000

b. = Average speed of ships that do not use kort nozzle = 10499.6667

c. = the difference between a and b = - 728.66667

So the increase in speed of

$$c / bx \text{ is } 100\% = 728.66667 / 10499.6667 = 6.9 \text{ or rounded to } 7\%.$$

There is an increase in speed of 7% for ships that use the *kort nozzle* when compared to those that do not.

Calculating the travel time of ships that do not use Kort Nozzle

$$Traveling \ Time = \frac{Distance}{Speed}$$

Known :

Fishing Ground Distance to Receiving Company = 14.5 NM

Speed 7 Knots

Then :

$$Travel \ Time = \frac{14.5 \ NM}{7 \ Knots} = 2.07 \text{ hours (124.2 minutes)}$$

Calculating the Travel Time of a Ship Using Kort Nozzle

$$Travel \ Time = \frac{Distance}{Speed} - 7\%$$

Then :

$$Time = \frac{14.5 \ NM}{7 \ Knot} - 7\% = 2.07 - 0.1449 = 1.925 \text{ hours (115.5 Minutes)}$$

The difference in travel time for ships that use kort nozzle and those that do not use kort nozzle are :

Time using kort nozzle – time not using kort nozzle

In hours = 2.07 hours – 1,925 hours = 0.145 hours

In minutes = 124.2 minutes – 115.5 = 8, 7 minutes

Speed Test Results Without Using Kort Nozzle

$$Speed = \frac{Distance}{Time}$$

Then :

$$Speed = \frac{14.5 \ NM}{2.07} = 7 \text{ Knots}$$

Speed Test Results Using Kort Nozzle

$$Speed = \frac{Distance}{Speed} + 7\%$$

Then:

$$Speed = \frac{14.5}{2.07} + 7\% = 7 + 7\% = 7.49 = 7.5 \text{ Knots}$$

The difference in the speed of ships using a nozzle kort with those not using a kort nozzle is :

Speed using a kort nozzle – Speed not using a kort nozzle

The difference in speed = 7.5 knots – 7 = 0.5 Knots

Added Thrust

Known ;

a. = Average thrust of ships using *kort nozzle* = 73.362

b. = Average thrust of ships that do not use kort nozzle = 69,525

c. = the difference between a and b = 3.837

So the additional thrust is : $c / bx 100 = 3.837 / 69.525 = 5.5\%$.

There is an increase in thrust of 5.5% for ships that use the *kort nozzle* when compared to those that do not.

From the results of the calculation of the speed obtained an increase in speed of 0.5 knots (926 m) so that the travel time is reduced by 8.7 minutes, although the increase in speed is not too large, the use of ships to carry the catch is still recommended to be used because the quality of the catch is maintained properly because it does not occur. repeated handling processes and on return can bring more ice.

IV. CONCLUSION

- 1 From the results of experiments and statistical tests carried out, there is a 7% difference in speed between ships that use a kort nozzle and those that do not use a kort nozzle.
2. With the addition of speed, it can increase the travel time to the recipient company even though it is not too big.
3. From the results of experiments and statistical tests carried out, there is a difference in thrust of 5.5% between ships that use the kort nozzle and those that do not use the kort nozzle.

ACKNOWLEDGEMENTS

This research is supported by the Marine and Fisheries Education Center, Ministry of Marine Affairs and Fisheries of the Republic of Indonesia, Jakarta Fisheries Business Expert Polytechnic. Thank you to my postgraduate friends from class X for their support and motivation, as well as the Ambon Waiheru Fisheries Business School

REFERENCES

- [1] Carlton, JS (2010). *Marine Propellers and Propulsion, 2nd edition. In Proceedings of the ICE - Maritime Engineering* (Vol. 163).
- [2] Huda Nurul. (2013). *Analisa Pengaruh Energy Device Pada Propeller Dengan Metode CFD. 10 number 3.*
- [3] Montolalu, C., & Langi, Y. (2018). *Pengaruh Pelatihan Dasar Komputer dan Teknologi Informasi Bagi Guru-Guru Dengan Uji-t Berpasangan (Paired Siample t-test) D'CARTESIAN, 7 (1), 44.* <https://doi.org/10.35799/dc.7.1.2018.20113>
- [4] Putra Desto Paradika. (2015). *Analisa Pengaruh Pemasangan Energi Saving Device (ESD) Propeller Boss Cap Fins (PBCF) dan Kort Nozzle Pada Propeller Type B-Series dan Propeller Type AU Terhadap Gaya Dorong*

Propeller Dengan Metode CFD . Journal Teknik Perkapalan.

- [5] Simbolon, H., Trimulyono, A., & Rindo, G. (2015). *Analisa Nilai Maksimum Trust Propeller D-Series dan Kaplan Series Pada Kapal Tugboat Ari 400 Hp Dengan Variasi Diameter, Jumlah Daun, Sudut Trake Menggunakan CFD. Jurnal Teknik Perkapalan 3(4), 394–404.*
- [6] SV. AA Harvard. (1983). *Resistance and propulsion of ships, Lyngby, Denmark.* Wibowo, GP, Chrismianto, D., Shipping, DT, & Diponegoro, U. (2017). *Analysis of the Optimum Thrust Value of Propeller B4-70, Ka4-70 and Au4-59 on a Package-II 2X1850Hp Tugboat with Variation of Rake Angle Using Cfd. Journal of Marine Engineering, 5(1), 27–37.*
- [7] Wibowo G.P, Chrismanto D, Perkapalan D. T & Dipenogoro, U (2017), *Analisa Nilai Trust Optimum Propeller B4-70, Ka4-70 Dan Au4-59 Pada Kapal Tugboat Pelabuhan Paket –II 2X1850 Hp Dengan Variasi Sudut Rake Menggunakan Cfd, Jurnal Teknik Perkapalan.*

Corporate Social Responsibility with Child Education in the Sertão Pernambucano: The Case of Agrodan

Me. Elijalma Augusto Beserra, Prof. Dra. Lúcia Marisy Souza Ribeiro de Oliveira, Prof. Dra. Eva Mônica Sarmiento da Silva, Prof. Dra. Luciana Souza de Oliveira

Received: 06 Jun 2022,

Received in revised form: 03 Jul 2022,

Accepted: 10 July 2022,

Available online: 14 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Education, Social
Responsibility, Irrigated Fruit Growing.

Palavras chaves— Educação,
Responsabilidade social, Fruticultura
Irrigada.

Palabras clave— Educación,
Responsabilidad Social, Fruticultura Bajo
Riego.

Mots-clés— Éducation, Responsabilité sociale,
Arboriculture fruitière irriguée.

Abstract— Data published by the Organization for Economic Cooperation and Development - OECD (2021), which took as a reference the Integrated System of Financial Administration of the Federal Government - SIAFI, indicate that, unlike the other members of the group, Brazil has reduced its investment in education among the years 2019 and 2020 (MEC, 2021). As if the particular way in which education has been administered in Brazil were not enough, the effects caused by the COVID-19 pandemic, a disease caused by the coronavirus (Sars-Cov-2), negatively marked the history of national education. Against this movement, the school teacher Olindina Roriz Dantas, implemented by AGRODAN in Pernambuco, has been standing out as an example of responsibility and social commitment in the field of irrigated fruit, recognized as a national leader in mango exports. Socializing the ideals that made this teaching unit an example to be followed was the challenge of this study, which demonstrates that it is possible to reconcile successful business practices with social commitment to the inclusive and sustainable development of a region located in the Brazilian semi-arid region.

Resumo— Dados publicados pela Organização para a Cooperação e Desenvolvimento Econômico - OCDE (2021), que tomaram como referência o Sistema Integrado de Administração Financeira do Governo Federal - SIAFI, indicam que diferentemente dos demais membros do grupo, o Brasil reduziu seu investimento em educação entre os anos 2019 e 2020 (MEC, 2021). Não bastasse a forma particular como a educação vem sendo administrada no Brasil, os efeitos causados pela pandemia de COVID-19, doença causada pelo coronavírus (Sars-Cov-2), marcaram de forma negativa a história da educação nacional. Na contramão deste movimento, a escola professora Olindina Roriz Dantas, implantada pela AGRODAN em Pernambuco, vem se destacando como exemplo de responsabilidade e compromisso social no ramo da fruticultura irrigada reconhecida como líder nacional na exportação de manga. Socializar os ideais que fizeram desta unidade de ensino um exemplo a ser seguido, foi o desafio deste estudo, que demonstra ser possível conciliar práticas empresariais bem sucedidas com compromisso social para o desenvolvimento inclusivo e sustentável de uma região localizada no semiárido brasileiro.

Resumen— Datos publicados por la Organización para la Cooperación y el Desarrollo Económicos - OCDE (2021), que tomó como referencia el

Sistema Integrado de Administración Financiera del Gobierno Federal - SIAFI, indican que, a diferencia de los demás miembros del grupo, Brasil ha reducido su inversión en educación entre los años 2019 y 2020 (MEC, 2021). Como si fuera poco la forma particular en que se ha administrado la educación en Brasil, los efectos provocados por la pandemia de la COVID-19, enfermedad provocada por el coronavirus (Sars-Cov-2), marcaron negativamente la historia de la educación nacional. Frente a este movimiento, la escuela maestra Olindina Roriz Dantas, implementada por AGRODAN en Pernambuco, viene destacándose como ejemplo de responsabilidad y compromiso social en el campo de la fruta irrigada, reconocida como líder nacional en las exportaciones de mango. Socializar los ideales que hicieron de esta unidad didáctica un ejemplo a seguir fue el desafío de este estudio, que demuestra que es posible conciliar prácticas empresariales exitosas con compromiso social por el desarrollo inclusivo y sostenible de una región ubicada en el semiárido brasileño. región.

Resumée— *Les données publiées par l'Organisation de coopération et de développement économiques - OCDE (2021), qui ont pris comme référence le Système intégré d'administration financière du gouvernement fédéral - SIAFI, indiquent que, contrairement aux autres membres du groupe, le Brésil a réduit ses investissements en éducation entre les années 2019 et 2020 (MEC, 2021). Comme si la manière particulière dont l'éducation a été administrée au Brésil ne suffisait pas, les effets causés par la pandémie de COVID-19, une maladie causée par le coronavirus (Sars-Cov-2), ont marqué négativement l'histoire de l'éducation nationale. Contre ce mouvement, l'institutrice Olindina Roriz Dantas, mise en œuvre par AGRODAN à Pernambuco, s'est imposée comme un exemple de responsabilité et d'engagement social dans le domaine des fruits irrigués, reconnu comme un leader national des exportations de mangue. Socialiser les idéaux qui ont fait de cette unité d'enseignement un exemple à suivre a été l'enjeu de cette étude, qui démontre qu'il est possible de concilier des pratiques commerciales réussies avec un engagement social pour le développement inclusif et durable d'une région située dans la zone semi-aride brésilienne Région.*

I. INTRODUCTION

In the first verse of the poem “O Infante” (1934), the Portuguese poet Fernando Pessoa (1888-1935), coined one of the most representative epigraphs of Portuguese culture, when, in greeting the saga of Infante D. Henrique, he sentenced: “Deus quer, man dreams, the work is born” (PESSOA, 1972, p. 57). Moved by a similar thought, Celso Furtado and, later, the first 16 settlers of the Public Irrigated Project (PPI) managed to materialize the dream of creating the Bebedouro Project, which became the embryo of the largest irrigated fruit growing pole in the Brazilian semi-arid region (BESERRA, 2020). , p.42).

Half a century later, the phrase consecrated by Pessoa (1972) is remembered by those who pass through the thresholds of the school teacher Olindina Roriz Dantas, located in the Rural Zone of the Pernambuco municipality of Belém de São Francisco, because, in the midst of a

semi-arid region, in a city that, according to data from the National Institute of Educational Studies and Research Anísio Teixeira - INEP (2020), in 2017 had a Basic Education Development Index for the early years of elementary school of 4.8 reference units, it became a landmark for the municipality, with classrooms full of happy children, hopeful of a glorious future, for being there guiding them, competent teachers, with excellent pedagogical and technical training, who use modern tools with a view to effective learning.

The CEO of AGRODAN Comércio e Representações de Produtos Agropecuários, engineer and professor Paulo Alvares Roriz Dantas, as well as his collaborators, believe that children, upon completing their studies in this rural school, will be able to enter any public, state or federal, without major difficulties, considering the high level of education practiced there, where students

have classes in English, French and Spanish; they build robots as a didactic activity; they use information technology as a research tool and are part of art and culture through theater, dance, music, literature and textual production.

AGRODAN transformed the dry lands of the sertão into the largest orchard of mangoes of different species. In 2021, in the midst of the economic crisis caused by the Covid-19 pandemic, the company produced 33 million kilos of mango (*Mangifera Indica L.*), consolidating itself as the largest producer and exporter of this fruit in Brazil. Despite the auspicious numbers, for businessman Dantas (2021), the group's greatest achievement was the creation of the Agrodan Social Foundation, an institution founded in November 2017, which since February 2018 has been investing in the training of children, young people and adults residing in the surroundings of the Prof. Olindina Roriz Dantas, a space for the construction of knowledge.

II. IRRIGATED FRUIT CULTURE AS A DRIVERS FOR DEVELOPMENT

For many years the municipality of Belém do São Francisco presents itself as a reference in irrigated agriculture. Research carried out by Beserra (2020), alluding to Silva (2001), highlights that in 1932 there were already farmers there who used the wheel to transport water to be used in the irrigation of their plantations (BESERRA, 2020, p. 149).

Other records of the use of irrigation for food production were identified by the same author in the region of Petrolina-Juazeiro, a recognized fruit growing hub in the sub-medium São Francisco. In 1946, the Bishop of Petrolina Dom Avelar Brandão Vilela already encouraged the riverside people to produce irrigated vegetables and fruits, using rustic techniques, but which were indicative of the region's vocation and potential for food production. It was only in 1952 that farmers in the region began to make use of more suitable methods resulting from research, through the technical advice offered by the São Francisco Valley Commission - C.V.S.F, being its precursor the Portuguese technician José Cabral de Noronha, who started to recommend the use of fertilizers and pesticides and the control of diseases and pests to increase productivity (BESERRA Apud. POSSIDIO, 2020, p. 30).

Another major milestone in irrigated agriculture in Pernambuco was the implementation in 1968 of the Bebedouro Irrigation Project, the result of a technical partnership signed in 1960 between the Brazilian government, represented by the Superintendence for the Development of the Northeast – SUDENE and the United

Nations Organizations – UN, which delegated the management of this international pact to FAO – Food and Agriculture Organization of the United Nation, creating the technical conditions for the consolidation of irrigation in the São Francisco Valley (BESERRA, 2020, p.127).

Despite the contradictory positions on the subject, scholars of irrigated agriculture in the semi-arid region of Pernambuco recognize that irrigated fruit farming is an instrument of economic growth in the submiddle São Francisco region. In 2014, 85% of the mango exported to Europe and the United States came from this region, with data being kept until 2020 (MOURA et al., 2015, p. 497).

According to Mauco et al. (2012), much of this success was the result of a set of factors that came together to provide the ideal conditions for this activity, among which the following stand out: climatic conditions determined by high luminosity, low relative humidity and high temperature; use of irrigation from the São Francisco River; remarkable resilience of farmers and entrepreneurs; and more recently, a high degree of appropriate technology, which, combined with irrigation management techniques, pruning and the use of plant regulators, allows for the scaling of production according to market demand, bringing commercial advantages. (MOUCO et al., 2012, p. 338).

Mango (*Mangifera indica L.*) is a typical plant from regions with tropical and subtropical climates, belonging to the Anacardiaceae family (SANTO, 2019; DE MOURA et al., 2015; MUJHERJEE et al., 2009). , more specifically in India (MOUCO et al., 2012, p. 342; DE MOURA et al., 2015). Studies indicate that the plant was introduced in Brazil by the Portuguese who brought it from Goa, around 1700, having been adapted here and becoming, over time, one of the most cultivated fruit species in Brazil (VETUCCI et al., 2016). Data from the Brazilian Fruit Growing Yearbook (ABF) indicate that in 2020 approximately 243,225,884 kg of fruit were exported (ABF, 2021, p. 36). In the first half of 2021, according to the Brazilian Association of Producers Exporters of Fruits and Derivatives - ABRAFRUTAS (2021), 9,230,854 kg of mangoes were exported, an amount 48% greater than the same period in 2020, representing 1.06 billion dollars, an increase of 20% compared to the same period in 2020. In this same period, AGRODAN produced approximately 33 thousand tons of mango, which allowed the company to surpass the historic mark of 30 thousand tons registered in 2017.

All these data demonstrate that Brazilian farmers have been standing out in the production of tropical fruits, obtaining the third position among fruit

exporters in the world. In the specific case of mango, Brazilian production ranks seventh in the world (ABF, 2021, p. 85), with Asian countries, led by China and India, being the world's largest producers (OLIVEIRA, 2017).

IBGE data (2021) indicate that the national production of mango in 2020 was around 1,569,011 tons, with an average production of 21,853 kg/ha, as shown in Figure 01.

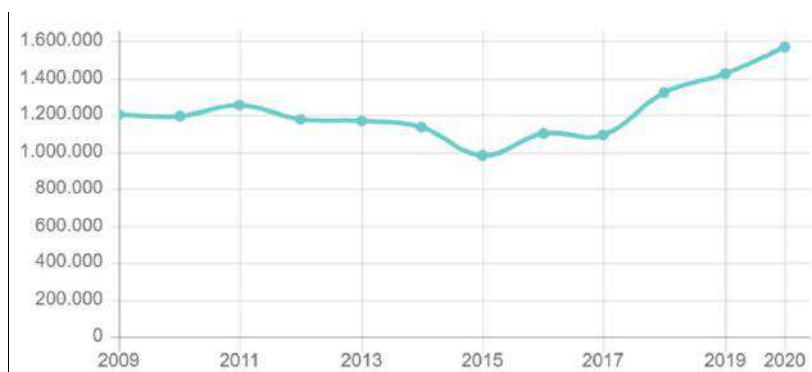


Fig.1 - National Mango Production

SOURCE: IBGE (2021)

Brazilian fruit farming generates about 6 million direct jobs, distributed in an area of approximately 2.4 million hectares, with mango farming responsible for employing an average of 1 to 2 people per ha (ABRAFRUTAS, 2018). Among the main mango varieties produced, we highlight Espada, Rosa, Haden, Keitt, Kent, Palmer and Van Dyke. On AGRODAN farms, Tommy Atkins, Keitt, Kent and Palmer varieties are produced.

It is important to highlight that the desired development for the semi-arid region of Pernambuco is not only represented by an increase in the region's GDP, but a liberating, powerless development that, in Sen's (2018) view, goes beyond the mere accumulation of monetary capital, where economic factors are better distributed, allowing the community as a whole to achieve a state of social well-being and appreciation of human, cultural and environmental capital.

In this perspective, the prosperity of the peasant communities is directly related to the disposition of the means of agricultural production as instruments of social inclusion, so that sustainable development becomes effective. Within this vision, rural development, according to Bourdieu (1989, p. 134), needs to be based on the idea of multidimensionality of development, where all aspects are considered, respecting local vocations and the knowledge consecrated by the community.

III. METHODOLOGY

This study is qualitative-quantitative, descriptive and interpretive, where sociocultural elements such as values, feelings, beliefs, concepts and attitudes were considered to understand social interactions and reports of lived experiences (TRIVIÑOS, 1987).

This possibility of merging different types of research has been gaining strength in recent years, as the complexity and fluidity of the ways in which social relationships are built is verified. According to Domingues (2004), in interpretive research, the agent seeks to identify the changes produced in the research group. These changes in the paradigms of the social group are reflections of facts and processes that took place in a certain period, which end up causing changes in the relational nature of the community; in social phenomena; and in the meanings and values that are attributed to social structures.

The focal objective of the study is the school implemented by AGRDAN at Fazenda Bom Jesus and its impacts on the lives of residents in the surroundings of the industrial park, being therefore a case study, which according to YIN (2001), consists of promoting the examination of a certain object and its interrelation with the subjects involved in the study. This method aims to deepen knowledge about a specific topic, enabling its information to be used as parameterization in similar studies. In this scenario, the researcher needs to apply procedures that allow the collection of necessary and sufficient data to shed light on the circumstances in which the phenomenon occurred, which results were obtained and the nature of the phenomena produced.

As collection instruments, in addition to documentary and bibliographic research to know the state of the art on the subject in books, scientific articles and periodicals, "in loco" visits were made for observations and interviews with local actors, which supported this work.

IV. OLINDINA RORIZ SCHOOL IN THE CONTEXT OF AGRODAN

AGRODAN is a family business founded in 1987 in the city of Belém de São Francisco, as a dream come true for the children of doctor Álvaro Dantas, who dedicated his life to caring for the population of Belém do São Francisco and the region. To this end, they mortgaged the entire family's assets as a guarantee for a bank loan with Banco do Brasil, with the purpose of investing in the cultivation of irrigated fruits, through the implantation of 400 ha of mango, grapes and bananas, in the area of Fazenda Bom Jesus. , owned by the family.

It was a dangerous and risky attitude, as the local tradition was to grow onions in an ebb area, which is when the river fills and recedes, leaving its edges wet for a long time, facilitating the plant's development. The first experience was the planting of bananas, the result of which was not encouraging. Afterwards, the young entrepreneurs started to implement a vineyard, which, due to the high maintenance costs and also the lack of technical knowledge, proved to be unprofitable. These failed attempts led the owners to bet on the mango, which at the time was not commercially cultivated in the region. It was a happy choice, considering that in 2018, production was 5,013 tons, with an average productivity of 28.6 tons per hectare (SANTOS, 2019, p. 14).

These results encouraged entrepreneurs to build a new market outside the country, taking advantage of the spread of irrigated fruit growing in the sub-medium São Francisco, where the characteristics of the climate associated with the abundance of water from the São Francisco River formed the ideal conditions for the development of this activity.

According to studies carried out by Santos (2019), in 2019, the last year without the effects of the pandemic associated with Covid-19, AGRODAN in the seven farms, five in the municipality of Belém de São Francisco/PE and two in the municipalities of Abaré and Curaçá, in the state of Bahia, totaling approximately 1,000 hectares in production, had more than 1,200 direct workers, all with a single mission determined by the owners: to produce the best mango in the world in a safe and sustainable way (SANTO, 2019, p. 14).

The particularity of AGRODAN, which differentiates it from other companies in the region, was its concern to seek growth that reconciled the search for profits and dividends with social issues involving employees and residents of the region. From this perspective, practices such as profit sharing; training and ongoing training of employees; existence of a professional advancement program within the company; building national and international partnerships; investment in innovative technologies, were actions that allowed the company to account for approximately 25% of all mango exported to the common European market. Despite its location in the interior of Pernambuco, it received the title of largest exporter of mangoes in Brazil.

When the social project emerged in 2014, the idea was to work in adult education, to improve the level of workers. The proposal ran into logistical difficulties, considering that the adult public lived on the islands and in rural communities dispersed and far from the company's headquarters, where the classrooms would be implemented for nighttime operation.

To overcome the problem, we sought to formalize a partnership with the Roberto Marinho Foundation, to implement a tele-classroom system in the communities, however this solution proved to be unfeasible, given that the Foundation only enters into agreements with states and municipalities. The limiting element for the adult education project was constituted as a driving force for the construction of a school unit on the farm, aimed at the quality education of children in kindergarten and elementary school, compatible with the best public or private schools in the country. region, so that they could compete on equal terms with those of the urban area, with a view to a dignified future. At the time, the rural schools they attended had multigrade classes, where a single teacher attended to students from three different grades, making the children's learning very deficient (PEREIRA et al., 2012, p. 242; BESERRA et al., 2012, p. 242; BESERRA et al. al., 2019, p. 179).

The precariousness with which these schools were structured was already contested by teacher Olindina, the matriarch of the family and a public teacher in the municipality. The teacher's reports returned to populate the memories of the businessmen, who felt obliged to contemplate their mother's memory, implanting a decent school on the farm where they spent so many happy years. Following in the footsteps of the rural educator Kolling (2002), education cannot be seen only as an instrument for transmitting knowledge, but as a mechanism for promoting the social development of rural men and women, to be subjects of their own own destiny. Therefore, education

has to be related to culture, values, the way of producing, training for work and social participation (KOLLING et al., 2002, p. 19).

At the OlindinaRorizDantas school, children can choose to be farmers in the future if they wish, but they can dream of being doctors, lawyers, engineers, teachers, zootechnicians and whatever else they want, because they will be prepared to get wherever they want, according to the speech of the director of the company.

The school's structure was designed to highlight the importance of individuals in the educational process, so its bold architectural design is nothing short of



the best schools in the state. There are eleven classrooms equipped and furnished according to the age group of the students. In addition, the equipment has specific environments for computer classes, plastic arts, dance, music, theater, laboratories for science classes, and foreign languages. With regard to pedagogical support, there is a library, a multi-sport court, an Olympic swimming pool and a multimedia room, all with accessibility and with the capacity to serve 200 students, as shown in figures 02 and 03.



Fig.2 - Students at Escola Olindina Roriz Fig. 3 - Aerial view of the school.

SOURCE: DANTAS (2021) SOURCE: DANTAS (2021)

In addition to the pedagogical spaces, there is an entire parallel structure formed by an administrative environment, cafeteria, industrial kitchen, collective garden, children's playground, and internal patio, and these spaces are surrounded by an area built from a landscape project of trees and gardens. which transmits an air of summer camp in the midst of nature.

The implementation of this entire structure initially took place with AGRODAN's director entrepreneur's own resources, who during the process obtained contributions from local and external investors. As for its maintenance, AGRODAN bears the responsibility, considering that both Constitutional Amendment No. 108/2020, and Law No. 14,113/2020 that regulate the matter, do not allow resources from the Basic Education Maintenance and Development Fund of Education Professionals Appreciation – FUNDEB, can be destined to private institutions. In this way, 10% of the company's annual profits are destined for this purpose, as well as for the maintenance of the health post, which, similarly, was built in the same region as the school.

In the period of the pandemic, like other educational institutions in the state, teachers began to teach classes remotely, through the internet, deployed free of charge in students' homes, so that they would not be harmed.

Important support was given by Fundação Banco do Brasil, which provided 265 pieces of equipment free of charge, including 196 notebooks and 69 tablets, an investment of approximately BRL 475,000, so that children could continue attending classes, which prevented evasion and abandonment. school.

Another initiative in this period of the pandemic associated with Covid-19 was the resumption of the idea of promoting adult literacy. For this purpose, the AlfabetizaSertão Program was created, but this time, the students of the Olindina School became facilitators in the process of training their relatives, being accompanied by a pedagogue in this process. This form of education, in addition to allowing adults to read and write, overcame the problem of displacement, allowing the consolidation of affective bonds, given that children began to live more with their relatives.

Children spend eight hours at school, receiving breakfast, snacks, lunch, snacks, in addition to uniforms, transport and books. Those who live on the islands have a boat provided by the company to transport them, in a clear demonstration of the company's commitment to education. The families' initial fear with the displacement of their children turned into satisfaction, as they observed the transformation in their realities. Currently, the school has 265 students between kindergarten and eighth grade of elementary school, being recognized as a success story among the community in the region. The number of students per classroom does not exceed 30, in order to ensure that the teacher meets their individual needs, which has ensured near-excellent school performance.

To evaluate the pedagogical development of the school, the Teaching Quality Institute (IQE) was hired, which is a civil association with an educational and social assistance nature, whose aim is to improve the quality of the educational project; identification of limitations and potential of students, so that no one is left behind.

As one of the Pedagogues of the institution points out, “the differential of the school is the Political Pedagogical Project (PPP), resulting from the accomplishment of a contextualized work with the region, starting from the local to the global and also the insertion of technologies as potentiators of teaching and learning”.



Fig.4 - Mapping of internet points provided to students at Escola Olindina Roriz.

SOURCE: DANTAS (2020)

The existence of a high percentage of residents of the regional rural area who still cannot read and write or are functionally illiterate was a nuisance for the directors of AGROGAN.” We cannot accept that at the present time, with the stage of development of the means of communication and information technology, that there are still people who use fingerprints to sign a document” This is what makes me return to the sertão alphabet” (PAULO, November of 2021).

At first, adults were discouraged, thinking that people aged 60 and over would not be able to learn. To encourage them, the company started to contemplate everyone who started to study a basic food basket at the end of each month, as long as the attendance was full to the classes.

The methodology adopted followed the principles of Jean Piaget's theory (1993), with regard to

respect for the stages of cognitive development for the acquisition of knowledge by the student, as well as the Pedagogies of Célestin Freinet (1989, 1998) and Paulo Freire (1996). These theorists advocate that the child's social development and the acquisition of knowledge must occur through interaction with other children and adults, in a cooperative, critical and transformative way, exchanging and building knowledge in a collective and linked way. to its social-historical context, aiming at the transformation of reality and meaningful learning.

Pedagogue Adriano Sobral, coordinator of the Alfabetiza Sertão Program, highlights the project's boldness in using children and adolescents to teach their relatives and the feeling of responsibility they now have, participating in workshops to prepare for the activities. At the end of each month, teachers at Escola Olindina, voluntarily, apply assessment tests to adults on reading,

writing and mathematics, in order to observe the effectiveness of the work performed by the children. It is a family interactive process, but above all a training for citizenship and social responsibility.

As the pedagogue Ramos (2022) informs:

Despite being a sensitive audience, as we have parents who work all day and arrive home tired, students have played an important role in the literacy process. One of the issues to be highlighted is the writing of the name. Many parents did not know how to write their name and this is very important, as this literacy process has already begun to bear fruit and not only in the coding and decoding of the letters, but in the strengthening of family ties and the development of student responsibility.”

For the year 2023, the school's management intends to implement vocational high school and, for that, new spaces are being built for classrooms and laboratories. The proposal is an Information Technology (IT) course, in partnership with CESAR School, an innovative teaching institution, focused on training professionals with skills for the development of social projects; of entrepreneurship and market. According to the director, the project is to develop skills that allow students to be protagonists, leaders and entrepreneurs.

The choice for CESAR School was due to the teaching method they work with, PBL – Problem-Based Learning, according to which, starting from an existing problem in the market, students work on themes, concepts, theories and practices, achieving develop their skills and attitudes.”

V. RESULTS ACHIEVED

In Brazil, the regular institution of rural schools dates from the 20th century. Before that, the prevailing idea was that peasants did not need knowledge beyond those used in their work (VENDRAMINI, 2015, p. 55). And its emergence did not occur to improve the population's level of education, but as a strategy to contain the migratory flow to the city, thus ensuring labor for the farmers and also to alleviate the swelling and imbalance resulting from the users of the services offered to the inhabitants of urban areas (PEREIRA et al., 2012, p. 253).

In this perspective, for many years the rural school was structured to serve a small part of the residents of the non-urban areas of the municipalities, who received

an instrumentalized education, limited to the attendance of elementary educational formation, more destined primarily to the training and training of hands of constructions. In this logic, the dichotomy between the countryside and the city persisted, where the rural was synonymous with backwardness and the urban with development.

The lack of attention to rural schools materialized in the adoption of single-teacher schools, with multigrade classrooms and an excessive workload for the teacher (PEREIRA et al., 2012, p. 242; BESERRA et al., 2019, p. 179). With the closure of these schools and the nucleation of rural schools, their effects were more harmful compared to the previous situation. Dropout and dropout were the most observed milestones in this change.

In the case of AGRODAN, the pass rate of students in 2021 was 90.04% among the 271 enrolled. The learning measurement mechanism involved written and oral assessment; participation in projects and other activities offered by the school, without any withdrawal throughout the year. The 23 teachers carefully selected by the company, have higher education and, in addition to technical competence, must present characteristics that suit the purposes of the school.

With the project in constant growth, for the year 2023 the proposal is to create high school professional courses and in 2026, a Faculty of Technology, in the belief that such investments do not constitute non-reimbursable expenses, but investments, which will bring development for the region and, as a consequence, for the company itself, which in 1987 launched 400 crops for the processing of 40 tons of mango per hour, having the most modern Packing House in the northeast.

VI. SOME CONSIDERATIONS

In a scenario where the Ministry of Education's scarce resources cannot meet the demands of public education units, where most schools do not have adequate and sufficient structures for the training of children and adolescents, interventions such as AGRODAN's are revered as republican and social responsibility.

If public education in Brazil had as presuppositions typical values of a social democracy, the school teacher Olindina Roriz Dantas would not be seen as a benchmark, however, as the reality of national education does not prioritize it in the distribution of budgetary resources, an intervention with private financing, which is not a tradition in the country, as in other countries.

To sprout in the middle of the rural backlands, in a poor region, an educational institution that focuses on integral study, involving the cognitive, emotional,

psychological, artistic, cultural, affective dimensions, with a pedagogical project contextualized to the local reality but with a view to learning everything what happens in the world, investing in the individual and collective potential of learners, is an experience to be socialized and imitated by other private companies and by the state itself.

The care of teachers and coordinators in monitoring the performance of each child, from the perspective of their evolution, implies in extra hours of work, in the perspective that the objective of not leaving any student behind is achieved. It is being a teacher in its essence, someone who cares about the other and with their fulfillment as a citizen and citizen, hence the company's concern in educating adults who did not have the opportunity as young people to go to school. The "AlfabetizaSertão" Project currently has 53 students being taught to read and write by the children who have already passed this stage of education, providing dignity to these workers who have already contributed so much to the country's wealth.

The institution's curricular matrix has chosen technical and professional training in IT as one of the ways to promote and develop skills and abilities for the world of work, pointing out these emerging technologies as useful to be applied to the countryside, which is agriculture 5.0.

This way of thinking and doing education in and Do the countryside that AGRODAN has been applying has generated some discussions about its suitability to the culture and knowledge of that society, in this case, the rural community of Belém do São Francisco/PE. But the question that arises is to know which field is being talked about. The countryside of the past, of beaten earth, of subsistence crops, of poverty, or the countryside of today, of irrigated crops for export, of jobs with decent wages; the countryside as a space for life, work and leisure; the field sought to relieve the stress of urban life. What is the boundary today between rural and urban? What is there in the cities that does not exist in the countryside, with due proportion? The rural region of Pernambuco has treated and piped water on the properties; Internet; TV and radio signal; public services; health Center; trade and industry opportunities; asphalted roads; public and private transport. Therefore, teaching needs to be connected with these changes and this new field.

REFERENCES

[1] ABRAFRUTAS, Associação Brasileira dos Produtores Exportadores de Frutas e Derivados. **Comparativo mensal de exportação de frutas 2020-2021**. 2021. Disponível em: <https://abrafrutas.org/2021/08/dados-de-exportacao-1a-semester-2021-2/>. Acesso em: 10 jan. 2022.

- [2] AGRODAN. **Agrodan Social**. Disponível em: <https://agrodan.com.br/agrodan-social/>. Acesso em: 04 jan. 2022.
- [3] AGRODAN. **Nossahistória**. Disponível em: <https://agrodan.com.br/nossa-historia-missao-visao-e-valores/>. Acesso em: 08 jan. 2022.
- [4] ALVES, R. E.; FILGUEIRAS, H. A. C.; MENEZES, J. B.; ASSIS, J. S.; LIMA, M. A.
- [5] C.; AMORIM, T. B. F.; MARTINS, A. G. 2002. Colheita e Pós-colheita. In: GENUÍ, P.
- [6] J. C.; PINTO, A. C. Q. **A cultura da mangueira**. Brasília: Embrapa Informação Tecnológica, 2002. p. 383-405.
- [7] ANUÁRIO BRASILEIRO DA FRUTICULTURA. **Brasilian Fruit Yearbook 2021**. Santa Cruz do Sul: Gazeta, 2021.
- [8] BESERRA, Eljalma Augusto; DE SOUZA RIBEIRO, Marcelo Silva. **As TIC como instrumento de preservação da identidade social das comunidades camponesas de Petrolina/PE**. Debates em Educação, v. 11, n. 24, p. 175-196, 2019.
- [9] BESERRA, Eljalma Augusto, **Projeto Bebedouro: 50 anos de experiências de vida na construção da irrigação**. 1ª edição, Rio de Janeiro: Editora Autografia, 2020.
- [10] BOURDIEU, Pierre. **O Poder simbólico**. Rio de Janeiro: Editora Bertrand Brasil, 1989.
- [11] KAGEYAMA, Ângela. Desenvolvimento rural: conceito e medida. **Caderno de Ciência e Tecnologia**, Brasília, n.3, v. 21, p. 379-408, set-dez. 2004.
- [12] KOLLING, Edgar Jorge; CERIOLI, Paulo Ricardo; CALDART, Roseli Salete. **Educação do Campo: identidade e políticas públicas**. Brasília: Articulação Nacional Por uma Educação do Campo, 2002.
- [13] DAVIDSON, Francis. **O novo comentário da Bíblia**, 3ª edição. Traduzido por Russel P. Shedd. São Paulo: Sociedade Religiosa Edições Vida Nova, 1995.
- [14] DE MOURA, Magna Soelma Beserra et al. Aptidão climática da mangueira frente ao clima atual e aos cenários futuros. **Embrapa Semiárido-Artigo em periódico indexado (ALICE)**, 2015.
- [15] MARCONI, Mariana de Andrade; LAKATOS, Eva Maria. **Fundamentos de Metodologia Científica**. São Paulo: Atlas, 2017.
- [16] MOUCO, Maria Aparecida Carmo; SILVA, D. J.; PRADO, R. M. Mango cultivation in Brazil. In: VALAVI, S. G.; RAJMOHAN, K.; GOLVI, J. N.; PETER, K. V.; THOTTAPPILLY, G. **Mango: cultivation in different countries**. Houston: Studium Press LLC, 2012. v. 2, p. 331-345.
- [17] MUKHERJEE, S. K. et al. Introduction: botany and importance. **The mango: Botany, production and uses**, n. Ed. 2, p. 1-18, 2009.
- [18] OLIVEIRA, Thiago Azevedo de. **Revestimentos comestíveis de misturas de polissacarídeos na conservação pós-colheita de manga Tommy Atkins**. 2017. 105 f. Tese (Doutorado em Fitotecnia) – Universidade Federal Rural do Semi-Árido, Mossoró. 2017.
- [19] PEREIRA, Isabel Brasil et al. **Dicionário da Educação do Campo**. (Orgs.) Roseli Salete Caldart, Isabel Brasil Pereira,

- Paulo Alentejano e GaudêncioFrigotto.v. 1, 1ª ed. Rio de Janeiro, SãoPaulo: Escola Politécnica de Saúde Joaquim Venâncio, Expressão Popular, 2012
- [20] PESSOA, Fernando António Nogueira. O infante. **PESSOA, Fernando. Mensagem. Lisboa: Parceria António Maria Pereira**, p. 51, 1934. 10ª ed. Lisboa: Ática, 1972.
- [21] SANTOS, Vandson Felipe dos. **Estágio supervisionado obrigatório na Empresa Agrodan (Agropecuária Roriz Dantas): cultura da manga (*Mangifera indica L.*)**. 2019. Trabalho de Conclusão de Curso. Brasil, 2019.
- [22] VENDRAMINI, Célia Regina. **Qual o Futuro das Escolas no Campo?**. EducaçãoemRevista, v. 31, p. 49-69, 2015.
- [23] VETUCCI, J. P.; CALDERAN, A. N.; BERALDO, P. E. P. A Manga.Grupo de Pesquisa e Extensãoem Marketing e Gestão. **Boletim Mark Esalqem Rede**,v. 4, n. 16, 2016.

In Some Selected Districts of Bangladesh During the Covid-19 Pandemic Period, Sanitation and Health Service Facilities

Md. Rasidul Islam¹, Wenbin Zhao², Zekrullah Qasimi³, Mehedi Hasan Sagar⁴, Hasan Ahmed Joy⁵

^{1,2,3}Department of Civil Engineering, Taiyuan University of Technology -TYUT, Shanxi, China.

^{4,5}Department of Civil Engineering, Stamford University of Bangladesh, Dhaka-1219, Bangladesh.

Received: 11 Jun 2022,

Received in revised form: 06 Jul 2022,

Accepted: 10 July 2022,

Available online: 14 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Questioner Survey, Selected Location, Quarantine place.

Abstract— Our goal was to gain a sense of sanitation and health-care infrastructure in a few Bangladeshi regions during the Corona period. Performing our duties during the Corona era was difficult. During the lockdown, we had to get the job done despite the people's opposition. We went to everyone's residence and assessed the sanitary system, but since they were afraid of Corona, many of them did not completely reveal their concerns. As a result, we had to deal with a slew of issues. Many people have avoided eating out as a result of the Corona problem. They're sipping water that's boiled. During the corona time, we learnt about the reaction to human health awareness through the internet. Sanitation's overarching goals are to offer a healthy living environment for everyone, safeguard, natural resources (such as the surface-water, ground-water and soil), and provide people with safety, security, and dignity when they defecate or urinate.

I. INTRODUCTION

The Globe Health Agency has declared the newest corona virus (COVID-19) outbreak a pandemic and a global public health crisis, and the whole globe is fighting to combat it. It's a situation that's always shifting and altering. In the five months since the virus initially surfaced in December 2019, about two million individuals in 185 countries have been identified as confirmed instances of corona virus disease.(COVID-19). Researchers from all across the world are attempting to better understand the biology and epidemiology of COVID-19, a new corona virus illness (COVID-19).The projected basic reproduction number is substantially larger than that have many other infectious illnesses, and this might cause health-care facilities to become overburdened, even in nations with the most modern healthcare systems. Around 20% of cases result in clinically significant and

complicated diseases. Adults over 60 years of age with co-morbid diseases are the most susceptible group, with occasional infrequent incidences of serious illness in younger people. Non-therapeutic techniques to stop the virus from spreading are the most effective way to halt it because no viable booster or antiviral drugs have yet been approved for the sickness. As a result of the pandemic, it is evident that in the coming days, improvements in basic water, sanitation, and health-care facilities must be a key priority. The present scenario in Bangladesh's COVID-19 districts (Dhaka, Barishal, Madaripur, and Jamalpur) is described in this article, along with some suggestions for how the government could address the pandemic.

II. DETAILS OF THIS STUDY

➤ The To investigate the current state of health and

sanitation services in four districts Bangladesh.

- To contrast the current situation with the ideal situation.
- To determine the constraints of Bangladesh's present health and sanitation services in four districts.
- To make some suggestions for improving the research location's current circumstance.

III. LITERATURE REVIEW

This paper examines the history, successes, and problems of a critical part of Bangladeshi hygiene, specifically, moving people away from open defecation and toward the use of sanitary latrines. The Bangladesh case has taken on worldwide relevance now that the newly stated Sustainable Development Goals include a goal to "Make sure access to safe and affordable safe and affordable drinking water for all" by 2030. Bangladesh has mostly succeeded in encouraging people to use latrines and decreasing open defecation to less than 1% of the population. Although every country environment is unique, reviewing the procedures that led to this success may be informative for others. Because no vaccinations or antiretroviral medications have been licensed for the disease, non-therapeutic methods to stop the virus from spreading are the most effective way to prevent it. Hundreds of millions of people are staying at home throughout the world to prevent the virus from spreading. Preventive measures, such as eremite office activities, foreign travel restrictions, obligatory lockdowns, and social isolation, are being implemented in several nations. Bangladesh, a low-income country with one of the world's densest populations, is fighting to contain the disease's spread. In this article, we outline the present COVID-19 situation in Bangladesh and offer some suggestions on how the government might tackle the epidemic [1].

IV. WORK PROCEDURE

1.1 Study Area: Dhaka 21%, Barishal 30%, Madaripur23%, Jamalpur26% Fig-1:

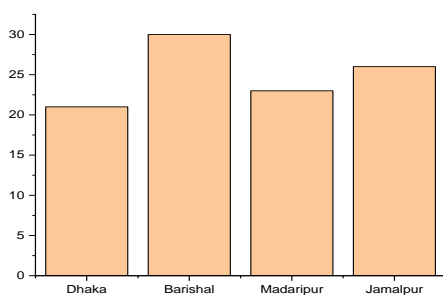


Figure 1: The Area location of the respondent.

1.2: Bangladesh Sanitation History: Bangladesh is a hub of research and development in the field of sanitation. It is well-known across the globe as the first place where Community-Led Total Sanitary (CLTS) was employed to eradicate open defecation from whole villages. The usage of latrines has increased substantially since then, yet this success is built on a broad base. Intensive sanitation promotion in Bangladesh dates back to the 1960s and has a long and convoluted history [2].

1.3: Community-led total sanitation: As previously stated, the Community-led Total Sanitation (CLTS) technique was initially created in Bangladesh in the rural working areas of Water Aid Bangladesh-affiliated NGO, VERC (the Village Education Resource Centre). This strategy is based on a participatory approach to sustainable development and the recognition that successful control of fecal-oral disease transmission necessitates community-wide transformation. Neighbors are put on danger if even one home fails to use a latrine. It is expected that if people comprehend the benefits of "complete sanitation," they will continue to use latrines when the intervention ends. Persuasive "ignition" actions that "trigger" transformation are essential to the process. As societal standards shift, shaming open defecators is typically an element of the strategy. Volunteer "Rural Engineers" are taught to bring improved toilet technology to their neighbors. Subsidies at the household level are not available. Kar and Chambers (Kar and Chambers, 2008)CLTS has had a significant impact on Bangladesh's sanitation system, while not being the only technique utilized to encourage latrine use and related hygiene modifications. Many other groups adopted CLTS, principles and procedures to their own aims and methods as word of its success in rural areas spread. There have been a number of "complete sanitation" solutions developed. In 2004, a major initiative called dishari began to scale up the approach to the level of a whole union, putting the union chairman and council in control of the ignition and triggering process and supporting a staff post to handle sanitation concerns within the union office. Plan Bangladesh, Dhaka Ahsania Mission, and the HYSAWA Fund all included an emphasis on the union in their water and sanitation efforts. UNICEF launched the School-Led Total Sanitation (SLTS) initiative, which has evolved into Community Approaches to Total Sanitation (CATS) [3].

1.4: Emergency Sanitation: The administrative and technical techniques necessary to provide sanitation in an emergency are known as emergency sanitation. During humanitarian assistance activities for refugees, victims of natural catastrophes, and internally displaced individuals, emergency sanitation is essential. The Emergency

response is divided into three phases: immediate, short-term, and long-term. The immediate focus is on controlling open defecation, for development toilet technology, different type toilet being used. Technology such as urine-diverting dry toilets, tanks, and decentralized systems might be deployed inside the near term. Hand washing stations and fecal sludge management are also included in emergency sanitation.

1.5: Hygiene Challenges: The hygiene issue encompasses a variety of human actions that, in addition to latrine usage, help to minimize diarrheal illness transmission by interrupting fecal-oral transmission chains. Hand washing, covering stored water and food, and solid waste management are examples of these habits. Menstrual hygiene management (MHM) is a new hygiene issue that has ramifications for women's health and girls' education, according to sanitation specialists. According to the above-mentioned national hygiene study, less than half of all family latrines provided soap and water for hand washing. Given that hand washing reduces the risk of disease transmission even more than latrine use, this issue warrants special attention in the next phase of sanitation programs. During the last two or three years, the international WASH community has paid renewed attention to the issue of menstrual hygiene management. Given how often the phenomena of menstruation are connected with shame and dread, this is a significant shift. Recent professional conversations have stressed the idea that menstruation is a natural and normal part of life, and that humiliating menstrual girls harms their self-esteem, violates their rights, and disrupts their education. Men and boys, girls and women, as well as local authorities, are having discussions about this issue in try to modify everyone's perspectives. In order for school girls to feel comfortable attending school during their menstrual periods, more emphasis is being paid to providing safe and adequate facilities where they may change or dispose of pads, and so on. To ensure that safe pads are inexpensive, NGOs and others are distributing new types of pads made from locally accessible materials (used fabric, for example). According to the Bangladesh Government's June 2015 directive; schools must include girl-friendly toilet facilities. This is a huge step in the right direction for the new trend. Although water is essential for practically all hygiene-related operations, engineers are not tasked with addressing personal hygiene behaviours. It is a duty of health education. The ministries of health and education both have staff and knowledge that are well-suited to dealing with sanitary issues. However, important interviewees say that the Ministries of Health and Education are not yet properly involved with sanitation concerns. Government officials should take advantage of

this chance to strengthen inter-ministerial collaboration in order to reaffirm the nation's sanitation accomplishments' public health advantages. In order to feed the world's rising urban populations, wastewater is increasingly being seen as a viable supply of water and nutrients for agricultural development.

1.6: The Benefits of improving sanitation:

The advantages of improved sanitation go well beyond lowering the incidence of diarrhea [4]. These include:

- Reducing the spread of neglected tropical diseases such as intestinal worms, intestinal parasites, and respiratory disease, which affect millions of people.
- Malnutrition's severity and impact are being reduced.
- Increasing respect and protection, particularly for the female and younger girls.
- Rising student participation: Girls' attendance is increased when separate sanitary facilities are provided.
- Water, renewable energy, nutrients might be recovered from face waste.

1.7: Bangladesh's Response to COVID-19:

Bangladesh government confirmed the first COVID-19 case on its soil on March 7, however numerous experts believe that nCoV-2 may have invaded the country earlier but remained unnoticed due to inadequate surveillance. As of April 13, COVID-19 has been documented in 803 cases across the country, with 39 fatalities. However, there have been concerns that the country's testing assays are poor, resulting in many cases going undetected. In response to the emergence of the virus, Bangladesh government reduced international flights and inside flights thermal scanner inspections for passengers, and closed schools; open a few industry and company for work March 26. On March 15, the country banned all European flights save those from the United Kingdom; nonetheless, planes from Europe were still allowed to land at airports. As a result, over 631 thousand migrants arrived in the country in just 55 days, starting on January 21. The Institute of Epidemiology, Disease Control and Research (IEDCR) claimed to have tested everyone who entered the country, although the testing facilities at the ports of entry have been widely questioned. All travelers entering the country were subjected to a 14-day compulsory quarantine beginning March 16. It aimed to take tourists to a quarantine facility from Italy, which had become a new pandemic hotspot. Due to a lack of preparedness, the operation was widely criticized, and the passengers were allowed to enter the country on the condition of conscience

for 14 days [5].

1.8: Better and Unpaved Sanitation:

Inadequate sanitation (also known as "access to adequate sanitation service") is a monitoring term that is used to characterize several types of sanitation. This is the term for the management of human waste at the household level). In the JMP definitions, "unimproved sanitation" is the polar opposite of "improved sanitation." From 2015 onwards, the same words are used to track progress toward Sustainable Development Goal 6. They are a part of the definition of "safely managed sanitation service" in this case [6].

1.9: The Impact of Covid-19 on Bangladesh & Key findings of the survey: In recent weeks, I spoke with a number of social activists and non-governmental organization (NGO) campaigners in Bangladesh about the impact of the corona virus on their country. Many people are afraid to express their worries and opinions about their government's response to the epidemic in public, especially to members of the foreign media and non-governmental organizations (NGOs). Bangladesh's government appears to have been suppressing free expression since the middle of March 2020, according to a Human Rights Watch assessment. Rather than giving correct and timely information about the virus, the authorities are detaining people, including students, activists, and even physicians, and accusing them of spreading rumors and disinformation about Covid-19's effects on the public. The Information Ministry is currently monitoring social media and numerous television stations for "rumors" concerning Covid-19 cases, citing the draconian Digital Security Act. The findings of the poll examine the impact of COVID-19 on businesses and their answers to the issues they face. The poll also inquired about current government assistance as well as the short- and long-term options that respondents want to seek in order to deal with COVID-19. The survey included respondents from the textile, clothing, leather, food and beverage, chemical, including pharmaceuticals, plastic, furniture, printing, machinery, and other sectors, such as wood, recycling, and other transport equipment [7].

1.10: Starvation Defies Lockdown:

The corona virus pandemic and the nearest have disproportionately affected people from lower socioeconomic strata, as has been the case worldwide. According to the Bangladesh Bureau of Statistics, at least 10 million of Bangladesh's 25 million wage and salary employees rely on their daily salaries. Thousands of frightened textile workers traveled several kilometers to preserve their jobs after the lockdown was announced,

despite the lack of transportation. Many others just walked out in search of food, hunger and despair driving them. The government's emergency food aid initiatives are limited. Many activist organizations have found it increasingly difficult to continue their humanitarian activities after the lockdown began in the second week [8].

1.11: Overwhelmed Health System: Due to the knowledge that Covid-19 had been circulating throughout Asia for two months, the Bangladeshi health system was unprepared. The advent of the corona virus has aggravated the problem, making it inevitable. Exams are few. The number of persons who have tested positive does not accurately reflect the problem due to a scarcity of testing. The administration also looks to be striving to hide the real numbers. Activists have termed the government's plan a "No test-No Corona" policy.

1.12: Safely Managed Sanitation: COVID-19 has wreaked havoc on educational standards throughout the world, prompting the great majority of pupils to temporarily drop out. With about 40 million students enrolled, Bangladesh is one of the countries most affected by total school closures. Administrators must guarantee that children's learning time and well-being are preserved during this period because all schools will be closed for at least two months. The Corona virus pandemic, regardless of its effects on family poverty, will have a direct influence on learning outcomes by lowering time spent in learning activities both in and out of school. While classroom disturbance is common, learning deprivation outside of the classroom varies depending on the family's economic situation, access to technology, and parental abilities. At home, there is likely to be a gendered reaction to children's educational demands. If allowed to continue, the state-wide strike risks wiping out some of the country's previous educational achievements, such as near-universal primary school attendance and gender parity in secondary education. A multi-respondent survey will be used to acquire primary data for this study.

1.13: The Impact of Corona virus on Livelihood: 2020-03-08, Bangladesh saw its first official instance of Covid-19 death. Bangladesh, like other countries across the world, has decided to put the country on formal lockdown starting March 26, 2020, in order to curb the spread and prevent communal transmission. While most of the service industry can benefit from work-from-home agreements, the lockdown has put 85 percent of the country's working population, who are now employed in the informal sector, out of work. These workers are the most vulnerable category during this national economic downturn due to a lack of effective job benefits and pay structures. The bulk of these employees are in the low- and lower-middle-income categories, earning barely enough to meet their

living expenses while living in the outskirts of cities. As a result, a loss of job or income would have a direct impact on the lives of these urban LIC and LMIC employees, exposing them to the negative consequences of the economic downturn and driving them to the point of no return. According to the survey, respondents' average age was 35 years old, and their average monthly income prior to Covid-19 was BDT 20,193. Each wage earner was found to sustain the lives of about three dependent family members, with 54 percent of homes having only one wage earner. Respondents were from a variety of occupations, with a higher percentage of RMG and manufacturing sector workers in the greater Dhaka North (Gazipur, Ashulia) and the larger Dhaka East (Narayanganj). Domestic assistance, shop personnel, restaurant staff, and office support staff, among others, were among the respondents in the Dhaka Metro (Mirpur, Tejgaon, Korail).

2.1: Geographic of this study, Distribution of the Respondents: Employers in both the public and commercial sectors were asked if they are aware of their employees' susceptibility and risk, if they provide support, and what future plans they have to enhance their employees' health and safety. Dhaka accounted for more over half of the responses, owing to the enormous number of sanitation and trash employees employed by the two City Corporations (45 percent). Telephone interviews were performed from 2020-05-08 to 2020-05-16. On average, each interview lasted around one hour. Water Aid Bangladesh prepared the questionnaire, and the organization's personnel performed all of the interviews. Staff got extensive training on how to conduct interviews and collect data using the Water platform. On the same platform, the data was analyzed. Prior to each interview, informed consent was obtained, and each interviewee was compensated for their time.

2.2: The study's main concerns are as follows:

- COVID-19 is well-known within sanitation and trash employees.
- COVID-19 information sources.
- Safety equipment is readily accessible and can be used.
- Usage, cleaning, and reuse of personal safety equipment currently in use.
- Practices are being followed of hand hygiene in the workplace.
- During COVID-19, there will be no existing guidelines.
- If and how service demand has altered as a result of COVID-19, as well as the financial

implications for workers.

- The main difficulties that employees face.
- As part of the government's reaction to COVID-19, be aware of any special support, such as insurance, financial compensation, or relief measures.

Table 1. Total Covid-19 Confirm Cases and Total Deaths up to December 2020

Location (Our Districts)	Month	Confirm Cases	Confirm Deaths
Dhaka	March-December	7076	248
Barisal	March-December	3032	34
Madaripur	March-December	2033	21
Jamalpur	March-December	1512	26
	Total	13653	329

V. QUESTIONERS SURVEY

1. What is the age range?

The age range of the respondent below the chart Figure 2.

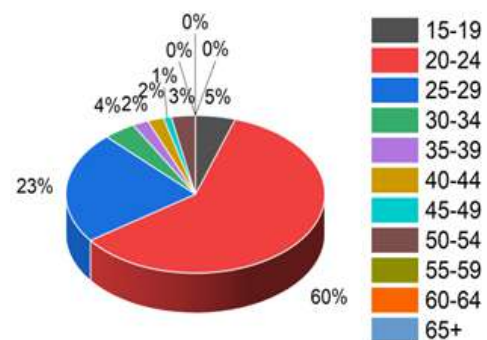


Fig.2: The Age range of the respondent.

2. Do you have any idea in COVID 19?

About any idea of the covid-19

Respondent below the chart Figure: 3.

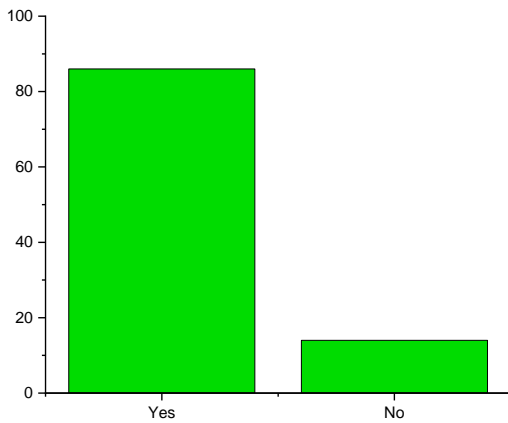


Figure 3: Covid-19 ideas in survey area

5. Do you purify your water?

Respondent below the chart Figure: 6.

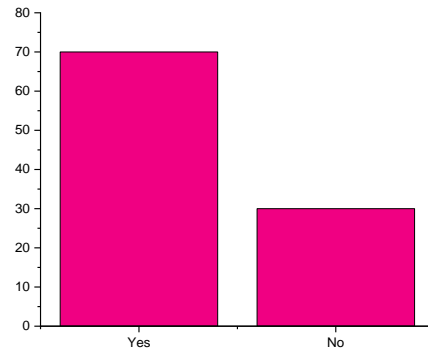


Figure 6: Purifying of water

3. Do you have anyone COVID 19 positive in your family?

Respondent below the chart Figure: 4.

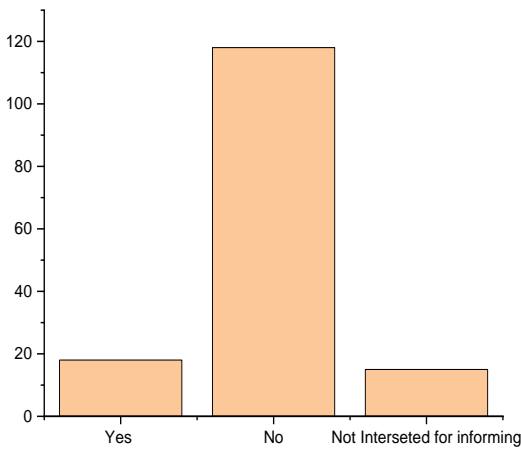


Figure 4: Presents of Covid-19 positive cases in your family.

6. What percent of cleaning area?

Respondent below the chart Figure: 7.

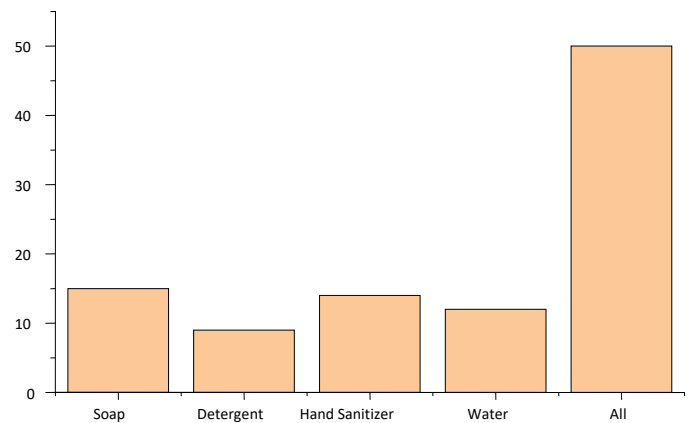


Figure 7: Use for cleaning in the survey area.

4. What is your water source?

Respondent below the chart Figure: 5.

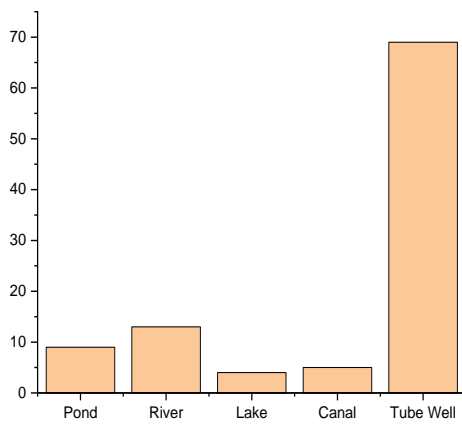


Figure 5: Sources of water of the respondent.

7. What do you use for Covid-19?

Respondent below the chart Figure: 8.

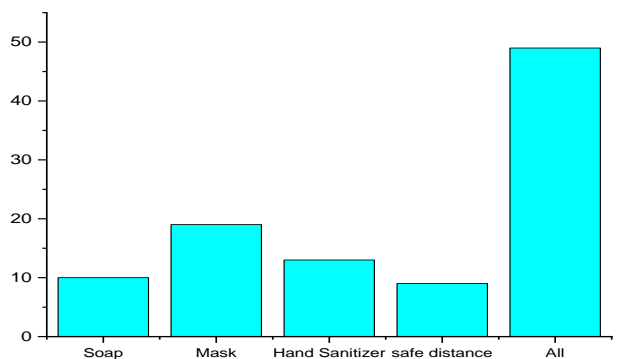


Figure 8: Using for Covid-19

VI. CONCLUSION

The goal of this study was to look at water consumption, basic sanitation facility availability, and environmental sanitation and health service conditions during the COVID-19 outbreak in four Bangladeshi districts. In our district, this investigation was conducted at the home level. In the research, the majority of families had renovated own toilets. Pit toilets accounted for nearly half of the upgraded toilets. Despite having a clear awareness of the benefits of having toilet facilities, a large percentage of families in the study region continued to utilize unimproved toilet facilities. As a result of this condition, improved basic sanitary facilities are inaccessible. Inadequate service levels in study areas might be viewed as an opportunity for more targeted changes aimed at improving access to improved water and sanitation services. In order to prevent and safeguard human health during any infectious disease epidemics, including corona virus illness, health services, sanitation, and sanitary surroundings are required COVID-19. Bangladesh, as a lower-middle-income country, has so far faced significant challenges in controlling the virus's spread. The government must increase its testing and healthcare facilities while maintaining the lockdown at all costs with tougher upkeep. It must maintain a steady supply of personal protective equipment (PPE) for healthcare professionals. 77.8% of the people in the selected districts do not receive emergency healthcare, and 49 percent of the people in the selected districts do not get primary healthcare support, affecting 65 thousand individuals.

ACKNOWLEDGEMENTS

Md. Rasidul Islam and Wenbin Zhao are grateful for the financial support of the study.

REFERENCES

- [1] BBC News. Corona virus: Bangladesh Locks Down a Million in Rohingya Camps. (2020). Available online at: <https://www.bbc.com/news/world-asia-52227924>
- [2] <https://opendocs.ids.ac.uk/opendocs/bitstream/handle/20.500.12413/15527/LP2%20Bangladesh%E2%80%99s%20sanitation%20achievements%20and%20the%20second%20generation%20challenges%20-%20Hanchett.pdf?sequence=3&isAllowed=y>
- [3] <https://www.communityledtotalsanitation.org/page/clts-approach>
- [4] <https://www.who.int/news-room/factsheets/detail/sanitation>
- [5] <https://www.worldbank.org/en/news/video/2022/04/06/ban>

- [gladesh-s-response-to-covid-19-and-its-future-preparedness](#)
- [6] <https://www.who.int/data/nutrition/nlis/info/improved-sanitation-facilities-and-drinking-water-sources>
- [7] https://www.unido.org/sites/default/files/files/2021-03/UNIDO%20COVID19%20Assessment_Bangladesh_FINAL.pdf
- [8] <https://www.arabnews.com/node/1658186/world>
- [9] Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *NEnglJMed* (2020) 382:1199–207. doi: 10.1056/NEJMoa2001316 PubMed Abstract | CrossRef Full Text | Google Scholar
- [10] Bootsma MCJ, Ferguson NM. The effect of public health measures on the 1918 influenza pandemic in U.S. cities. *Proc Natl Acad Sci USA*. (2007) 104:7588–93. doi: 10.1073/pnas.0611071104 PubMed Abstract | CrossRef Full Text | Google Scholar
- [11] Perera W. Bangladesh Government Downplays COVID-19 Threat as Job Losses Mount (2020). Available online at: <https://www.wsws.org/en/articles/2020/03/16/bang-m16.html> (accessed March 26, 2020). Google Scholar
- [12] Directorate General of Health Services. Novel Corona virus (COVID-19) Press Release (2020). Available online at: <https://www.dghs.gov.bd/index.php/en/home/5373-novel-coronavirus-covid-19-press-release> (accessed April 11, 2020). Google Scholar
- [13] Institute of Epidemiology DC and R. COVID-19. (2020). Available online at: <https://www.iedcr.gov.bd/index.php/component/content/article/73-ncov-2019> (accessed April 11, 2020). Google Scholar
- [14] World meter. Covid-19 Corona virus Pandemic (2020). Available online at www.worldometers.info/coronavirus/ (accessed April 13, 2020).
- [15] Javed HAI. Passengers from Europe Land in Dhaka Despite Ban. (2020). Available online at: <https://www.dhakatribune.com/bangladesh/dhaka/2020/03/16/defying-bar-european-flight-lands-in-dhaka> Google Scholar

Bibliometric Study on the Profile of Agroecology Research in Journals of Agrarian Sciences

Valdeni Venceslau Bevenuto¹, Marcus Metri Corrêa², Luciano Pires de Andrade³

¹PhD student in Agroecology and Territorial Development from UFRPE, Brazil

Email: valdeni.bevenuto@ufrpe.br

²Phd teacher from UFRPE, Brazil

Email : marcus.metri@gmail.com

³PhD teacher from UFAPE, Brazil

Email : luciano.andrade@ufape.edu.br

Received: 04 Jun 2022,

Received in revised form: 02 Jul 2022,

Accepted: 08 July 2022,

Available online: 15 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *Agriculture, Organic, Sustainability.*

Abstract — *There are few Brazilian researches of scientific production in the field of Agrarian Sciences that are dedicated to the field of organic production presenting the Agroecology as a science with themes, references, authors and methodological approaches. Therefore, this study proposes to study the profile of studies on the theme of Agroecology published in agrarian science journals qualis A1, A2 and B1 from 2011 to 2022. The concern of this study is to understand: how Agroecology is being portrayed and which designs are being taken in Brazilian journals of Agrarian Sciences. The study is supported by bibliographic analysis research, which will help to quantify and analyze all selected scientific production (Cooper & Lindsay, 1998; Leite Filho, 2006). All data collection took place between articles published from the end of 2011 to the beginning of 2022. After selection, the material was cataloged in the Mendeley Desktop software. The Qualitative Data Analysis tool was fundamental in this process, once it helped in the tabulation, creation of graphics and as a subsidy of descriptive and qualitative statistics in the analysis of data while support of studies coming from Critical Ecosystem Linguistics. The results of this study show that a considerable part of the research focuses precisely on the question of organic agriculture, without opening up to a greater understanding of Agroecology, so that it also leaves aside the interdisciplinary character of Agroecology. Most of the articles are signed by a group of authors, which demonstrates a sharing of knowledge and knowledge.*

I. INTRODUCTION

The Brazilian financial system has a publicly traded company that resulted from the merger of three companies: São Paulo Stock Exchange [BOVESPA], Commodities and Futures Exchange [BM&F] and Central for Custody and Financial Settlement Securities [CETIP], which is currently called B3 [Brazil, Stok Exchange, Counter]. The B3 has 13 tradable companies in the food production setor.

Brazil Foods [BRF], João Batista Sobrinho [JBS], Marfrig Global Foods [MGF] and Minerva are the companies that make up B3 and are part of the Bovespa Index [Ibovespa], accounting for around 80% of all business in the area.

In recent years, some of these companies that work with manipulated products and medicines have brought organic ingredients to the financial market and have carried out an Initial Public Offering [IPO] offering

their shares to society for the first time, which has attracted investors. Driven by little public investment in the area of organic products, the Landless Rural Workers Movement [MST] announces, in 2021, its entry into the financial market with the purpose of raising funds to finance the production of organic food through associations and cooperatives.

In recent years this type of product has conquered consumers. According to Organig (2021), the number of consumers of this type of food in 2021 grew by 63%, which has maximized the supply and diversity of pesticide free products. This movement of products without pesticides in the dispute for spaces with conventional and industrialized products has also produced satisfactory effects in the understanding of the role of Agroecology for agriculture and for the Brazilian agricultural economy.

This work will adopt a concept for Agroecology and another for organic agriculture. The first, understood in this article as a scientific approach that aims to transition from one model of agriculture to another, or rather, from conventional to sustainable agriculture. This way of thoughts opposite to the Agroecology to the idea of products that the Green Revolution idealized. No does it restrict the term merely to a substitution of chemical inputs for alternative, organic inputs (Caporal & Costabeber, 2004). In this way, organic agriculture will be a form of cultivation that is based on natural methods.

Briefly if a producer provides a product based on an ecological perspective, without poison, being able to work on a large scale, in which it delivers to an intermediary, this can be inserted in an organic vision. This product can be agroecological when the producer provides food without using chemical elements, inserted in a production system that involves ethical, cultural, political, ecological, economic and social dimensions (Caporal & Costabeber, 2004). Organic and agroecological products start from the same base and they not impact the soil, but with different dimensions. Organic agriculture, therefore, would be one of the types of agriculture practiced within what this study considers the science of Agroecology.

In the agricultural scenario of Sciences in Brazil, studies on organic agriculture as an agriculture of Agroecology that deal with themes, authors and authors, references and methodological approaches are still very incipient, even less studies that treat Agroecology as an interdisciplinary science. Nonetheless, this study starts from the following question: how is the theme of Agroecology being portrayed and what outlines are being taken in Brazilian journals of Agrarian Sciences? From there, this research wants to reach its objective: to present

the designs built by research in Agrarian Sciences on Agroecology.

The Englishman Lord Northbourne (1896-1982) used firstly the term *organic agriculture*. However, the Englishman Albert Howard (1873-1947) who studied the lectures of the German Rudolf Steiner (1861-1925) created the practice of organic agriculture. Rudolf Steiner (1861-1925), in 1924, has prepared a course based on a series of conferences for producers, in which he conceptualized agriculture beyond its economic dimension, presenting the concept of an agricultural organism, initiating the school of biodynamics. Howard (2012) advocates that the foundation of sustainability is the conversion of soil fertility, highlighting the importance of soil microorganisms for the work of agriculture.

Other types of agriculture were being developed around world. In the 1930s studies of organic farming arose, with the Swiss Jerome Ehlers (1958-2014) as a representative, who advocated soil management, fertilization and crop rotation. In the same decade, a type of agriculture called natural agriculture was developed, whose ideas defended by the Japanese Masanobu Fukuoka (1913-2008), proposed minimal human intervention in nature by the absence of plowing and without the use of fertilizers. Similar to these studies, Lady Eve Balfour (1898-1990) developed studies in Great Britain in which they approached the relationships of life and health of soils, observing the life of plants and animals.

In the 1980s permaculture appeared through the studies of Bruce Charles Mollison (1928-2016) and Holmgren (1955-2017) who proposed an integrated system of small animal and plant species useful to humans. Mollison (1928-2016), or Bill Mollison, observing the animals in the forest, imagined creating a system similar to what he saw, having a mandala as a model, together with the Australian David Holmgren (1955-2017), he developed a structure for a sustainable and self-perpetuating system, where there is "harmonious interaction between people and the landscape, providing food, energy, shelter and other needs, material or not in a sustainable way" (Mollison & Slay, 1998).

Putting organic agriculture, permaculture and Agroecology in the same thread, the three would be branches of the same trunk, that is, the same ecological approach, but which differ from each other.

Altieri (2004) suggests that there is a very restricted relationship between permaculture and agroecology. Both Agroecology and Permaculture are characterized as sciences and both originated in the same period. This two terms are very close to sustainability. However, there are differences between the two.

Agroecology focuses on the definition of agriculture and the other, permaculture, embraces agriculture, sanitation, housing, land occupation, etc. Permaculture is based on three ethical principles: caring for the land, caring for people and sharing surpluses. In this way, it supplants the function of the land as just the supply of food, as if just producing was enough. What also happens with Agroecology that, for Altieri (2004, p. 17), “to be effective, development strategies must incorporate not only technological dimensions, but also social and economic issues”, ratified by Caporal and Costabeber (2004) when they use similar vision.

Common difference from permaculture and agroecology to organic agriculture is what is organic is not always sustainable, considering what Caporal and Costabeber (2004) advocate. Already between organic agriculture and agroecology there are differences in the relationships established to produce and commercialize. The organic seal, a requirement in modern capitalist agriculture for organic products, can be given to large, heavily mechanized large estates, which involve little or even expel the labor of peasants from their lands.

Organic farming sometimes produces “new labels” on “old bottles”. The agricultural system does not change, the elements remain independent and the organic inputs are inserted into a structure that remains traditional. The logic of production and marketing remains the same.

Some countries have created laws that make organic agriculture viable, even surpassing conventional activities in agriculture. Although producing epistemological confusions, in its differences and common points with Agroecology, organic agriculture manages to bring the agenda of Agroecology to the political agenda. In fact, the agenda of Agroecology is the result of discussions and popular participation.

In the Brazil, in May 1999, a law was created which provides for norms for the production of organic products. By Decree 7794, in August 2012, the National Policy on Agroecology and Organic Production [PNAPO] is established, establishing a pact between the Federal Government and civil society in order to stimulate actions, policies and programs in the scope of organic production and the agroecological transition.

This decree takes as a concept for organic agriculture activity and agroecologically based production the provisions of Law 10831, of December 2003. The legal framework for organic agriculture also includes: Law 10831/2003; Decrees 6323/2007 and 6913/2009; Normative Instructions 54 “On the Commissions” and 64 “Of the Organic Systems of Animal and Plant Production”; Normative Instructions 17 “On Sustainable Organic

Extractivism” and 18 “Processing, Storage and Transport” and 19 “On Organic Quality Control and Information Mechanisms”. This entire legal framework of organic agriculture refers little to Agroecology, and the framework itself is often an obstacle even for commercialization and organic production.

However, the history of the organic products market in the Brazil didn’t start from the legislation, on the contrary, in the 90s there were already significant initiatives, although there’s no legislation for its regulation (Costa, 2017). It was also in the 90s that the expression Agroecology started to be used as a way of representing sustainable agriculture, observing the ethical, cultural, political, ecological, economic and social dimensions (Caporal & Costabeber, 2004), based on the reflections developed around the agroecological experiences observed in different places in Latin America.

The current meaning of the term Agroecology leaves aside the understanding that was had in the 1920s, which according to Gliessman (2000) was presented as alternative agriculture, to be understood as a science, with a great contribution from Altieri (1989; 2004). Although, this “alternative agriculture” being researched in depth by many researchers who have demonstrated its effectiveness, it was still not well accepted in the industrial, political and academic circles. Understood as a discipline that studied agroecosystems, the contribution of other fields of knowledge was fundamental to broaden the concept. Thus, its origin is demarcated in Agricultural Sciences, in Ecology, in social movements and in the analysis of agroecosystems of traditional communities and in the study of rural development (Hecht, 2002).

Lord Northbourne (1896-1982), Jerome Ehlers (1958-2014), Masanobu Fukuoka (1913-2008), Lady Eve Balfour (1898-1990), Mollison and Holmgren (1981) began to be revisited by several researchers in the Agrarian Sciences, in a search for ecological relationships with agricultural systems.

In Brazil, this revisitation was carried out by several authors who helped to build and spread the concept of Agroecology as Paschoal (2019), Primavesi (2002), Lutzenberger (1983), Machado and Machado Filho (2014), Pinheiro (2018), Caporal and Costabeber (2004).

In the 1990s, the first Brazilian documents about these ideas come from the First Brazilian Meeting of Alternative Agriculture, in 1981. In 1984, the Second Brazilian Meeting of Alternative Agriculture takes place and, three years later, the third Meeting. These events were fundamental for the dissemination of Agroecology as an emerging science.

For Hecht (2002) social issues began to emerge with greater force by the agricultural literature at the exact moment when social movements presented themselves as resistance to the conventional form of agriculture and as a consequence of rural development studies and at the moment when scholars were concerned to report and describe the agricultural practices of traditional peoples. For the same author (2002), the existence of this kind of study about diversity and lines of thought, contribute to the development of Agroecology and a interdisciplinarity movement. And, therefore, being the most appropriate to deal with the problems present in the rural world. From this point of view, this study could hypothesize that current research has been rethinking the epistemological position of the Agrarian Sciences regarding Agroecology. Is it? This is what this study will investigate from the central questioning about the designs taken by the researches of the Agrarian Sciences.

After this introduction, this article is organized in material and method, results and discussions and conclusion. Material and method describes the methodological processes adopted in the research. The results and discussions present all the development of the research and some reflections that were elaborated from the collected data. The conclusion present some answers to the discussed of the article.

II. MATERIAL AND METHOD

To answer the central question, bibliographic analysis research is given up, which will help to quantify and analyze all the selected scientific production (Cooper & Lindsay, 1998; Leite Filho, 2006). The first step was to enter the Scopus platform, in the quadrennium option 2013-2016, in the area of Agrarian Sciences, and search for journals that have the strata proposed in this study. A total of 462 A1 records, 450 of A2 and 890 of B1 (national and international) were found. The selection was based on the journals in which the object of study could be found.

Thirty journals were chosen: Scientia Agrícola, Annals Science and Agrotechnology [UFLA], Science and Agrotechnology, Vitis, Acta Amazonica, Acta Botanica Brasílica, Acta Limnológica Brasiliensis, Arquivos do Instituto Biológico, Biodiversidade Brasileira, Biota, Neotropica, Bragantia, Brazilian Archives of Biology and Technology, Brazilian Journal of Biology, Brazilian Journal of Botany, Brazilian Journal of Chemical, Brazilian Journal of food Technology, Brazilian Journal of Plant Physiology, Brazilian Journal of probability and Statistics, Ebape BR, Food Science and Technology, Forestry Science, Rural Science, Agricultural Engineering, Forest and Environment, Irrigation, Brazilian Journal of

Agricultural and Environmental Engineering, Caatinga, CERES, Agronomic Science Journal.

Due to the actuality and importance of the subject of this study, there was a concern for the methodological procedure and the validation of the finding that support this research. Thus, the analysis by triangulation of methods was proposed by the “use of multiple methods, or triangulation, reflects an attempt to ensure an in-depth understanding of the phenomenon in question” (Denzin & Lincoln, 2006, p. 19).

All data collection took place between articles published from the end of 2011 to the beginning of 2022. After selection, the material was cataloged in the Mendeley Desktop software. The Qualitative Data Analysis [QDA] tool and the Microsoft Office Excel software were fundamental in this process, because they helped in the tabulation and creation of the graphs and as a subsidy of descriptive and qualitative statistics in the analysis of the data, with the contribution of Critical Ecosystem Linguistics [LEC] that takes into itself the principles of “ecomethodology” (Garner, 2004). Ecomethodology is fundamental in this study, as the pedagogy of its method is centered on the learning of the daily and daily doing of the subjects, with the purpose of promoting sustainability in development.

This paper observes yet the openness that exists for Brazilian research to be published in other languages, even in Brazilian journals. Therefore, the selection of articles on the topic of Agroecology was based on the insertion of keywords in English and Portuguese (Agroecology, organic agriculture, sustainable agriculture, permaculture). The selected articles had in their titles, keywords or abstract at least one of the words observed. Some articles were discarded, as they appeared in the inclusion criteria of words without, however, appearing them in the title, abstract or keywords, containing words that, although they were in the same lexical field, were not necessarily in the semantic field of Agroecology, for example, the words: agricultural, agro-industry, farming or expressions such as “fertilization of organic origin”.

As previously mentioned, together with the QDA, the LEC (Couto, 2020) will be used, which has been increasingly dedicating itself to a more ecological view of the world, advocating that human beings and their way of living, existing and thinking are inserted in a large ecosystem, which discards the cartesian view of the world. Unlike other areas of knowledge, in the field of linguistics and discourse analysis, LEC has its epistemological basis built on ecological concepts, and the most important concept in this field is that of ecosystem.

Observing the phenomenon of language, it can be considered, therefore, that there is not only one linguistic ecosystem, depending on the perspective, four or more can be found: natural language ecosystem, mental ecosystem, social ecosystem, which can converge into a single, the integral language ecosystem and, in this way, the language can be associated with an environment (natural, mental, social or integral). Thus, when talking about the environment, we need to know the reference bases whom will depend on the researcher's approach (Couto, 2015). Boff (2012) argues that it is necessary to identify not only the type of ecology but to include the integral ecology that encompasses the other three. The narrative of life takes place in this intertwining of ecologies. To this end, the

LEC will better support the understanding of this intertwining, as it emphasizes life (Agroecology is life) and what develops from it, such as the resistance of peoples to remain in their territories.

III. RESULTS AND DISCUSSION

Returning to the periodicals cataloged in Mendeley, in the period from 2011 to the beginning of 2022, 48 articles were found, involving 187 authors, in 14 periodicals, of 26 volumes, sometimes appearing in the same volume more than one publication. . This count takes into account the special editions of the Periodicals.

Table 1: Articles found

Year	Article	Authors	Journals found
2022	Composition differences between organic and conventional processed foods: a meta-analytical study	6	Rural Science
2022	Investigating the leading drivers of organic farming: A survival analysis	6	Rural Science
2022	Potato genotypes and environments under potato in the Brazilian Cerrado biome	6	Rural Science
2022	Environmentally sustainable practices in hospital food and nutrition units	3	Brazilian Journal of Food Technology
2021	Agave pulquero (Agave salmiana), socio-economic and agro-ecological importance and its development perspectives: a literature review	2	Rural Science
2021	Coffee waste as an eco-friendly and low-cost alternative for biochar production impacts on sandy soil chemical attributes and microbial gene abundance	10	Bragantia
2021	Conversion to organic farming: a dynamic opportunity for Pakistani smallholders of fresh fruit	2	Rural Science
2021	Determinants of Rulindo tea farmers' perception towards organic farming	2	Rural Science
2021	Economic Viability of beet crops using Calotropis Procer Biomass as soil fertilizer in two growing seasons	6	Caatinga Magazine
2021	Effect of sowing time and density for vegetative and reproductive traits of genotypes of maize landrace in an agroecological system	2	Rural Science
2021	Perception of fungi by farmers in the Cerrado	7	Brazilian Journal of Biology
2021	Sulfonamide resistance genes in soils treated with waste from animal production in an organic production system	8	Seminar: Agricultural Sciences
2021	The cherry tomato under an organic system inoculated with <i>Trichoderma asperellum</i> and intercropped with vegetables of family fabaceae	6	Agronomic Science Magazine
2021	Yield and quality of passion fruit under organic cultivation with input levels and irrigation in the state of Acre	5	Caatinga Magazine

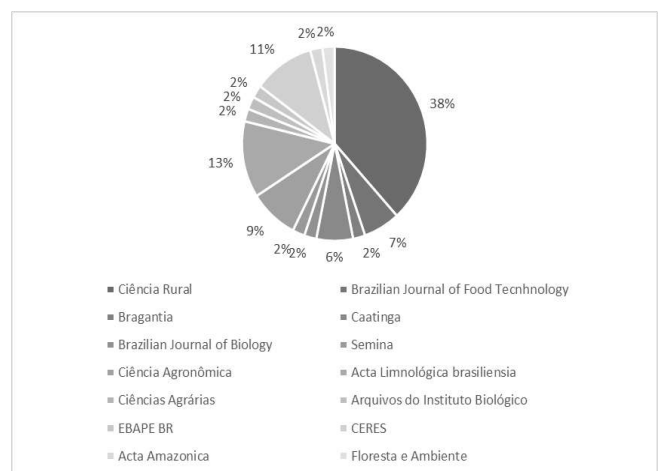
2020	Alpha and beta diversities of Trichoptera (Insecta) assemblages in natural and rural subtropical streams	6	Acta Limnológica Brasiliensia
2020	Application of multivariate methods and geostatistics to model the relationship between CO ₂ emissions and physicochemical variables in the Hidrosogamoso reservoir, Colombia	3	Acta Limnológica Brasiliensia
2020	Demystifying agroecology in Brazil	2	Rural Science
2020	Determining the performance of alfalfa population collected from a narrow agroecological zone of Turkey	3	Rural Science
2020	Consumer preferences toward organic food and the moderating role of knowledge: a case of Pakistan and Malaysia	5	Rural Science
2020	Work in organic farming : an overview	3	Rural Science
2020	women working in animal husbandry : a study in the agroecological transition context	3	Rural Science
2020	Work in organic farming : an overview	3	Rural Science
2019	Family farming in agroecological transition : a look at the marketing of milk and dairy products in municipalities of the Zona da Mata of Minas Gerais State , Brazil	2	Rural Science
2019	Production costs and profitability in coriander fertilized with <i>Calotropis procera</i> under organic cultivation	5	Agronomic Science Magazine
2019	Quality and sensory acceptance of 'Pearl' pineapple grown in soil with application of organic fertilizer	5	Rural Science
2019	Potato genotypes reaction to early blight and late blight in organic cultivation	5	Rural Science
2018	agronomic characteristics of the pacovan organic banana in irrigation sustains in the Açu-RN valley	4	Caatinga Magazine
2018	Effect of pigeon pea intercropping or shading with leucaena plants on the occurrence of the coffee leaf miner and on its predation by wasps in organic coffee plantings	5	Rural Science
2018	Organic residue inputs influence soil biological properties in organic farming systems	5	Brazilian Journal of Agricultural Sciences
2017	Biodiversity of nematodes biological indicators of soil quality in the agroecosystems	2	Archives of the Biological Institute
2017	Copepod assemblage structure (Crustacea: Copepoda) along a longitudinal environmental gradient in a tropical river-floodplain system, Brazil	5	Acta Limnologica Brasiliensia
2017	Designing resistance: aesthetics and counter-hegemony in the agroecological movement in Brazil	2	EBAPE BR
2017	Factors affecting assemblage attributes of freshwater Oligochaeta in Neotropical shallow floodplain lakes	5	Acta Limnologica Brasiliensia
2017	Leguminous cover crops for banana plantations in semi-arid regions	3	Caatinga Magazine
2016	Qualitative attributes and postharvest conservation of green ears of maize grown on different cover crops in organic no-till system	6	CERES
2016	Fluvial lateral environments in Rfo de La Plata basin: effects of hydropower damming and eutrophication	4	Acta Limnologica Brasiliensia

2016	Quality of tomato fruits grown in an organic production system and treated with lemongrass by-products	5	Agronomic Science Magazine
2015	Socioeconomic alternatives for family farmers: the role of an agroecological association	2	CERES
2015	Ecological guilds of epiphytic diatoms (Bacillariophyta) on <i>Acrostichum danaeifolium</i> Längst. & Fisch in a subtropical wetland in southern Brazil	2	Acta Limnologica Brasiliensia
2014	Green manure with sunn hemp intercropped with baby corn preceding kale under organic management	5	CERES
2014	Cultivation of vegetables in the organic system	3	CERES
2014	Damage of fruit flies (Diptera, Tephritidae) on citrus managed in the organic production system	4	CERES
2013	Environmental risk assessment due to metallic contamination and organic material in sediments from the Aurá River basin, Metropolitan Region of Belém – PA	2	Acta Amazonica
2013	Indicator of sustainability of agroecosystems: case study in corn growing areas	2	Rural Science
2013	Yield and nutritional status of the conilon coffee tree in organic fertilizer systems	4	Agronomic Science Magazine
2012	Microbiological aspects and nutritional information of organic tomato sauce from family farming	5	Brazilian Journal of Food Technology
2012	Attitudes and motivations in relation to the consumption of organic foods in Belo Horizonte – MG	2	Brazilian Journal of Food Technology
2012	Litter Stock and Microbial Activity in Soil under Agroforestry Systems	4	Forest and Environment

In the total numbers of journals researched, the articles that make up the *corpus* of this research are in 14 in the area of Agrarian Sciences. All articles found are located in journals in the stratum classified as B1 of the Coordination for the Improvement of Higher Education Personnel [CAPES, acronym in Portuguese].

The graphic in Table 2 shows that in the total number of journals surveyed, 62% of the volumes found are concentrated in 03 journals. If scientific publications are used as an indicator of performance in areas of knowledge, this graph reveals a statistically significant correlation regarding a small degree of interest of Qualis CAPES B1 journals for the theme of organic agriculture related to Agroecology perhaps also reveals the lack of interest of periodicals A1 and A2 in the subject. Therefore, the number of publications on the subject of Agroecology does not match the current offer of organic products and medicines in the financial market and in the number of articles published on the subject of organic crops.

Table 2: Total number of volumes in percentage



Considering the profile of the journals, which are focused on areas such as Agronomy, Veterinary Medicine, Food Engineering, Water Resources Engineering, Animal Science, the expectation was that there would be a much greater number of articles directly related to the science of Agroecology and, mainly, , in larger strata. For Gliessman (2009) despite the emergence of Agroecology in the

1930's, show us that this science approach gained strength in the 1980s, as a result of the association of Agronomy and Ecology. These two science, Agronomy and Ecology, were previously considered dichotomous, and the reflection of this dichotomy can be seen in other branches of these sciences, and it still seems to be current when considering the almost erasure of Agroecology in journal texts around Agrarian Sciences. “ With due caution, there is no need to be afraid of eclecticism” (Couto, 2018, p. 23), even knowing that this eclecticism, which can be called multi-inter-transdisciplinarity in this study (Altieri, 1989), may present, at least in methodological terms, obstacles that can be observed in the most varied sciences and disciplines. But in the science of Agroecology this form of approach is the “exit to the fenced and exhausted world of our time” (Leff, 2002).

About the authors and author numbers, if we consider the author and author number for the text number, we would have almost 4 per production. But this correlation does not relate in that way. Of these 48 articles, more than 50% were written by 4 or more authors and authors. This may represent a peculiar characteristic of adherence to the collective production of texts that are written by researchers who come from various fields of knowledge, a very particular characteristic in the scientific production of the science of Agroecology, and which seems to be characteristic in studies within the scope of publications with organic farming themes, at least in these journals. This type of scientific attitude welcomes the interdisciplinary and ecosystemic way that conduct the types of research carried out that investigate the integral ecology mentioned by Boff (2012).

In the Agroecology science, collaboration and cooperation are passes for the exchange of knowledge and practices. In the context of scientific production in the field of Agroecology, this characteristic reflects in such a way that the subjects involved in the action are sometimes considered as co-authors of the scientific production, which was not possible to identify this form of authorship in the articles found.

The Table 1 shows the number of publications carried out on organic cultivation/production and Agroecology. The Table 3 resumes this information, but bringing us the types of approaches performed by these articles.

Table 3: Research approaches and types

Year	Approach			search type		
	Quantitative	Qualitative	quantitative	Exploratory	descriptive	Explanatory
2011	0	0	0	0	0	0
2012	3	0	0	0	3	0
2013	3	0	0	0	3	0
2014	3	0	0	0	3	0
2015	1	1	0	0	1	1
2016	3	0	0	0	3	0
2017	4	1	0	0	4	1
2018	3	0	0	0	3	0
2019	4	0	0	0	4	0
2020	5	1	1	3	2	2
2021	9	0	1	1	9	0
2022	4	0	0	0	4	0
Total	42	3	2	4	39	4

The preference of authors for quantitative approaches is notorious. But occasionally there is emergence of the qualitative approach in journals as we can see in the years 2015, 2017 and 2020. These researchers who have chosen an approach that does not follow the others seem to be part of a minimal group of scholars in which it is assumed that it is not necessary in science, whatever it may be, to adopt a single and exclusive model of approach. Going deeper and returning to the articles in this review, it is possible to say that these few authors are in the group of those who defend Agroecology as a science (Caporal & Costabeber, 2004), without getting lost in a lay confusion between Agroecology and organic agriculture.

In the same Table, almost the same total employment of the quantitative approach and the type of descriptive research we have observed. The paths of investigation between the descriptive approach and quantitative research seem to be the same, assuming a posture of annuity of interference of the researcher subject. This understanding is disconnected from Agroecology, as a science, which needs an approach that already presupposes its interference at the exact moment of the question of which environment the research will study (Couto, 2015).

Table 4: Data analysis procedures

Analysis					Year
Statistic	diagnosis	Contents	Speech	Historical	
0	0	0	0	0	2011
3	0	0	0	0	2012
3	0	0	0	0	2013
3	0	0	0	0	2014
1	1	0	0	0	2015
3	0	0	0	0	2016
4	0	0	1	0	2017
3	0	0	0	0	2018
3	0	1	0	0	2019
5	0	1	0	2	2020
10	0	0	0	0	2021
4	0	0	0	0	2022
42	1	2	1	2	Total

In reference to data analysis presented, the preference of authors is aggregated in the statistical analysis (geostatistics, biostatistics, etc.). If a relationship is made between the use of the statistical method and the descriptive approach, and the result is almost equal in number of use by the authors, it could be said that this statistic with the more descriptive approach can have the purpose of to describe as much data as possible, as can be better perceived by the use of a large number of graphics analysis and tables in the articles selected for this research. At the same time, in the last two years there has been a vertiginous increase in the Agroecology/organic theme, it seems that there is no attempt to diversify the methodological procedures. For the Agroecology science, the use of just one type of methodological procedure places research on a non-interdisciplinary path, an important condition to contribute to the expansion of the concept of Agroecology. Therefore, it is sometimes difficult to see, for example, the possible territorial dispute that may exist between Agroecology and other production models. The territorial dispute category would evidence power relations, construction of new processes to face patriarchy, the involvement of ancestry and religiosity in the construction and understanding of organizational and training processes, the communication process involved in the articulation of knowledge, practices and daily experience and in the marketing of products, etc.

As for the research procedures, of the total of 09 types adopted (documentary, bibliographic, participatory research, etc.), 26 were inserted in what is commonly called experimental and 11 were of the survey and field type. The experimental one was preferred by the researchers, as it is considered one of the main types of research due to the fact that it has greater control over the variables. If they are placed in the same group as field research and survey, which is possible, this number increases considerably to 37. Faced with so many research procedures, the choice for a few may occur merely as an epistemological option, or even influences from the Cartesianism, the journals' criteria for publication or the agility of the processes avoiding greater bureaucratic publication procedures, hypotheses that cannot be proven in this study.

Regarding the topics covered, it is divided into three groups here: 1. Articles that did not make any reference to Agroecology, even when talking about organic agriculture or agroecosystem; 2. Those who present clarity regarding the defense of agroecology, as a new and interdisciplinary science, and the distinct understanding that there is between Agroecology and organic agriculture, or yet, when it presents a critical view while having it as a science; 3. Those which somehow link Agroecology to other sciences or agriculture.

Synthetically, by the historical line that was presented in the theoretical basis of this study, it is possible to affirm that Agroecology is the benchmark of new proposals of sustainable agriculture and becomes indispensable to understand the new ways of doing agriculture. Agroecology is understood as a science that aims to support the transition from current models of rural development and conventional agriculture to more sustainable models (Caporal & Costabeber, 2002). This new science starts from the concept of agroecosystem as a unit of analysis that relies on scientific bases to study agrarian activity from different scientific disciplines in an ecological perspective (Altieri, 2004) that is concerned with identifying not only the type of ecology, but seek it in its form of integrality (Couto, 2015) that involves several dimensions (Caporal & Costabeber, 2004), a little different from what Baiardi and Mendes claim (2005, as cited in Baiardi & Pedrosa, 2020, p. 2, free translation):

In Brazil it was no different. When they reverberated, the scientific community officially didn't worry about them, except about isolated manifestations of some of its members. These irrational manifestations that took place under the mantle of neo-obscurantism gradually evolved to an almost hysteria in relation to genetic modifications, with condemnation of researches

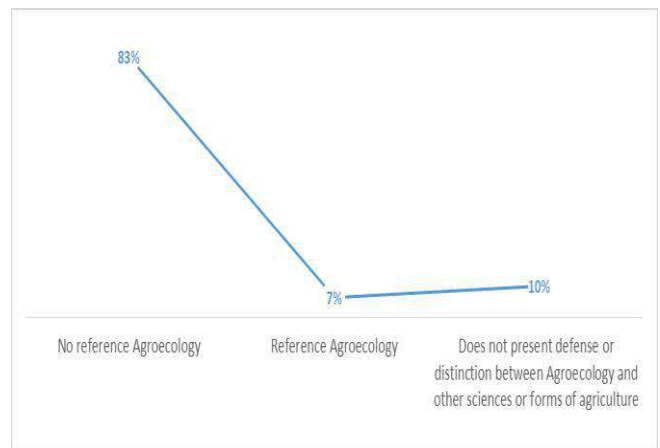
in modern biotechnology in their discourse, not being, in essence, anything different from those in which theological thought attempted not take into account the discoveries of Copernicus, Galileo, Descartes and Darwin.

This way of seeing Agroecology can be seen in Table 05 as “new visions”, despite not being a new conception because this type of questioning arises at the same time that Agroecology appears in Brazil as a proposal of science. Baiardi and Pedroso (2020, p. 3) consider that Agroecology does not have an exact definition that is scientifically accepted, since “as a ‘particular science’, only as defined by its leaders, depends on external conditions to the world of science and in the same time, it is defined as a non-agrarian science, as a science of sustainable agriculture, not dissociated from the idea of holistic”. If these authors (2020) consider Agroecology as a distant dream with a disarranged designer, it is that, perhaps, they do not treat it without detaching it from Cartesian schemes, since this new science is integrative and holistic, and consequently would be Agroecology, as a theory and practical, more appropriate to understand sustainable rural development (Caporal, Costabeber & Paulus, 2006, p. 21).

On the other hand, in this “new vision” of Agroecology, Naves and Reis (2017), based on a new analysis, build a defense of Agroecology in which they point to new forms of production, bringing aggregating elements to the concept of Agroecology, pointing out indicators of sustainability (however, they do not mention this term), such as: income generation, eco-efficient equipment, environmental health and family health, product qualities, community participation, workers' autonomy, diversification of production, forms of marketing and valorization knowledge and traditional knowledge.

Another important point for the Agroecology concept is the participation of social movements and the territorial dispute waged in the agrarian and agricultural field. At this point, these authors (2017, p 312) resort to the concept of antagonism as a form of resistance that social movements seek. Thus, the authors present a defense of the concept of Agroecology as a science that highlights, knowledge, values, habits, experiences of building territories of life and political and identity organization.

Table 5: References to Agroecology



The articles that did not make any reference to Agroecology, even talking about organic agriculture or agroecosystem are talking about what? If, in the theoretical assumptions of some authors, more than 80% of the articles do not make any relationship with Agroecology, it seems that the cultivation of organics in these cases still remains in the same agricultural system, being inserted in a traditional agrarian and agricultural structure, of monoculture and in which the narrative is not understood from all the dimensions that Caporal and Costabeber (2004) suggest.

There is still, and there are not few, mainly in the agrarian environment, a confusion of understanding between Agroecology and organic or organic and Agroecology, as well as those who defend that Agroecology and organic can be part of the same processes. The 10% indicated in the graphic frame may be situated in this context of hypothesis.

These conceptions can occur for several reasons, considering: Agroecology is still a science under construction, and therefore needs to better define its paradigms and that its principles and epistemologies need more studies and reflections (1); that Agroecology is not a science, but only a process that takes place in practice and on a daily basis (2); Agroecology and organic are the same reality because they start from the same base – ecology (3); the Agroecology term is not autonomous because it is an interdisciplinary science (4). Finally, the Agroecology term is a “new fad” and will soon pass; or even, to present new postures that its defenders still can’t see.

IV. CONCLUSION

The results of this study show that a considerable part of the research focuses precisely on the question of organic agriculture, without opening up to a greater understanding

of Agroecology, so that it also leaves aside the interdisciplinary and transdisciplinary character of this new science. The articles demonstrated in this study are open to new ways of doing science, such as the collective production of articles. However, it is observed that more studies in the area are necessary, mainly in the treatment of Agroecology as a new science, which is being in construction and in the same way is a complex and multi-trans-disciplinary approach, has its object of study and its epistemological bases clear and that it opens the door to be expanded in its way of seeing reality. It's a new science, but its foundations are as old as the history of agriculture.

REFERENCES

- [1] Altieri, M. (1989). *Agroecologia: as bases científicas da agricultura alternativa*, 2nd. ed. Rio de Janeiro: PTA-FASE.
- [2] Altieri, M. (2004). *Agroecologia: a dinâmica produtiva da agricultura sustentável*, 4rd. ed. Porto Alegre: UFRGS.
- [3] Boff, L. (2012). *As quatro ecologias: ambiental, política e social, mental e integral*. Rio de Janeiro: Mar de Ideias.
- [4] Caporal, F. R. Costabeber, J. A. (2002). *Agroecologia: enfoque científico e estratégico*. *Revista Agroecologia e Desenvolvimento Rural Sustentável*, vol. 3. Porto Alegre: UFRGS, pp.13-16.
- [5] Caporal, F. R. Costabeber, J. A. Paulus, G. (2006). *Agroecologia: matriz disciplinar ou novo paradigma para o desenvolvimento rural sustentável*. Brasília: DATER/SAF/MDA. Retrieved from <https://pt.scribd.com/document/360256467>.
- [6] Caporal, F. R. Costabeber, J. A. (2004). *Agroecologia: alguns conceitos e princípios*. Brasília: MDA/SAF/DATER-IICA.
- [7] Cooper, H. M. Lindsay, J.J. *Research synthesis and meta-analysis*. (1998). In BICKMAN, L. ROG, D. J. *Handbook of social research methods*. Thousand Oaks, CA, United States: Sage Publications, pp. 315-242. Retrieved from <https://www.researchgate.net/publication/230557448>.
- [8] Costa, M. B. B. (2017). *Agroecologia no Brasil: história, princípios e práticas*. São Paulo: Expressão Popular.
- [9] Couto, H. H. (2018). *A metodologia na Linguística Ecolinguística*. *Ecilinguística*. In *Revista Brasileira de Ecologia e Linguagem*, vol, 4. Brasília: UNB, pp. 18-33. Retrieved from <https://periodicos.unb.br/index.php/erbel/article/view/1235>.
- [10] Couto, H. H. (2015). *Linguística ecossistêmica*. *Ecilinguística*. In *Revista Brasileira de Ecologia e Linguagem*, vol. 1. Brasília: UNB, p. 47-81, 2015. Retrieved from: <https://periodicos.unb.br/index.php/erbel/article/view/9967>.
- [11] Couto, H. H. (2020). *Discursística*. In *Revista Linguagem e Glotopolítica*. Brasília: UNB. Retrieved from: <https://ilinguagem.blogspot.com/2020/03/discursistica.html>
- [12] Denzin, N. K. Lincoln, Y. S. (2006). *Introdução: a disciplina e a prática da pesquisa qualitativa*. In DENZIN, N. K. LINCOLN, Y. S, Eds. *O planejamento da pesquisa qualitativa: teorias e abordagens*. 2nd. ed. Porto Alegre: Artmed, pp. 15-41.
- [13] Garner, M. (2004). *Language: an ecological view*. Berna: Peter Lang.
- [14] Gliessman, S.R. (2009) *Agroecologia: processos ecológicos em agricultura sustentável*. 4nd. ed. Porto Alegre: UFRGS.
- [15] Hecht, S. B. (2002). *A evolução do pensamento agroecológico*. In Altieri, M. A. *Agroecologia: bases científicas para uma agricultura sustentável*. Guaíba: AS-PTA, pp. 21-51.
- [16] Howard, S. A. (1940). *Testamento Agrícola*. 2nd. ed. São Paulo: Expressão Popular. Retrieved from <https://periodicos.unb.br/index.php/erbel/article/view/9967/8800>.
- [17] Leff, E. *Agroecologia e saber ambiental*. (2002). In *Agroecologia e Desenvolvimento Rural Sustentável*, v. 3, Porto Alegre: pp. 36-51.
- [18] Leite Filho, G. A. (2006). *Padrões de produtividade de autores em periódicos de congressos na área de contabilidade no Brasil: um estudo bibliométrico*. São Paulo: Congresso USP Contraladoria e Contabilidade, Retrieved from <http://www.congressousp.fipecafi.org>.
- [19] Lutzenberger, J. (1983). *Fim do Futuro? Manifesto Ecológico Brasileiro*. 3rd ed. Porto Alegre: UFRGS.
- [20] Machado, L. C. P. Machado Filho, L. C. (2014). *Dialética da agroecologia*. São Paulo: Expressão Popular.
- [21] Mollison, B. Holmgren, D. (1981) *Permacultura um: uma agricultura permanente nas comunidades em geral*. São Paulo: Ground LTDA.
- [22] Molisson, B. Slay, R. M. (1998). *Introdução a permacultura*. Brasília: MA/SDR/PNFC.
- [23] ORGANIS, Associação de Promoção dos Orgânicos. (2021). *Panorama do Consumo de orgânicos no Brasil 2021*. São Paulo: Ciorgânicos.
- [24] Paschoal, A. D. (2019). *Pragas, agrotóxicos e a crise ambiente: Problemas e soluções*. São Paulo: Expressão Popular.
- [25] Pinheiro, S. *Agroecologia 7.0*. (2018). São Paulo: AGPTEA.
- [26] Primavesi, A. *Manejo ecológico do solo: a agricultura em regiões tropicais*. (2002). São Paulo: Nobel.

Animal protein production in aquaculture in the semi-arid northeast - challenges and perspectives for small businesses

Msc. Dajana Gabriella Nóbrega Santos da Silva¹, Dr. Jairton Fraga Araújo², Dr. Luciano Sergio Ventim Bomfim³, Dra. Anna Cristina Freire Barbosa⁴, Dra. Eliane Maria de Souza Nogueira⁵

¹Doutoranda no Programa de Pós-Graduação em Agroecologia e Desenvolvimento Territorial PPGADT- Universidade Federal do Vale do São Francisco- UNIVASF/Universidade do Estado da Bahia – UNEB, Campus – III, Juazeiro – BA, e-mail: engenheiradajana@hotmail.com

²Docente no Programa Pós-Graduação em Agroecologia e Desenvolvimento Territorial PPGADT - Universidade Federal do Vale do São Francisco- UNIVASF/Universidade do Estado da Bahia – UNEB, Campus – III, Juazeiro – BA, e-mail: jafararaujo@uneb.br

³Docente no Programa Pós-Graduação em Agroecologia e Desenvolvimento Territorial PPGADT - Universidade Federal do Vale do São Francisco- UNIVASF/Universidade do Estado da Bahia – UNEB, Campus – III, Juazeiro – BA, e-mail: lbomfim@uneb.br

⁴Docente no Programa Pós-Graduação em Agroecologia e Desenvolvimento Territorial PPGADT - Universidade Federal do Vale do São Francisco- UNIVASF/Universidade do Estado da Bahia – UNEB, Campus – III, Juazeiro – BA, e-mail: acbarbosa@uneb.br

⁵Docente no Programa Pós-Graduação em Agroecologia e Desenvolvimento Territorial PPGADT - Universidade Federal do Vale do São Francisco- UNIVASF/Universidade do Estado da Bahia – UNEB, Campus – III, Juazeiro – BA, e-mail: emsnogueira@gmail.com

Received: 08 Jun 2022,

Received in revised form: 05 Jul 2022,

Accepted: 10 July 2022,

Available online: 15 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *Economy, Development, Aquaculture, Possibilities.*

Abstract— *In this article, we sought to analyze aquaculture in the northeastern semi-arid region, with an emphasis on the animal production of Nile tilapia (*Oreochromis niloticus*), dialoguing with its challenges and perspectives for small business and potential impacts on its performance. The region presents as a prominent factor the climate, which is responsible for the variation of the other elements that make up the landscapes. The activity uses natural, human and manufactured resources. In order to achieve the proposed objectives and obtain data on the state-of-the-art on the subject, we sought to carry out a literature review of articles published in national and international journals, published in the Scielo, Google academic and Science direct databases, and classic authors.*

I. INTRODUCTION

The Brazilian semi-arid region is composed of 1,262 municipalities, belonging to the states of Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, Bahia and Minas Gerais. The criteria for delimiting the semi-arid region were: average annual rainfall equal to or less than 800 mm; the Thornthwaite Aridity Index equal to or less than 0.50 and; the daily percentage of water deficit equal to or greater than 60%, considering every day of the year (IBGE, 2018).

The purpose of this article focuses on the analysis of aquaculture activity in this region, with a view to the challenges and perspectives for small business and projection with other territories. Given this scenario, we will analyze the aquaculture of Nile tilapia.

For Duarte, the growth potential of global aquaculture is significant because it can operate in the ocean, which despite covering 70% of the Earth's surface, represents only 2% of human food production (DUARTE et al., 2009).

In this scenario, aquaculture represents 41.2% of the total volume of fish produced in the world and contributes to the growth of international trade with species of high value, such as salmon, sea bass, sea bream, shrimp and molluscs, but also species of lower value. such as tilapia, catfish, panga and carp, traded both nationally and in major producing regions, as well as internationally (FAO, 2014).

According to Embrapa (2017), the most common species produced in the country, by region, are: i) tambaqui, pirarucu and pirapitinga in the North region; ii) tilapia and marine shrimp in the Northeast; iii) tambaqui, pacu and painted in the Midwest; iv) tilapia, pacu and painted in the Southeast; and v) carp, tilapia, silver catfish, oysters and mussels in the southern region.

Currently, aquaculture can be carried out through four basic production systems, namely: (i) ponds; (ii) net tanks; (iii) raceways (tanks that simulate the conditions of a rapid for fish); and (iv) recirculation systems, such as aquariums and ponds. Fish production, for example, can be carried out in any of these systems, according to the best suitability of the chosen species (CALDER, 2005).

Among the species, tilapia has already established itself as the main fishery/aquaculture product in Brazil, being often cultivated in net-tanks and excavated ponds (MATOS; MATOS, 2018). It was primarily responsible for the high growth rates of the white fish sector, with production expanding to more than 80 countries and volumes growing at an average rate of 11% per year over the past decade. Currently, tilapia is the second most cultivated fish in the world, after carp (HEINHUIS; NIKOLIK, 2015).

Aquaculture has thus become a source of employment and income for families in the semi-arid region since the 19th century, because in the face of the scarcity scenario caused by recurrent droughts, alternatives and answers have been sought to cope with its effects, so that the activity is seen as a food strategy.

For the year 2050 it is estimated that the world population will be 9 billion people and, to feed this growing number of individuals, the annual production of meat will have to increase by more than 200 million tons. Population growth, food security and environmental sustainability are among the main challenges to be faced by the fish farming production chain for the coming decades. However, the average annual rate of production has been decreasing, which can be explained by factors such as water limitations, the limited availability of ideal locations for production and the rising costs of fishmeal, fish oil and other foods (FAO, 2012).

According to data from the Food and Agriculture Organization of the United Nations (FAO, 2016), world fish production in 2015 – aquaculture and capture – reached 199.7 million tons, of which 106 million came from aquaculture and 93.7 million tons. million, from capture.

The present research is the result of discussions originated in the Doctorate in Agroecology and Territorial Development, by the Federal University of Vale do São Francisco - UNIVASF and the State University of Bahia-UNEB, in particular the concerns proposed by the professors of the discipline Agroecology, Territory and Development, regarding the challenges and prospects of aquaculture, specifically tilapia, for small businesses. Therefore, it was necessary to analyze and reflect on the challenges and economic research of the activity, as well as the environmental issues experienced.

II. DEVELOPMENT

In Ávila's (1983) perspective, we define "scientific research as a "stimulating and solitary activity that develops between the limits of logical certainty and science fiction" (ÁVILA-PIRES, 1983, p.17).

Quali-quantitative research structured in three sequential phases, being first carried out a bibliographic review of the literature in order to present a theoretical basis on the object of study, with the definitions corresponding to the research object being exposed.

In the second moment, to survey the articles, in the month of April and 2022, a systematic literature search was carried out, using as descriptors: Embrapa (2016). FAO (2016). The keywords were related, since the purpose of the investigation was to identify the scientific studies that correlated the research study objects

At this point, the study was carried out through bibliographic research, with data analysis and condition that makes it possible to identify the state-of-the-art on the topic addressed and to collect better subsidies for the basis of the topic in question, as well as the expansion of the discussion of the its generalities. Thus, the analysis and reflection on the subject are based on material available in the written press and publications (books, internet portals, monographs and theoretical articles), worth mentioning: Arana (1999), Casaca; Tomazelli Junior, (2001), Embrapa (2016). FAO(2016). Heinhuis; Nikolik, (2015). IBGE(2008-2009) Lima; You are; Souza(2013), OECD(2017). FISH (2020). Rana(1997). Rocha,(2008) Silva(2007). Valenti,(2008).Vieira Filho; Gasques, (2017) Ximenes (2021), among others.

In the third moment, the inclusion and exclusion criteria were established. As inclusion criteria, it was required: to be a scientific article and concluding in writing.

The delimitation of the study included the Brazilian semi-arid from a holistic view, since the look turns to aquaculture activity as a whole.

III. DELIMITATION OF THE RESEARCH FIELD

For the elaboration of this article, the territory of the Brazilian semi-arid or landlocked in the Brazilian Northeast was used as a geographical cut. Given the boundaries (figure 01) of the states Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, Bahia and Minas Gerais. (IBGE, 2018)



Fig.1: Delimitation of the Brazilian semi-arid region Source: National Water Agency-ANA/Ministry of Integration-MI

To better elucidate the theme, it is necessary to define the semi-arid terminology, especially in the reality observed in Brazil and, in this way, we can say that:

The technical concept of semi-arid is derived from a rule of the Brazilian Constitution of 1988, more precisely from its Article 159, which establishes the Constitutional Fund for Financing of the Northeast (FNE). The constitutional norm requires that 50% of the resources allocated to the Fund be invested in the semi-arid region. Law 7,827, of September 27, 1989, regulating the Federal Constitution, defines as semi-arid the region within the Sudene area of operation, with average annual rainfall equal to or less than 800 mm. According to the last delimitation made by the Ministry of National Integration, according to Ministerial Ordinance n. 89, of March 2005, the Semi-arid region covers 1,133 municipalities in an area of 969,589.4 km²,

corresponding to almost 90% of the total area of the Northeast plus the northern region of Minas Gerais. With a population of around 21 million people (11% of the Brazilian population), it is an increasingly urban space (SILVA, 2007, p.468-469).

A major highlight when dealing with the semi-arid region lies in the understanding that it constitutes the most comprehensive biome in the sub-area of the Brazilian northeast, today widely known as semi-arid. Thus, we can say that the caatinga is "the only uniquely Brazilian biome" (CONTI; SCHROEDE, 2013, p.10).

It is also worth considering that:

One of the outstanding factors of the landscape is the caatinga vegetation. It is a biome with high biodiversity, where the xerophilous plant formation stands out with small leaves that reduce transpiration, succulent stems to store water and roots spread out to capture as much water as possible. In addition to cactus, tree, herb and shrub species stand out (SILVA, 2007, p.469).

The semi-arid regions are generally characterized by arid climate, water deficit with unpredictability of rainfall and the presence of soils poor in organic matter. The prolonged annual dry period raises the local temperature, characterizing seasonal aridity (SILVA, 2007, p.468). This demonstrates the importance of the debate about alternatives to guarantee the population's food sustainability.

IV. AQUACULTURE AS ALTERNATIVE

In the 1990s, there was a leap in growth in fish farming, when studies and research in management began to emerge and expand, as well as specialized publications that greatly contributed to the dissemination of technology and knowledge. Feed began to be manufactured specifically for the most cultivated fish species, as factories and animal nutrition researchers focused on the quality and effectiveness of the product in terms of weight conversion. The processing structures contributed to the increased consumption of farmed fish in the market. The Public Authorities recognized the potential and importance of this activity, in the economic context, and subsequent years (SEBRAE/BA, 2005).

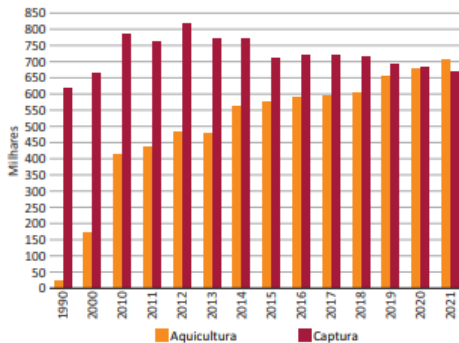
The potential that aquaculture has to meet the challenges of food security and job creation is more than evident when looking at the rapid expansion of the sector, which has experienced an annual growth rate of more than

8% since 1981, unlike of what has happened with the livestock and fishing sectors, whose growth rates are 3 and 1.6% per year, respectively (RANA, 1997).

Thus, in the planning of fish farming, the economic aspects of the activity are highly relevant. Investments carried out without proper economic analysis may constitute a loss (CASACA and TOMAZELI JÚNIOR, 2001).

In Brazil, the behavior of fish production was similar to that observed worldwide, with the stagnation of the volume of capture and the vertiginous growth of aquaculture from the 2000s onwards. Considering only the most recent data from FAO (2020), which correspond to the period from 2010 to 2018, aquaculture grew by 4.94% p.a., while fisheries retracted by -1.18% p.a. As shown in the chart below of Brazil's fisheries production by capture and aquaculture (in thousand tons), prepared by the authors of FAO Fisheries & Aquacultures (FAO, 2020).

Graph 1 – Fisheries production in Brazil by capture and aquaculture (in thousand tons)



Source: Prepared by the authors of FAO Fisheries & Aquacultures (FAO, 2020).

Notes: Estimated fisheries and aquaculture data (2019, 2020, 2021)

Northeastern production was affected by the effects of the long drought that lasted from 2012 to 2017, and caused the depletion of water resources in the dams and, consequently, the continuity of the rivers. For 2021, under the effects of the La Niña phenomenon, a good rainy season is estimated in the Region, which should replenish the reservoirs (XIMENES, 2021).

Also according to Ximenes, the Northeast, predominantly the semi-arid region, contributed in 2019 with 25% of national aquaculture production, around 151 thousand tons. The main species cultivated in the Region are tilapia (38.61%) and marine shrimp *Litopenaeus vannamei* (35.83%). Shrimp is predominantly produced in

the Northeast (99.6%), although it represents only 9.03% of the volume of aquaculture production in the country, it is the second aquaculture billion (23.0% of the total) showing the high added value of this product, in current values (XIMENES, 2021).

In this context, we seek to bring in the table below IBGE product with the highest production value in Brazil, R\$ 1.18 data in the timeline of the years 2013 and 2015 in the Brazilian regions of tilapia production.

Region	2013	2015	%
North	293.550	527.700	0,2
North East	48.103.265	52.964.653	24,1
Midwest	11.524.425	17.785.914	8,1
Southeast	45.834.891	57.083.226	26
South	63.549.880	90.967.713	41,5
Brazil	169.306.011	219.329.206	100

Source: IBGE, 2016

Prepared by the author

Analyzing the data, we noticed that the Northeast had a growing production, which may be associated with new technologies and investments in the area.

It is worth noting that for the development of economic activity, it is essential to comply with its environmental legislation before the competent bodies, analyzing average production, polluting potential and production volume, in the search to ensure harmony between the activity and the environment.

V. FINAL CONSIDERATIONS

It was healthy to talk about the activity of aquaculture, in the search for development for the semi-arid region, which experiences long periods of drought; envisioning small businesses.

It is worth mentioning that the design of small businesses in the creation of tilapia is still covered by challenges that need to be overcome with viable strategies. For this, it is necessary to return to the perspective of Sustainable Local Development, making it evident that we need specific public policies for the countryside.

Therefore, it is up to the government and society to plan and execute collective and individual actions that seek solutions to the impacts suffered by the physical, biotic and anthropic environment, and which have significant effects on the socio-environmental good of the activity.

Finally, this study was of substantial relevance, as it allowed for a dialogue with the challenges and perspectives for small businesses, which will certainly be one of the indications for the search for better solutions.

REFERENCES

- [1] ARANA, L. V. **Aquicultura e desenvolvimento sustentável**. Florianópolis:, Editora da UFSC, 1999.
- [2] CASACA, J. de M; TOMAZELLI JÚNIOR, O. **Planilha para cálculos de custo de produção de peixes**. Florianópolis. Epagri 2001. 38p
- [3] EMBRAPA – EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA. **Mercado da Tilápia** – 2o trimestre de 2016. Palmas: Embrapa, 2016. (Informativo Mercado da Tilápia, n. 8). Disponível em: <<https://www.embrapa.br/pesca-e-aquicultura/busca-de-publicacoes/-/publicacao/1051014/o-mercado-da-tilapia---2-trimestre-de-2016>>.
- [4] _____. **Pesca e aquicultura**. Palmas: Embrapa, 2017. Disponível em: <<https://www.embrapa.br/tema-pesca-e-aquicultura/>>. Acesso em: abr. 2017.
- [5] FAO - FOOD AND AGRICULTURE ORGANIZATION. **Of the United Nations. Fishery and aquaculture statistics**. Rome, Italy: Fisheries and Aquaculture Department f FAO, 2010. 72p.
- [6] _____. **Global aquaculture production statistics 2009**. Rome: FAO, 2011. 256 p.
- [7] _____. **The state of world fisheries and aquaculture: opportunities and challenges**. Rome: FAO, 2016. 243 p.
- [8] _____. **The state of world fisheries and aquaculture**. Roma, 2012. 209p.
- [9] _____. **The State of World Fisheries and Aquaculture 2020**. Roma: FAO. Disponível em: . Acesso em 9 dezembro de 2020
- [10] HEINHUIS, L.; NIKOLIK, G. The rise of the aquatic chicken. **Rabobank Industry Note**, Netherlands, Vol. 471, 6 p.,2015.
- [11] IBGE – INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. **Pesquisa de Orçamentos Familiares – 2008-2009**. Rio de Janeiro, 2010. Disponível em: <<http://biblioteca.ibge.gov.br/visualizacao/livros/liv45419.pdf>>. Acesso em: 20 abril 2022.
- [12] _____. **Produção Pecuária Municipal**. Rio de Janeiro 2016.
- [13] _____. **Semiárido Brasileiro**: IBGE, 2018.
- [14] LIMA, C. S.; TUESTA, G. M. R.; SOUZA, C. S. **Redução de proteína bruta em rações para peixes como estratégia para diminuir a excreção nitrogênio**, Viçosa, MG, 2013. In: V SIMPÓSIO BRASILEIRO DE AGROPECUÁRIA SUSTENTÁVEL; II CONGRESSO INTERNACIONAL DE AGROPECUÁRIA SUSTENTÁVEL, 2013, Anais...Viçosa, 2013. p. 139-142.
- [15] LUCHESI, J. D.; NEU, D. H.; COSTA, J. M.; FRIES, E. M.; BOSCOLO, W. R.; FEIDEN, A. **Proteína bruta na dieta de alevinos de quinguio (*Carassius auratus*)**. Revista Agrarian. Dourados, v.7, n.23, p.101-106, 2014.
- [16] MATOS, A. P.; MATOS, A. C. **Tilapicultura em tanques-rede: uma realidade no Oeste Catarinense**. Agropecuária Catarinense, Florianópolis, v.31, n.2, p.33-36, maio/ago. 2018
- [17] OCDE – ORGANIZAÇÃO PARA A COOPERAÇÃO E DESENVOLVIMENTO ECONÔMICO. **The ocean economy in 2030**. Paris, 2016. Disponível em: <https://www.oecd-ilibrary.org/economics/the-ocean-economyin-2030_9789264251724-en>. Acesso em: 26 out. 2017.
- [18] PEIXEBR - ASSOCIAÇÃO BRASILEIRA DA PISCICULTURA. **Anuário Brasileiro da Piscicultura PEIXE BR 2020**. São Paulo: ABP. Disponível em: <<https://www.peixebr.com.br/anuario-2020/>>. Acesso em 21 de dezembro de 2020. 2020. 136p.
- [19] RANA ,K. **Recent Trends in global aquaculture production 1984 -19995**.FAO Aquaculture Newsletter, Rome, n. 13, p.14-19, ago 1997.
- [20] ROCHA, I.P.**Panorama da Produção Mundial e Brasileira de Pescados, com ênfase para o segmento da Aquicultura**.2008
- [21] SILVA, R. M. A. Entre o Combate à Seca e a Convivência com o Semi-Árido: políticas públicas e transição paradigmática. Revista Econômica do Nordeste, Fortaleza, v.38, n.3, p.466-485, 2007.. DA SILVA, R. M. A. Entre o Combate à Seca e a Convivência com o Semi-Árido: políticas públicas e transição paradigmática. Revista Econômica do Nordeste, Fortaleza: V.38, n. 3, p. 466-485, jul.-set. 2007.
- [22] VALENTI, W. C. 2008. **A aqüicultura Brasileira é sustentável?** Palestra apresentada durante o IV Seminário Internacional de Aqüicultura, Maricultura e Pesca, Aquafair 2008, Florianópolis, 13-15 de maio de 2008.
- [23] VIEIRA FILHO, J. E. R.; GASQUES, J. G. **Agricultura, transformação produtiva e sustentabilidade**. Brasília: Ipea, 2016.
- [24] _____. **Agricultura e indústria no Brasil: inovação e competitividade**. Brasília: Ipea, 2017.
- [25] XIMENES LUCIANO F. **PRODUÇÃO DE PESCADO NO BRASIL E NO NORDESTE BRASILEIRO**. Caderno Setorial ETENE, Ano 5 | Nº 150 | janeiro | 2021.
- [26] ASC – AQUACULTURE STERWARDSHIP COUNCIL. <www.asc-aqua.org>.
- [27] FAO DATABASES. Fisheries and Aquaculture. <www.fao.org>.
- [28] SRAC – SOUTHERN REGIONAL AQUACULTURE CENTER.

Vulnerability of Environmental Components to Climate Change and Farming Strategies in the Adja-Ouere-Pobe Doublet in the South-Eastern Benin

Guy Cossi Wokou

University of Abomey-Calavi (UAC); Department of Geography and Regional Planning (DGAT)
Pierre PAGNEY Laboratory "Climate, Water, Ecosystem and Development" (LACEEDE)
E-mail: segla1645@gmail.com

Received: 12 Jun 2022,

Received in revised form: 06 Jul 2022,

Accepted: 12 July 2022,

Available online: 22 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Plateau Department,
vulnerability, climate change, environmental
components

Abstract— This research studies the vulnerability of environmental components to climate change and the peasant strategies adopted in the doublet. Adja-Ouèrè-Pobè in the Plateau department in Benin.

The climatological data consist of rainfall amounts and temperatures over the period 1981-2017. The determination of the evolution of the climate was made using climate diagnostic analysis tools (moving average, indices, etc.) and descriptive statistics (average, standard deviation, etc.). The environmental impacts were evaluated through the Leopold matrix crossed with the reference framework of the ABE and the degree of vulnerability is measured from the resistance capacity of the environmental components in the face of the impacts.

The results obtained show a warming trend of around 0.9°C over the period 1981-2017 and a decrease in annual rainfall totals. These cumulative situations would disrupt agricultural activities. This weakens the main components of the environment between 1981 and 2006 with an average rate of regression of -12.42%. By 2050, if demographic and climatic trends continue, the environment of the study area will be increasingly degraded.

I. INTRODUCTION

Africa's vulnerability to climate change has been analyzed and projected in key sectors of this continent that ensure the protection of human life, livelihoods and ecosystems. Thus, according to forecasts, the population likely to be exposed to an increased risk of water stress will be 75 to 250 million people by 2020 and 350 to 600 million by 2050. In some countries, the Yield reductions could reach 50% by 2020 (World Bank, 2013, p.10). Although they have already demonstrated a great capacity to adapt to their environment, the rapidity with which climate change is manifesting requires an analysis of the current challenges in terms of vulnerability and adaptation (V. Larivière, 2011, p.xv).

In West Africa, climate change has manifested itself in a poor spatio-temporal distribution of rainfall, floods, increasingly frequent pockets of drought, violent winds and an increase in temperature (C. Roncoli, K Ingram & P. Kirshen., 2002, p.5 and YT Brou, F. Akindès and S. Bigot., 2005, p.1).

Climate change is one of the major challenges of this time. This is one of the threats to agricultural development today. The poorest peasant communities are undoubtedly those who will suffer the most violent impacts and will suffer disproportionately from its negative effects (B. Doukpolo, p.8). Although several disciplines agree to accept a common definition of vulnerability as "liable to harm", the use of the

term changes according to disciplines and research sectors. Climate science views vulnerability in terms of the

likelihood of occurrence of climate-related events and impacts (Nicholls et al., 1999).

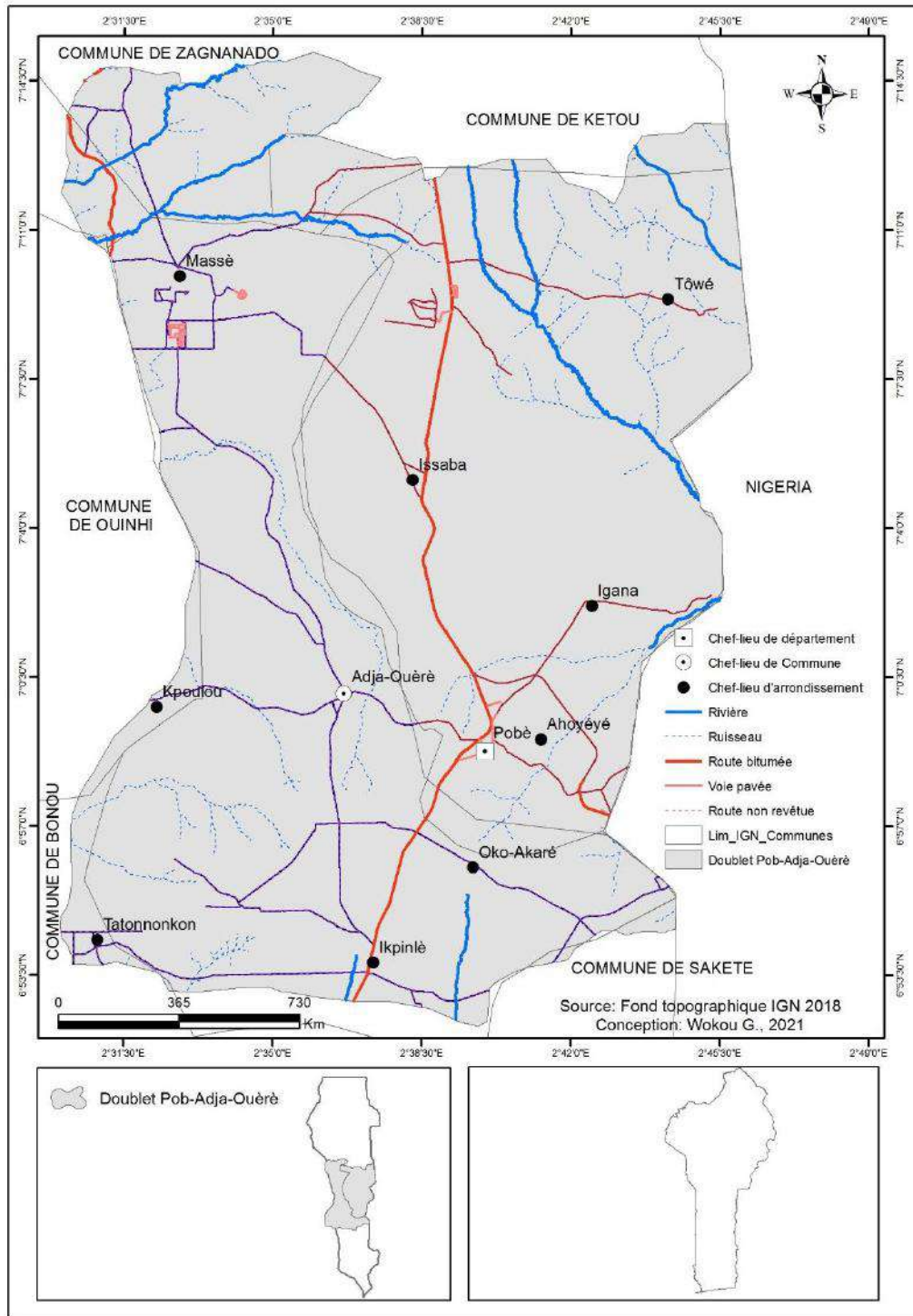


Fig.1: Geographical location of the Adja-Ouèrè-Pobè doublet

The living environment as it is designed for the majority of the populations of the Globe, and the system of production of consumer goods are strongly influenced by the ambient climate (Klein et al., 2007). These upheavals jeopardize the development of agriculture, which remains rainfed and

therefore makes agricultural producers vulnerable in terms of food security (R. Dimon, 2008, p.7).

In Benin, the demographic pressure associated with the evolution of the climate loaded with risks for agriculture, weakens the capacity of the environment to meet the food

needs of the rural populations. In response to this situation, farmers had to modify certain agricultural practices (GC Wokou, 2014, p.8).

In fact, the rearrangement of the agricultural calendar, the adoption of a new variety of crop, the practice of hoe-hilling, the increase in area sown, staggered and repeated sowing, the use of chemical fertilizers and phytosanitary products and the system agroforestry are all strategies developed to increase agricultural production and which directly or indirectly contribute to the deterioration of the environment in the study area (FS Djogbenou, 2008 p.7). Thus, adaptation is like one of the options that would allow the human community to reduce the effects of pronounced climate change. The Adja-Ouèrè-Pobè doublet is located between 6°52'14" and 7°15'11" north latitude and 2°35'54" and 2°46'16" east longitude, it is located in the southwest of the Republic of Benin in West Africa (figure 1). It covers an area of 914.84 km². It is bounded to the north by the commune of Kétou, to the northwest by the commune of Zagnanado, to the west by the commune of Ouinhi, to the south by the commune of Sakété and to the east by the Federal Republic of Nigeria.

II. MATERIALS AND METHODS

2.1 Mode of characterization of the climatic physiognomy in the study area

The determination of current temperature and rainfall trends (1981 to 2017) was made using the time series method. The equation of the trend line is of the form $y = at + b$ where y represents the explained variable and t the time; a and b being constants, such that:

$$a = \frac{(\sum y)(\sum t^2) - (\sum t)(\sum ty)}{N\sum t^2 - (\sum t)^2} \quad a = \frac{(N)(\sum yt) - (\sum t)(\sum y)}{N\sum t^2 - (\sum t)^2} \quad (1)$$

The Cotonou station was chosen to analyze the observed data and identify the related trends on the thermometric level. A wet year or a dry year is defined in relation to the Lamb index (1983) (the deviation from the mean normalized by the standard deviation) which is expressed by: $I(i) =$

$$\frac{P_i - P_{moy}}{\sigma(i)} \quad (2)$$

Where P_i represents the average annual total obtained by kriging for year i , P_{mean} and $\sigma(i)$ represent, respectively, the mean and the standard deviation of the series considered. The standard deviation, noted $\sigma(i)$, is the square root of the variance and is expressed by the formula:

$$(3) \quad \sigma(i) = \sqrt{V}$$

Where V , the variance, is expressed by: $V = \frac{1}{n} \sum_{i=1}^n (P_i - P_{moy})^2$ (4)

Thus, if $-0.1 < \text{index} < +0.1$ then normal year; if $\text{index} > 0.1$ then wet year; if $\text{index} < -0.1$ then dry year. The climate balance is expressed by the following formula: $Bc = P - ETP$ (9) with Bc = climatic balance in mm; P = total annual rainfall in mm; ETP = actual evapotranspiration in mm. ETP is defined as the climatic demand for water vapour. If $P - ETP > 0$, then the balance sheet is in surplus; If $P - ETP < 0$, then the balance sheet is in deficit; If $P - ETP = 0$, then the balance sheet is balanced. The calculation of the probabilities of exceeding the rainfall thresholds and the sequential curves made it possible to analyze the monthly distribution of rainfall. Thus, when the start of the rainy season is fixed as being: the pentad of the year from which the rainfall threshold of 10 mm is reached or exceeded one year out of two (1), and this regularly (2).

2.2 Estimation of climate change by 2050

Based on national development policies, and considering the results and recommendations of the Long-Term National Prospective Studies (Benin 2025) and the work of Ogouwalé (2006), Yabi (2008) and Issa (2012), the Analogue Scenario Dry (SAS) was chosen. With regard to the statistical protocol, the evolution of the temperatures is considered to follow an exponential type law with the mathematical formula: $Y_{\delta t} = Y_{ref} \cdot e^{-\alpha \cdot \delta t}$ (6)

Where: $Y_{\delta t}$, represents rainfall and temperature at a projection horizon (δt); Y_{ref} , the weighted moving average of the variable centered on the reference year; α , the regression coefficient determined from the equation on the graph; δt , the time in years separating the reference year and the projection year. The adjustment coefficient thus makes it possible to correct and adjust the projected values in accordance with the changes already known. Its mathematical expression is as follows: $\varphi = (Y_{ref} - \alpha \delta t) / Y_{\delta t}$ (7) From (6) and (7) we obtain: $\varphi = Y_{\delta t} / Y_{\delta t}$ with,

$Y_{\delta t}$, the temperature at a defined projection horizon (δt); $Y_{\delta t}$, the temperature at the same projection horizon (δt) for which readings have already been taken; and where $0 < \varphi \leq 1$. The closer the value is to 1, the stronger the correlation between the simulated trends and the values already observed. The multiplier coefficient which gives the margin of error of the forecast is therefore applied to all the other projection years. The corrected simulations made it possible to simulate the value of each parameter up to 2050.

2.3 Vulnerability assessment

The evaluation of the vulnerability of the populations requires the use of several techniques and tools, in particular

the crossing and the analysis of causal links between different localities using statistical methods, as well as the combination and the superimposition of the different sources. Information via Geographic Information Systems (GIS). Most vulnerability analysis studies use statistical techniques such as regression, correlation, principal component analysis, with the aim of reducing the dimensionality of a large number of variables into a grouping of dependent variables, and multi-criteria analysis tools. The objective of this research is to identify the most vulnerable sectors and populations according to a combination of specific factors. These methods lead to the development of synthetic indicators, and the establishment of a risk index by aggregating all the indicators considered. Other approaches combine the CART1 algorithm (Classification And Regression Tree; Breiman et al., 1984), principal component analysis and the "Fuzzy Set" procedure (Eastman and Jiang, 1996). The CART algorithm

was used to measure and analyze the various indicators of food security in Ethiopia (Seyoum, 1995), in particular to assess the average number of people requiring food aid. The data then analyzed includes the Normalized Vegetation Index (NDVI),

In other words, the vulnerability of populations is linked on the one hand to the exposure of the territory and to the sensitivity of economic activities to natural hazards. This is the case, for example, of the Sahelian zone where the seasonality of the rains makes it very vulnerable to variations in the quantity of precipitation and its distribution within the wet season, significantly affecting agro-pastoral activities (cyclical vulnerability and structural). The system's level of conjunctural vulnerability also depends on the individual and institutional capacity to cope with the impacts of climate variability, while structural vulnerability mainly affects the poorest groups of individuals in society.

III. RESULTS

3.1 Evolution of the climate in the study area from 1981 to 2017

Figure 2 presents the evolution of the minimum and maximum temperature in the department of the plateau.

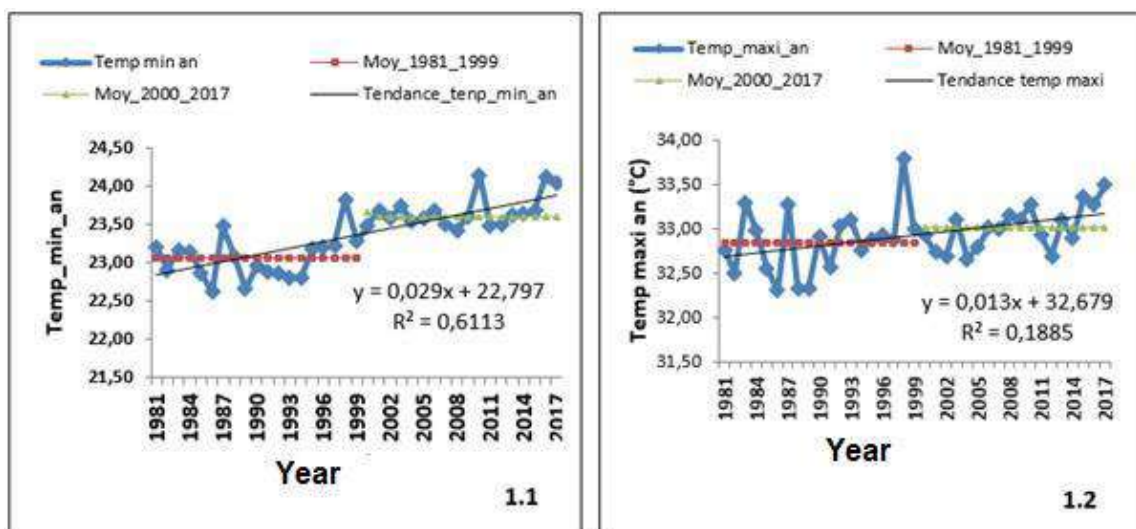


Fig.2 : Evolution of the minimum (1.1) and maximum (1.2) temperature over the period 1981-2017 (Cotonou station)

Source :ASECNA data, April 2012

Analysis of the figure reveals a general upward trend in temperatures (minimum and maximum) over the period (1981-2010). In addition, the minimum temperatures increase more quickly than the maximum ones. The years 1986 and 2010 recorded the extreme values of minimum temperatures. These values are 22.61°C and 24.15°C respectively. The highest value of maximum temperatures was recorded in 1998 and the lowest value in 2002. These values are 33.78°C and 30, 18°C. This

temperature rise confirms the work of IPCC (2007) which showed that warming has accelerated by 0.8°C in one century, and by 0.6°C over the last thirty years. According to WMO and UNEP (2002), the yield of rain-fed agriculture could fall by 50% by 2020 due to the deterioration of climatic parameters. As a result, agricultural production and access to food will be severely affected in many countries, with serious

consequences in terms of food security. The rain parameter cannot remain immune to this phenomenon.

Rainfall experienced significant spatio-temporal variability in the Adja-Ouèrè-Pobè doublet (figure 3)

3.2 Rainfall variability

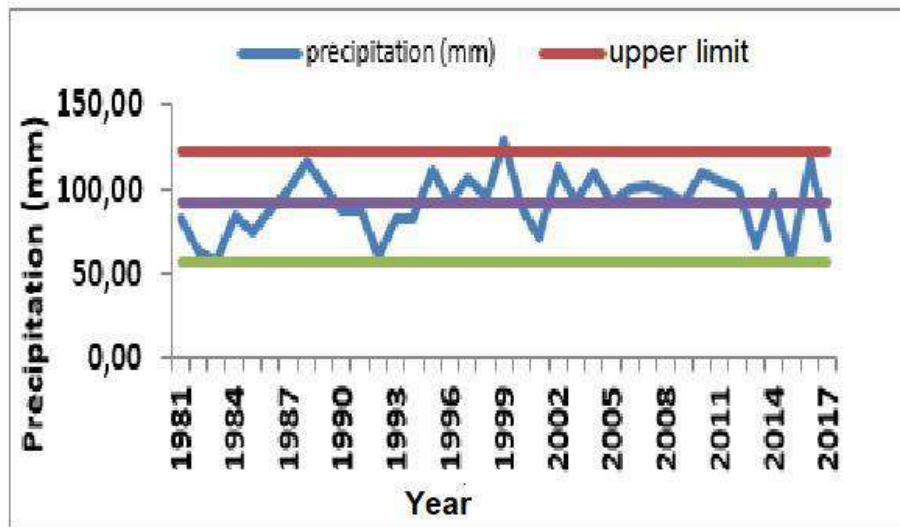


Fig.3 : Interannual variation in rainfall in the plateau department over the period 1981-2017 (Cotonou station)
Source: ASECNA data, April 2020

Figure 3 presents three periods distinguishing average, surplus and deficit years over the observation period (1981-2017). A year is said to be in deficit when the arithmetic sum of the annual precipitation is lower than 834.16mm (mean of the series minus the coefficient of variation), excess when it is greater than 1170.22mm (average of the series plus the coefficient of variation) and average when it varies between 834.16 mm and 1170.22 mm. In total, the observation period recorded nineteen (19) average years, seven (7) surplus years and four (4) deficit years which alternate asymmetrically. This alternation between average,

surplus and deficit years justifies the interannual variability of rainfall over the study period. It also makes agricultural activities in the plateau department uncertain. The rainfall indices of the various stations in the study area made it possible to assess the rainfall evolution.

3.3 Evolution of rainfall indices in the study area

The reduced centered indices have experienced a significant evolution in the Plateau department over the period (1981-2017) (Figure 4).

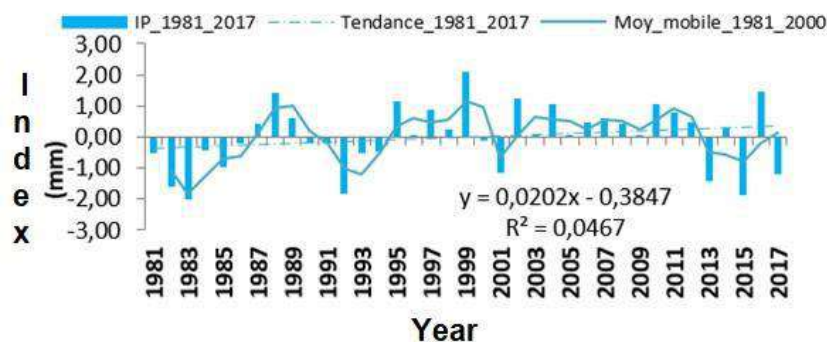


Fig.4: Evolution of the rainfall index over the period 1981-2017 (Cotonou station)
Source : ASECNA data April 2020

Analysis of the figure shows that the linear regression lines show upward trends. These reflect a period which

as a whole is marked by the abundance of the quantities of rain that fell.

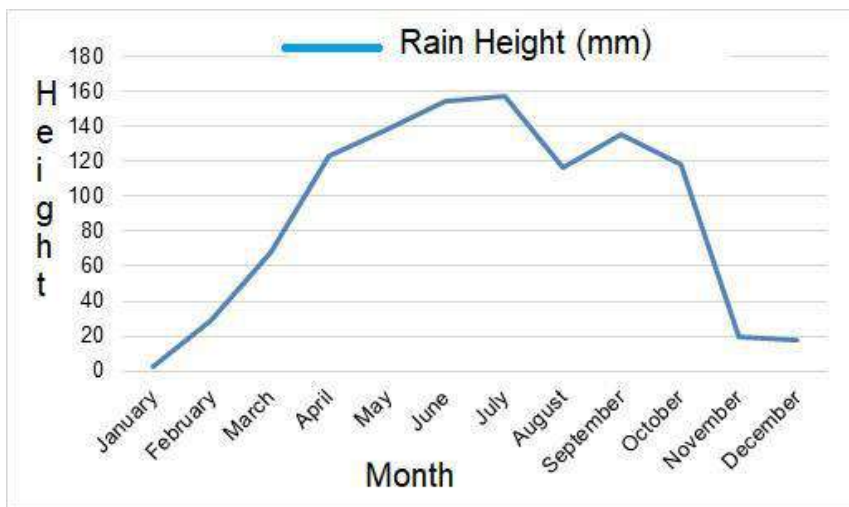


Fig.5 : Rainfall regime (period 1981-2017 : Cotonou station)

The analysis in Figure 5 shows an uneven intermonth distribution over the four years. Indeed, the years 1985, 1994 and 2002 recorded two rainy seasons interspersed with a dry season which covers the month of August. On the contrary, the year 2007 presents a unimodal pluviometric regime, characteristic of the Sudanese climate whereas we are in a subequatorial region. Furthermore, the inter-monthly distribution of rainfall does not follow a regular rhythm from year to year,

although these are average years when the risks are supposed to be lower. In this context, we note a break in the rain in June 1985 and in May 2002, a dwindling of the rains from April to June 1994 followed by excessive rains in October.

3.4 Climate change by 2050

The rainfall situation at the annual scale in 2050 is indicated in the table III

Table III: Rainfall projection for 2050

Annual rainfall (mm)		
Average (1981-2017)	Value in 2050	Change (%)
1099	1010	- 8.10

Source of data: ASECNA (2011) and projection results

Legend : Favorable situation

The study area therefore records rainfall levels that will reach 1000 mm, the minimum rainfall threshold for good cereal yield. However, agricultural activities are more intense in all the localities of the Plateau department where the rainfall drop is significant. At the same time, the

maximum and minimum temperatures will increase. The comparison of future maximum temperatures and those of the period 1981-2017 shows that the increase would exceed 2°C (Table IV).

Table IV: Temperatures by 2050 in the Plateau department in southwestern Benin

Stations	Temp	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Cotonou	max	37.5	38.9	38.5	37.3	35.5	33.4	31.7	31.6	32.7	34.2	36.2	36.4
	min	24.0	25.3	25.6	25.4	24.6	23.6	23.0	22.7	23.0	23.4	24.2	23.8

Source: Projection results

Legend : Temp = Temperature; max = maximum; min = minimum

	Favorable situation
--	---------------------

The possibility of climate change would aggravate the vulnerability of environmental components. The rise in temperature would cause an increase in potential evapotranspiration (ETP), a factor on which crop water requirements are highly dependent. This will negatively influence yields and therefore lead to a change in certain agricultural practices. All in all, the climatic uncertainties expected by 2050 will be manifested by a downward trend in rainfall totals; a contraction of the wet season and an increase in temperatures (maximum and minimum).

3.5 Vulnerability of environmental components to climate change

The vulnerability of a natural or human system is the fact of being sensitive to injuries, attacks or experiencing difficulties in recovering a balance that has been jeopardized after a natural disaster (Moss, 1996). There is

no universally accepted consensus on the definition of vulnerability. The notion of vulnerability is now commonly used to designate a state of fragility, a propensity to suffer damage or a low capacity to cope with disastrous events. It designates both individual and collective situations, both material and moral frailties, people as well as things or even territories. The term vulnerability, which has its origins in the literature of natural hazards, poverty, food insecurity and development, is widely applied to impact studies in the face of climate change (Downing, 2003; FAO, 2000). In this context, the term vulnerability has many meanings.

The results resulting from the application of the Leopold matrix crossed with the reference framework for the identification of environmental impacts of the EBA are presented in table V.

Table III: Identification/assessment of environmental impacts

Activity	Components affected	impactsPhysical environment	Importance
Shifting cultivation on slash and burn/Ecobuage	Floor	Cleared for seeding	Mean
		Destruction of nutrients	Mean
	Air	Air pollution by dust and fumes	Mean
Plowing by agricultural machinery/plow	Floor	Soil degradation by disturbance or compaction	Mean
		Destruction of nutrients	Weak
Use some products synthetic chemicals	Floor	Soil degradation (loss of organic matter) by heavy metal buildup	Weak
	Water	Degradation of water quality by heavy metal buildup	Strong
	Air	Air pollution by harmful gases and foul odors	Weak
Use of agricultural residues and animal droppings	Water	Degradation of water quality by filling and pollution	Weak
	Air	Air pollution by harmful gases and foul odors	Weak
Shifting cultivation on slash and burn/Ecobuage	Vegetation	Destruction of vegetation and disappearance of species (<i>Parkia biglobosa</i> , <i>Annona senegalensis</i> , <i>Vitellaria paradoxa</i> , etc.)	Strong
		Wildlife	Reduction of animals and birds sheltered by destroyed vegetation
			Disappearance or rarity of certain animal species sheltered by destroyed vegetation
Use	Vegetation	Destruction of vegetation by accumulation of heavy metals	Strong

some products synthetic chemicals	aquatic fauna	Decrease in fish species due to the degradation of water quality and the phenomenon of filling	Mean
Use of agricultural residues and animal droppings	aquatic fauna	Decrease in fish species due to the degradation of water quality and the phenomenon of filling	Mean

Legend

High vulnerability	
Medium vulnerability	
Low vulnerability	

Examination of Table V shows that several positive and negative environmental impacts are linked to climate change in the study area. It should be noted that the positive impacts are temporary. The major agricultural practices identified negatively affect the environment. These impacts are permanent and therefore their actions endure. With this already critical situation, what will be the future trend of the components of the environment.

3.6 Coping strategies in the face of vulnerability

Faced with future global climate changes, the UNFCCC (United Nations Framework Convention on Climate Change) has proposed emphasizing two fundamental strategies for responding to climate change: mitigation and adaptation (UNFCCC, 2006; Niasse et al., 2004). While mitigation seeks to limit climate change by reducing greenhouse gas (GHG) emissions, adaptation aims to alleviate adverse impacts through a wide range of actions on specific systems (Füssel and Klein, 2002). It is with this in mind that several Sahelian states came together to found in

1973 the Inter-State Committee for the Fight against Drought in the Sahel (CILSS). The means developed by CILSS to reduce the vulnerability of populations to the impacts of climate change consisted, among other things, in setting up: (i) the Early Warning System; (ii) the AGRHYMET Research and Training Center (AGRICulture HYdrology and METeorology) based in Niamey (Niger); and (iii) PRESAO (Seasonal Forecast of Rainfall and Runoff in West Africa).

The environmental components, namely water, soil, air, fauna and flora are altered in the face of the strategies adopted by farmers in order to improve agricultural yields which are weakened due to the current evolution of the climate in the department of Plateau like the other departments of the Republic of Benin. Plate 1 shows the use of pesticides for crops and an agricultural machine for soil disturbance. These practices are not without consequences on all agricultural components.



Board 1: Use of pesticides in Adja-Ouèrè and soil stirring machine in Pobè

Shooting: Wokou C. Guy, June 2021

From the observation of plate 1, it is observed on picture 1.1, the use of pesticides. Indeed, this practice, which aims to improve yields, leads to the disappearance of earthworms

and insect pests, to the destruction of weeds that can be harmful to crops. Also, in picture 1.2, a tool is used to stir and shake the soil. This machine participates in the

decomposition of organic matter in the soil. This form of development is destructive to the physical environment. To avoid these inconveniences on the environmental

components, some farmers use biological methods. Picture 3 shows the use of plants as a solution to pesticides.



Picture 3: Use of plants as pesticides in Adja-Ouèrè

Shooting: Wokou C. Guy, June 2021

Plants as alternatives to pesticides. Many pests affect agriculture in the study area. And cause millions of dollars in economic losses, threatening the food security of thousands of people. To control these pests, farmers use pesticides. Studies show that pesticidal plants can replace it in certain cases. It remains to organize the knowledge.

IV. DISCUSSION

The results of this research goes in the same direction as those of SF Djogbenou (2008, p.7) in the sense that it has identified the different peasant adaptation strategies in the face of climate change contributing directly or indirectly to the deterioration of the environment. In fact, the development of lowlands, the reorganization of the agricultural calendar, the adoption of new crop varieties, the practice of hoeing, the increase in area sown, staggered and repeated sowing, the use of chemical fertilizers and phytosanitary products and the agroforestry system are all strategies developed to increase agricultural production in the department. Faced with this situation and in a perspective of sustainability of good management of water resources of the Adja-Ouèrè plateau, like those of Comè and Allada, HS Vodounon Totin (2005, p.7), corroborates and emphasizes the low efficiency of current methods of water resource management given the projected reduction in its availability after analyzing the evolution of the hydro environment. climate of the plateaus of southern Benin. The conclusions of HS Vodounon Totin (2005, p.7), I. Yabi (p.6) then of G. Wokou and M. Boko (2009, pp.68-69) agree on the degradation of the various components of the environment in the face of the current evolution of the

climate, which has become variable. For HS Vodounon Totin (2005, p.7), the future management of water on the plateaus of Comè, Allada and Pobè will require an improvement of natural and artificial systems of productivity and use of water. . Consequently, strategic options adapted to the principles of precaution and anticipation are essential. For Yabi (p.6), the evocation of environmental degradation is rather linked to cashew-based agroforestry in addition to its socio-economic utility which tends to stabilize the farmer on the same crop area for several years. years. G. Wokou and M. Boko (2009, pp.68-69) in turn specify the soil component of the environment. For them, soil degradation is one of the consequences of climate variability because their study has shown that the climatic dynamics of the Agonlin plateau, analyzed using climatological statistics, shows a downward trend in rainfall and an increase in maximum and minimum temperatures. Since several authors agree on better adaptation, M. Fanta (2010, p.23) has developed vulnerability criteria, in order to promote a better ability to adaptation of Sahelian populations to climate variability. Thus, the development of perimeters and the development of rice cultivation on the Agonlin plateau requires precautions and more robust adaptation to soil conditions (drying and impoverishment of the soil) and climatic conditions (aggressive rainfall, flooding, runoff, excessive heat, high temperatures).

V. CONCLUSION

This research contributes to a better understanding of the vulnerability of environmental components to climate change and adaptation strategies in the Plateau

department. The climatic evolution in the Plateau department analyzed using climatological statistics shows a downward trend in rainfall and an increase in maximum and minimum temperatures. In addition to this critical situation, a warming trend of around 0.9°C over the period 1981-2017 and a decrease in annual rainfall totals. These cumulative situations would disrupt agricultural activities. In response to such a situation, farmers have had to change cultivation practices. This weakens the main components of the environment between 1978 and 2006 with an average rate of regression of -12.42%. By 2050, if demographic and climatic trends continue, the environment of the Zou watershed will be increasingly degraded (regression of -12)

REFERENCES

- [1] World Bank 2013, Development of a concept of Vulnerability Index to Climate and Environmental Change at the Regional Level, Kingdom of Morocco, Analytical Support Program for Morocco's Climate Change Strategy, P-ESW 113768, Strategy Note n. 2, Sustainable Development Department (MNSSD) Middle East and North Africa Region, 80p.
- [2] Carla Roncoli, Keith Ingram & Paul Kirshen (2002): "Reading the rains: local knowledge and rainfall forecasting among farmers of Burkina Faso". *Society and Natural Resources*, vol 1. 15p.
- [3] FANTA MARA (2010), Development and analysis of the vulnerability criteria of Sahelian populations in the face of climate variability: the case of water resources in the Sirba valley in Burkina Faso, Thesis presented as a partial requirement of the doctorate in sciences of the environment, 273p.
- [4] Yao Télésphore Brou, Francis Akindès, Sylvain Bigot(2005): Climate variability in Côte d'Ivoire: between social perceptions and agricultural responses. *Agriculture Notebooks* 8p
- [5] Bertrand Doukpolo (2014): Climate change and agricultural production in the West of the Central African Republic. *Earth Science*. University of Abomey-Calavi; Doctor in Geography and Environmental Geosciences (Agroclimatology and Development), French. ffitel-01053261f, 336p
- [6] Rodrigue Dimon(2008): Adaptation to climate change: perceptions, local knowledge and adaptation strategies developed by producers in the communes of Kandi and Banikoara, in northern Benin. Cotonou: UAC, Doctoral thesis: Agricultural engineer. Economics, socio-anthropology and communication for rural development: University of Abomey-Calavi, 193 p.
- [7] Claude Comlan Agbatan Ahouangninou (2013): Sustainability of market gardening in southern Benin: an essay on the ecosystem approach, 333p.
- [8] Alastair Alinsato and Urbain Yagbedo (2020): Analysis of the supply of market gardening products in Benin, 29p.
- [9] Aurélien van Caloen and Thomas Dagneau de Richécour (2015): Agroecological market gardening as a response to food insecurity in Burkina Faso: analysis and potential for creating a commercial sector, 176p.
- [10] Guy Cossi Wokou, 2014, Population growth, climate change and agricultural and environmental changes in the Zou watershed in Benin, Thesis for obtaining the Unique Doctorate of the University of Abomey-Calavi in Geography and Environmental Management, 244p.
- [11] Flora S. Djogbenou 2008, Environmental impacts of strategies for adapting agriculture to climate change in the hills department, Master's thesis, University of Abomey-Calavi (UAC), Department of Geography and Regional Planning (DGAT), 86p.
- [12] Henri S. Vodounon Totin 2005, Hydro-climatic trends and water resource management scenarios on the plateaux of southern Benin, University of Abomey-Calavi, Dissertation for obtaining the Diplôme d'Etudes Approfondies, 84p.
- [13] Yabi Ibouaïma, Role of cashew-based agroforestry in the dynamics of land use in the Monts Kouffè region, *University of Abomey-Calavi, Dissertation for Advanced Study Diploma (DEA)*, 96p.
- [14] Guy Wokou and Michel Boko (2009): Evaluation of pedoclimatic constraints to the development of rice cultivation on the Agonlin plateau, University of Abomey-Calavi, Pierre PAGNEY Laboratory, Climate, Water, Ecosystem and Development (LACEEDE), pp.60 -69
- [15] Virginie Larivière, 2011, Vulnerability and adaptation to climate change: A case study in kuujuarapik and whapmagoostui, Thesis presented as a partial requirement for the master's degree in environmental sciences, University of Quebec in Montreal, Library Service, 136p .

The Legal Effectiveness of the National Solid Waste Policy in Brazil Regarding Recycling Activities of Civil Construction Waste

Railson Gomes da Costa¹, Aldair Jône Almeida Soares², Marcus Vinicius Rivoiro³,
Delson Fernando Barcellos Xavier⁴, Jéferson Araújo Sodré⁵, Janylle Maria Araújo Silva⁶

^{1,2} Undergraduate in law – Federal University of Rondonia – UNIR

^{3,4} PhD from UERJ - Professor at the Federal University of Rondônia - UNIR

⁵ Master in Public Administration from UNIR – Administration Assistant at the Federal University of Rondônia – UNIR. Email: jeferson.sodre@unir.br

⁶ Undergraduate in law – International College of Paraíba. E-mail: janyarauji@gmail.com

Received: 11 Jun 2022,

Received in revised form: 09 Jul 2022,

Accepted: 14 July 2022,

Available online: 22 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— National Solid Waste Policy.
Effectiveness. Environment. Recycle

Abstract— This research aims to analyze the situation of the National Solid Waste Policy (PNRS) with the norms and guidelines for the recycling activities of civil construction waste, established in the country through Law 12.305/2010. The solid waste recycling policy, within only a decade, has been changing, modernizing and increasingly expanding its space in construction companies. Additionally, the increase in environmental pollution and its consequences has led society to reposition itself on the subject. The excessive generation of waste and its irregular disposal in most Brazilian cities raises the questions: Have environmental protection laws and the PNRS been effective in preventing, managing and controlling the environment? One of the great challenges in choosing this topic is that we live in a society that still does not properly value recycling in its various species. Whether for cultural reasons or for lack of proper waste valuation. In this perspective, we sought to present the legal tools that guarantee development with sustainability, thus guaranteeing environmental preservation for present and future generations in accordance with the provisions of the Federal Constitution of 1988. As for its nature, this is a qualitative research, as for its objectives it is classified as exploratory and was carried out through bibliographic research, with researches carried out on specialized sites that were duly referred to at the end of this study

I. INTRODUCTION

Law is a set of rules of conduct and the best way to understand a legal phenomenon is to understand its essential characteristics and principles.(REALE, 1995).

Life in society develops through normative instructions where people are involved in a tangle of rules that guide their actions, thus, the legal phenomenon is the

representation of normative experience that guides human behavior within society. (BOBBIO, 2010).

Despite the legal norm, most of the time there is a lack of factual and social basis, in other words, there is a lack of harmony between the law and the community. Regarding this, the Law 12.305/2010 so-called National Solid Waste Policy, has in its framework the principles, objectives and

instruments to achieve the perfect management of solid waste in Brazil. (BORBA; LUZ; MARCHI, 2021).

Some authors recognize the benefits generated with proper and correct recycling in civil construction. The reduction in the consumption of non-renewable raw materials (natural resources) in substitution for properly recycled waste and the reduction of pollution in some industries that would reduce the production of carbon dioxide (JHON, 2000).

According to Szigethy and Antenor (2020) in the majority of times, the environmental impact generated by Construction and Demolition Waste – CDW – is caused by the irregular disposal of waste. Although there are technologies available within the country on the market, in order to comply with the National Solid Waste Policy (PNRS), costs and the lack of greater integration in waste management have been pointed out by experts as the reasons for this behavior. Furthermore, Freitas (2009) argues that the recycling of construction rubble appears as a viable factor for generating income or at least reducing the costs of irregular depositions.

Thus, it is clear that solid waste recycling should contribute to sustainable development, reduction of environmental impacts, cost reduction in construction sites, a heating up in the market with the emergence of new product options and development of new technologies (PRS, 2014, p.6).

Thus, it was sought to make an analysis of the situation of the PNRS regarding the regulations and guidelines that dictates the recycling activities of civil construction waste. In this perspective, the problem raised by this research is: have environmental protection laws and the National Solid Waste Policy been effective in preventing, managing and controlling the environment?

Therefore, the objective of this research is to analyze the legal effectiveness of the guidelines listed in the PNRS and the gaps in the norm and the state negligence, in relation to the recycling measures that are being taken to ensure an ecologically healthy environment.

This study was carried out through bibliographic research, has a qualitative nature, also being classified as exploratory research according to its objectives.

II. THE NATIONAL SOLID WASTE POLICY (PNRS)

The National Solid Waste Policy (PNRS) is a law (Law n° 12.305/10) that organizes the way the country deals with waste. This law demands transparency from the public and private sectors in the management of their waste (BRASIL, 2010).

According to Gouveia (2012), in recent decades, the constant increase of consumption in cities has led to a large generation of urban waste. This growth is not followed by proper disposal, which can harm the environment and human health by contaminating the soil, water bodies and the atmosphere.

A great potential is wasted as many objects could be recycled or reused saving natural and financial resources and CO₂ emissions, which unbalance the greenhouse effect. (GOUVEIA, 2012), in disagreement with the objectives of the aforementioned Law in its article 7.

The Brazilian Regulatory Standard – NBR 10004/2004, classifies waste as:

those in solid and semi-solid states, which result from industrial, domestic, commercial, agricultural, service and sweeping activities. This list also includes sludge from water treatment networks, those generated in pollution control equipment and installations, as well as a series of liquids which, if released into the public sewage system, is unfeasible their demand for technical solutions to do so are economically unfeasible in the face of the best available technology. (ABNT, 2004, p.7 apud GLORIA; RIBEIRO JUNIOR; SOUZA, 2020, s.p.; free translation).

According to the same standard, item three has defined solid and semi-solid waste as:

[...] that result from activities of the community of origin: industrial, domestic, hospital, commercial, agricultural, services and sweeping. Included in this definition are sludge from water treatment systems, those generated in equipment and 1. Pollution control installations, as well as certain liquids whose particularities make their release into the public sewerage network or bodies of water unfeasible, which require technical solutions that are economically unfeasible in view of the best available technology (ABNT, 2004, p.8; free translation).

In Brazil, the NBR 10004 (ABNT, 2004) shows the classification of solid waste according to the potential risks to the environment that it can cause. Solid waste is thus classified into three distinct classes: Class I hazardous waste, Class II non-inert or banal waste, and Class III inert waste. According to Ramos (2010), the public power is

responsible for the proper management of urban solid waste and has been facing it as their greatest challenge. Tons of waste are disposed daily in sanitary landfills and dumps and even in river streams within large cities, which can have negative impacts on the environment.

To avoid these damages, proper treatment must be applied to this waste in order to prevent it from affecting all sectors of the economy and all citizens living near these places. The PNRS integrates public power, private initiative, and civil society and has at its core the article 7° on the objectives of the National Solid Waste Policy:

I-Protection of public health and environmental quality;

II-Non-generation, reduction, reuse, recycling and treatment of solid waste, as well as an environmentally appropriate final disposal of waste;

(...)

VI-Incentive to the recycling industry, focusing in encouraging the use of raw materials and inputs derived from recyclable and recycled materials;

(...)

XIV-Encouraging the development of environmental and business management systems aimed at improving production processes and reusing solid waste, including recovery and energy use;

XV- Encouraging environmental labeling and sustainable consumption. (BRASIL, 2010. on-line; free translation)

There are a number of specific rules that deal with solid waste, however the main one is the PNRS, so all others are subject to it.

III. PROJECT OF ENVIRONMENTAL CONTROL

The National Solid Waste Policy (PNRS) determines that all companies are responsible for the destination and final disposal of their waste. Resolution No. 307/2002 of the National Council for the Environment (CONAMA), defines responsibilities and duties, making it mandatory in all municipalities in the country and in the Federal District to implement Civil Construction Waste Management Plans, by their local government, seeking to eliminate the negative environmental impacts resulting from activities related to the generation, transport and destination of these materials (ALIPIO, 2010, p.49).

According to Lira (2016), “This resolution together with the National Solid Waste Policy (PNRS)”, aim to:

- Importance of applying techniques that reduce the environmental impacts generated by waste from the construction sector;

- The final disposal of waste according to a suggested classification and in specific locations according to the standard norm and licensed;

- Regarding the liability for civil construction waste arising from construction, renovation, repair, demolition, extraction, and any activity related to the sector, the generator itself becomes responsible for the waste;

- The recycling of civil construction waste and the integrated management of waste integrate an economy in the production and reuse of this junk as raw material, thus generating a gain for humanity, in the environmental, economic and social aspect. The Constitution of the Federative Republic of Brazil (CF/88), also known as the Magna Carta of the Nation, limits powers and defines rights and duties of all brazilian citizens, according to caput of the article 225 that states:

Everyone has the right to an ecologically balanced environment, good for common use by the people and essential to a healthy quality of life, imposing on the Public Power and the community the duty to defend and preserve it for present and future generations. (BRASIL, 1988, pág. 139; free translation)

Given the importance of the environment, it is up to the government and the community to defend and preserve the environment for present and future generations. Farias (2014) states that, this integrated and responsible management between public authorities and society with regard to management is essential because everyone is closely linked to the environmental cause, being a shared responsibility among all from inspection to the control of the causes of environmental impacts caused by the incorrect management of waste. (FARIAS, 2014).

According to the Resolution CONAMA 307 from 2002, that deals with the criteria and procedures for the management of waste from civil construction, it states on Art. 2°, and as presented to us by Fernandes (2015):

Civil construction residues: are those from construction, renovations, repairs and demolition of civil construction works, and those resulting from the preparation and excavation of land, such as: bricks, ceramic blocks, concrete in general, soils, rocks, metals , resins,

glues, paints, wood and plywood, linings, mortar, plaster, tiles, asphalt pavement, glass, plastics, pipes, electrical wiring, etc., commonly called construction rubble, limestone or shards (FERNANDES, 2015, p.40; free translation)

According to the resolution, ideally, solid waste should not be generated and a secondary goal should seek to reduce, reuse, recycle, and take due care with the final destination of the CDW. As for Pereira e Brito (2012), the environmental control project is a grouping of rules aimed at monitoring the impact on the flora and fauna in order to correct or reduce it. According to the authors "the foundation of environmental control is through three basic principles: Licensing, supervision and monitoring" (PEREIRA & BRITO, 2012, p. 21).

IV. LEGAL EFFECTIVENESS IMPOSED ON RECYCLING ACTIVITIES

Historically, in Brazil, there is no integration between the bodies that elaborate the norms and the ones that implement them, which has been causing problems in the execution of public policies, such difficulties compromise the effectiveness of legal norms. On this matter, Borba, Luz and Marchi (2021, p. 2) make clear that:

Normative effectiveness is the possibility of a norm to produce legal effects. Thus, given its instrumental character, the law is elaborated with a view to the elaboration of practical effects. Therefore, the effectiveness of a norm can be both legal and social. Legal effectiveness, also known as applicability, takes place when a norm has full normative resources for the production of its effects in the legal sphere. On the other hand, social efficacy, or effectiveness, occurs when a legal norm corresponds with the current reality. (BORBA; LUZ; MARCHI, 2021, p. 2; free translation)

The National Solid Waste Policy is considered a landmark in the issue of Brazilian environmental legislation since it is the precursor regarding the disposal of solid waste in the country's legislation.

According to Cabrera (2020), several laws dealt with the disposal of solid waste, however, it was only with the PNRS that the theme of environmental protection was consolidated based on new concepts of solid waste

management and presenting effective mechanisms of protection proposed by environmental and constitutional legislation.

The PNRS associated with the general principles⁷ of Environmental Law and the constitutional, administrative, and environmental guidelines, established principles of extreme importance to regulate all activities of public or private administration that were carried out within the law and with attention to environmental prevention and preservation.

V. THE POLLUTER PAYS PRINCIPLE

Since 1972, The Organization for Economic Co-operation and Development (OECD) had already incorporated the polluter pays principle, being reaffirmed at the 1992 Conference in Rio de Janeiro in its principle 16, as follows:

National authorities should strive to promote the internalization of the costs of protecting the environment and the use of economic instruments, in accordance with the principle that it is the polluter who should, in principle, assume the cost of pollution, within the concern of public interest and without distorting the game of international trade and investment (OLÍMPIO, 2007, s.p.; free translation)

This principle is the initial basis of Environmental Civil Liability, thus determining that those who benefit from the environment must share the costs that go to minimize or extinguish the threat of damage. It is the so-called internalization of costs. The polluter pays principle arises supported by economic principles that sought maximum efficiency in the internalization of costs with negative consequences generated by the development of economic activities that can only be understood through Environmental Law (SOUZA, 2018).

The principle of the user-payer establishes that the user of natural resources must pay for their use. The idea is of economic value definition to the natural good in order to rationalize its use and avoid its waste. The appropriation of these resources by one or several individuals, public or private, must provide the community with the right to financial compensation for the use of natural resources, goods of common use. (CARVALHO, 2014).

This principle adopts a dynamic of valuing the acquisition of the guarantee of the right to pollute according to economic demand through credit titles that guarantee the emission of carbon into the atmosphere.

This principle alludes to the socio-environmental function of the property, going beyond its use and enjoyment and demonstrating the importance of greening the property. It seeks to avoid environmental damage, value the preservation of the environment and always observes the ecological and social balance in accordance with environmental standards.

Thus, this principle is fundamental to environmental policies since facing the non-fulfillment of preservation duties, the polluting individual will be subject to the sanctions provided for in the Brazilian legal system.

This principle cannot be confused with the strict liability of the person causing the damage, given that holding the agent responsible for the damage requires the occurrence of a causal link between the phenomenon that caused the damage and the actual occurrence, thus, it cannot be restricted solely to the economic repair of the environmental asset that was harmed.

The polluter pays is a guiding principle when it comes to civil liability, of a precautionary and preventive nature, aiming at the internalization of environmental costs and risks and whoever causes the damage must bear the cost of its repair. Furthermore, it presents itself as a guideline that identifies an agent causing the damage and a penalty for their action, consequently having them paying for the repair of the damage caused to the environment through its harmful activity.

However, the polluter is not always the one who directly causes damage to the environment. It may be the person who caused the damage in situations of illicit repair, such as in cases of legal action to repair the environmental damage, so the costs must be borne by the person who took private advantages from that damaging action.

In consonance with Erika Bechara (2020), the polluter pays principle can be divided into four dimensions that help explain and identify the application of the principle: dimension of economic rationality, social ethics, environmental policy, legal-normative. From this perspective, the foundation of this principle is the prevention of environmental damage with the intention of avoiding costs that arise from an activity that causes environmental damage.

The author says that “The polluter pays principle establishes a wide range of possibilities for reactions, without necessarily predicting a single variant or a certain pattern for its realization.”(Free translation). It is a principle that counts the costs, where the causer needs to be affected and the cost is passed on to the consumer. “The polluter pays principle is preserved when the causer

deducts from the consumer the cost of his expenditure.”(Free translation).

These are the so-called negative externalities, factors that result from production and are received by the collectivity. It can be called “privatization of profits and socialization of losses”, with the application of the polluter-pays principle, the aim is to correct this cost that is added to society, where its internalization is imposed. Consequently, it is observed that the internalization of price externalities is often not fulfilled by the whole society, considering that if the rise in prices due to this phenomenon is not followed by everyone, there is a tendency for consumers to seek products that do not have this encumbrance on account of this principle, in exception the consumers who have a great ecological conscience.

The legislator's idea was to seek an equitable redistribution of environmental externalities. However, this principle is often distorted in the face of market competition and many authorities or even regulations present different costs to the agents causing environmental damage.

This principle is fundamental for the preservation of natural resources, and it is only necessary to make the proper adaptation of this marketing tool, and cannot be applied only as a mechanism for repairing the damage. The ideal would be to be applied as a prevention tool, as seeking to prevent environmental damage from occurring in order to seek repair.

Finally, despite still needing adjustments in the preventive methods, it can be said that the polluter pays principle is considered a great milestone for Environmental Law, reaffirming what is expressed in our Constitution in its article 225 that transformed the environment into a fundamental right of the present and future generations.

According to Milaré (2009), this principle is configured as the principle of responsibility in accordance with article 225 § 3, which prescribes the possibility of holding harmful agents accountable both criminally and administratively.

The user pays principle establishes that the user of natural resources must pay for their use. The idea is to define the economic value of the natural good in order to rationalize its use and avoid its waste. The appropriation of these resources by one or several individuals, public or private, must provide the community with the right to financial compensation for the use of natural

resources, goods of common use. (THOMÉ, 2015, p. 77; Free translation).

In consonance with Milaré (2009) the difference between the principles is on the payment by the polluter pays, which is a sanction and not a benefit. On the other hand, the user-pays, in the legal administrative act, has the freedom to enjoy natural resources with the free exercise of the activity granted by the public power.

VI. THE ENVIRONMENTAL DAMAGE

Although the Brazilian legislation did not express the concept of environmental damage, law 6,938/1981 clarifies some points that allow the understanding of its main characteristics (FREITAS, 2015). As mentioned above, environmental damage has a complex concept, given the breadth of the environment theme, diffuse and covering several aspects, it can be considered as a multidimensional and multifaceted characteristic of the environment. Despite being classified as a third generation right, it covers the first and second generation as well, thus shaped by the principle of solidarity. (ALVES; NOMURA; MANEIA, 2013).

Raising reflections regarding this topic, Antunes (2013) characterizes it as such:

Damage is the unfair loss caused to a third party, generating an obligation to compensate. The action or omission of a third party is essential. Needless to say, the concept only includes negative changes, as there is no harm if conditions are changed for the better, without prejudice. It is the negative variation, moral or material, that should be, as far as possible, measured so that the reimbursement can be affected (ANTUNES, 2013, p. 539; Free translation).

Following this, Leite (2012) teaches that:

Environmental damage means, in a first sense, an undesirable alteration to the set of elements called environment, such as, for example, atmospheric pollution; it would thus be an injury to the fundamental right that everyone has to enjoy and take advantage of an appropriate environment. However, in its second conceptualization, environmental damage encompasses the effects that this modification generates on people's health

and interests. (LEITE, 2012, p. 92; Free translation)

Therefore, environmental damage should be understood as the injury caused to any of the environmental classifications: natural, artificial or cultural, and may also have material or moral features. As for the classification and its amplitude it can be divided between: pure ecological damage (restricted); extensive environmental damage; and individual or reflex damage (partial). According to Leite (2003) damage can be classified by the amplitude of the protected property and its extent.

I - Regarding its amplitude:

a) Pure Ecological Damage: Injury to the environment, damage affects essential components of the ecosystem, requiring repair in order to restore a sustainable environment. Pure ecological damage intensely affects goods of nature, in the strict sense, having no relation to the components of cultural or artificial patrimony.

b) Environmental Damage Lato Sensu (Extensive): closely linked to diffuse interests of the collectivity, embracing all components of the environment. On this matter, Leite (2003, p.94) states that extensive environmental damage:

“[...] lato sensu, that is, concerning the diffuse interests of the community, it would encompass all components of the environment, including cultural heritage. Thus, the environment and all its components would be protected, in a unitary conception” (LEITE, 2003, p. 94)

Extensive environmental damage affects the entire environment, that is, the natural, the artificial and the work environment. In the broadest sense, harm is “all harm that someone suffers to his soul, body or property”

c) Individual Environmental Damage or Reflection: This case, reflects individual or collective interests of the injured party, but some scholars ensure the need to differentiate between the individual and the collective that would not be fully protected instantly

II – As for its extension:

a) Environmental Property Damage: Some scholars describe environmental property damage as material, one that reflects on the environmental good itself (the ecologically balanced environment). Hence, is directly related to the restitution, recovery or indemnification of the harmful environmental asset.

b) Extra-patrimonial or environmental moral damage: Popularly known as environmental moral

damage, the extra-patrimonial according to Leite (2005, p. 97) “[...] everything that concerns the sensation of pain experienced or equivalent concept in its broadest meaning or any non-patrimonial damage caused to society or the individual, due to the damage to the environment.”(Free translation)

Besides the constitutional foundation, environmental moral damage is supported by Law No. 7,347/1985, through the Public Civil Action, an instrument to defend the environment and diffuse and collective rights, an action that opened the doors for the damage caused to nature to reach the Judiciary.

Law 6,938/1981 expresses in its article 14 § 1 the two types of environmental damage when referring to “damage caused to the environment and to third parties”

VII. THE CIVIL RESPONSIBILITY FOR ENVIRONMENTAL DAMAGE

According to Milaré (2011) environmental degradation “is a phenomenon that has accompanied man since the beginning of his history. Only the legal perception of this phenomenon - even as a consequence of a new legal asset called 'environment' - is recent” (MILARÉ, 2011, p.23). As previously stated, environmental damage is a presupposition of great importance for the realization of the theory of environmental civil liability, several researches sought to build this concept trying to broaden the understanding in the face of reality, researches such as Antunes (2013) and Leite (2012) sought to make the proper conceptualization. According to Antunes (2013):

Damage is the unfair loss caused to a third party, generating an obligation to compensate. The action or omission of a third party is essential. Needless to say, the concept only includes negative changes, as there is no harm if conditions are changed for the better, without prejudice. It is the negative variation, moral or material, that should be, as far as possible, measured so that the reimbursement can be affected. (ANTUNES, 2013, p. 539; Free translation).

Legally, damage is one of the main bases of civil liability, the existence of which indicates the occurrence of injury to a legal asset, therefore any damage caused to the environment with degradation that reaches the balance of nature and the quality of life. The broad vision of the environment must consider the set of natural, artificial and cultural elements.

As for Leite (2012), the changes, in addition to being ecologically harmful, can at the same time transform the standards for survival, with interference in the health of the population and its interests. In agreement to Leite’s (2012) positioning, Fiorillo (2013, p. 94) in his studies shows that “In the event of injury to an environmental asset, resulting from an activity carried out by an individual or legal entity, public or private, who is directly or indirectly responsible for the damage, not only is it characterized, but also the identification of the polluter, who will have the duty to indemnify it.”. Following this idea, environmental damage is configured through action or omission, which as a presupposition causes damage in any of its forms, internal or external (ANTUNES, 2013).

According to Leite (2012), Environmental Law brings a new configuration of damage in relation to classical conceptions when it comes to environmental damage, a less individualistic view is presumed. Consequently, it is necessary to be attentive to the elements that make up the problems related to the legality between environmental and traditional damage.

Milaré (2011) brings some considerations about environmental damage, emphasizing the legal reaction called by the author “materialization of the principle of full responsibility of the degrader, which subjects him, cumulatively, to repressive and reparatory sanctions”. Damage to the environment has repercussions on the legal system in three different ways: Administrative Sanction, Criminal Sanction and Civil Sanction. Appearing in these different scopes, the responsibility has its own characteristics and norms, they are independent from each other so that in the end the result of the sanctions are specific to each legal sphere. As already mentioned, the relevance of the damages that were and continue to be caused to the environment with the devastation of the Amazon rainforest, leaving aside by the authorities the scientific knowledge produced until now, are of incalculable dimensions.

Environmental civil liability is intrinsically subject to the strict liability regime, which, despite the existence of fault or negligence, imposes liability on the person causing the damage. In summary, the existence of environmental damage and a chain of causality is essential for the configuration of civil liability.

Due to the Law 9,605/98, more than 60 types of environmental crimes with different types of penalties were typified: fines, restrictions, community service and imprisonment. In the case of legal entities, suspension of activities, embargo of works or activities, among other penalties, may also occur.

Keeping in mind the duty-power of inspection, the civil liability of the State for damages caused to the environment is characterized by the omission by the Executive Power, according to the Federal Constitution of 1988 on art. 225 § 3o “whereby, if the command of the Federal Constitution contained in art. 225 is not complied with, the Public Power will respond directly and exclusively, and the competent Public Civil Action must be instituted for this purpose”.

VIII. FINAL CONSIDERATIONS

According to the research carried out on recycling as an economic feasibility, it was observed that in the country there is a great concern on the part of the public authorities regarding the protection of the environment. In this context, the analysis of the National Solid Waste Policy and the CONAMA Resolutions that deal with the proper destination of the CDW.

Through the PNRS, it is clear the responsibility of companies for the destination and final disposal of waste through some resolutions of the National Council for the Environment, which made it mandatory for all entities of the federation to implement Civil Construction Waste Management Plans. Furthermore, the PNRS brings recycling as the responsibility of everyone in the production chain, thus considering the recycling process as one of the main objectives of environmental management.

This research aimed to investigate the effectiveness of environmental standards in relation to the environmental damage caused by the ineffectiveness of the management of companies in relation to the final destination of solid waste from civil construction, motivated by the great growth of this productive sector in the country.

Civil liability in Common Law resorts to subjective liability, while in the field of Environmental Law, civil liability is objective and based on the theory of integral risk, which states that whoever practices activities that may harm the environment, regardless of fault, has a duty to make reparation for the damage.

According to the literature, the fundamental objective is to repair the damage, its recomposition can be carried out in the different ways provided in Brazilian legislation. In addition to this, society finds in environmental civil action an effective instrument in protecting the environment, repressing practices of harmful acts and always seeking to repair the damage caused.

Regarding the rules and punishment, it can be observed that the Federal Constitution of 1988, on its article 225, imperatively imposes the protection of the environment, concomitant with Laws 6,938/81, 9,605/98

(ENVIRONMENTAL CRIME LAW) and also Decree no. 6514/2008 which in cases of harmful conduct guarantee penalties in the three spheres: administrative, civil and criminal.

REFERENCES

- [1] ANTENOR, Samuel. SZIGETHY, Leonardo. Resíduos sólidos urbanos no Brasil: desafios tecnológicos, políticos e econômicos. IPEA, 2020. Disponível em: <https://www.ipea.gov.br/cts/en/topics/217-residuos-solidos-urbanos-no-brasil-desafios-tecnologicos-politicos-e-economicos> Acesso em: 14 mar 2022
- [2] BECHARA, Erika. Princípio do poluidor pagador. Enciclopédia Jurídica da PUCSP. 2020. Disponível em: <https://enciclopediajuridica.pucsp.br/verbete/334/edicao-1/principio-do-poluidor-pagador> Acesso em: 21 mar 2021.
- [3] BOBBIO, Norberto. Teoria Geral do Direito. São Paulo: Martins Fontes; 3a edição, 2010.
- [4] BORBA, Laila Machado; LUZ, Laíze Lantyer; MARCHI, Cristina Maria Dacach Fernandez. A POLÍTICA NACIONAL DE RESÍDUOS SÓLIDOS: Eficácia Jurídica e Social das Diretrizes Impostas às Atividades de Reciclagem na Cidade de Salvador. Universidade Católica do Salvador | Anais da 24a Semana de Mobilização Científica - SEMOC | 2021
- [5] CABRERA, Maika Lígia Anacleto. A política nacional de resíduos sólidos e a responsabilidade civil ambiental decorrente da geração de resíduos da construção civil. 3o Congresso Sul-americano de resíduos e sustentabilidade. IBEAS, 2020. Disponível em: <http://www.ibeas.org.br/conresol/conresol2020/VIII-004.pdf> Acesso em: 21 mar 2022.
- [6] CARVALHO, Victor Nunes. O princípio do usuário-pagador no Direito Ambiental.
- [7] FERNANDES, Bruna Cristina Mirandola. A utilização de resíduos da construção civil e demolição – RCD – como agregado para o concreto. 2015. 68p. Trabalho de Conclusão de Curso (Engenharia Civil) - UNIFOR. MG. 2015. Disponível em: https://repositorioinstitucional.unifor.br/21074/xmliui/bitstream/handle/123456789/290/TCC_BrunaCristinaMirandolaFernandes.pdf?sequence=1&isAllowed=y Acesso em 14 mar 2022.
- [8] FREITAS, Lino. Reaproveitamento de resíduos sólidos da construção civil no Brasil. Revista Dom Total. Engenharia: ensaios em engenharia, ciência e sustentabilidade 2018. Disponível em: <https://domtotal.com/noticia/1262733/2018/06/reaproveitamento-de-residuos-solidos-da-construcao-civil-no-brasil/> Acesso em: 14 mar 2022.
- [9] JOHN, Vanderley Moacyr. Reciclagem de resíduos na construção civil: contribuição à metodologia de pesquisa e desenvolvimento. 2000. Universidade de São Paulo, São Paulo, 2000. Disponível em: <https://repositorio.usp.br/item/001124878> Acesso em: 14 mar 2022.

- [10] LEITE, Rhafael Evangelista. Responsabilidade civil nos danos ambientais. UEPB. Campina Grande-PB, 2012. Disponível em: <http://dspace.bc.uepb.edu.br/jspui/bitstream/123456789/917/1/PDF%20-%20Rhafael%20Evangelista%20Leite.pdf> Acesso em 18 mar 2022.
- [11] MILARÉ, Edis. Direito Ambiental. doutrina-jurisprudência- glossário. São Paulo: Editora Revista dos Tribunais, 2004.
- [12] _____. Direito do Ambiente – A gestão ambiental em foco. 7.ed. São Paulo: RT, 2011.
- [13] _____. Direito do Ambiente. 10a ed. rev. atual. ampl. São Paulo: Editora Revista dos Tribunais, 2015.
- [14] OLÍMPIO, Daniela. O que é o Princípio do Poluidor Pagador? ACESSA.Com, 2007 Disponível em: <https://www.acesa.com/consumidor/arquivo/vocesabia/2007/07/19-daniela/#:~:text=%22As%20autoridades%20nacionais%20dovem%20esfor%C3%A7ar,desvirtuar%20o%20com%C3%A9rcio%20e%20os> Acesso em: 21 mar 2022.
- [15] PEREIRA, Pedro Silvino. Controle ambiental / Pedro Silvino Pereira, Andréia Matos Brito. – Juazeiro do Norte, CE: Instituto Federal de Educação, Ciência e Tecnologia do Ceará, 2012. 110 p. Disponível em: https://www.ufsm.br/app/uploads/sites/413/2018/12/01_cortrole_ambiental.pdf Acesso em 14 mar 2022.
- [16] PRS. Projeto de Reciclagem de Resíduos da Construção Civil em Porto Velho. PMPV, 2014. Disponível em: <http://prsrecicladora.com.br/wp-content/uploads/2015/12/4bd67a6b0f8838c83160914598638f4b.pdf> Acesso em 14 mar 2022
- [17] REALE, Miguel. Lições Preliminares de Direito. 22a ed. São Paulo. Saraiva. 1995.
- [18] RIBEIRO, Flávio de Miranda. Política Nacional de Resíduos Sólidos (PNRS). Pós Graduação em conformidade Ambiental com requisitos técnicos e legais. CATESB, 2018.
- [19] SOUZA, Amós. Princípio Poluidor - Pagador: Características e sua Aplicação. Jus Brasil, 2018. Disponível em: <https://amosribeiro.jusbrasil.com.br/artigos/516891395/principio-poluidor-pagador-caracteristicas-e-sua-aplicacao> Acesso em: 21 mar 2022.
- [20] Railson Gomes da Costa – Undergraduate in Law at the Federal University of Rondônia – UNIR.
- [21] Aldair Jône Almeida Soares – Undergraduate in Law at the Federal University of Rondônia – UNIR.
- [22] Marcus Vinicius Rivoiro - Graduated in Law from the Higher Education Association of the Amazônia - AESA (2000), Master in Law from the University of Marília – UNIMAR (2007) and Ph.D. in City Law from the State University of Rio de Janeiro - UERJ (2016)
- [23] Delson Fernando Barcellos Xavier - Graduated in Legal and Social Sciences from the Federal University of Rio de Janeiro - UFRJ (1992), specialization in strategic policy (ADESG/UNIPEC) and Public Law (UNIR), Master in Constitutional Law from the University Federal of Minas Gerais - UFMG (2003) and Ph.D. in City Law from the State University of Rio de Janeiro - UERJ (2013)
- [24] Jéferson Araújo Sodré - Graduated in Law from the Federal University of Rondônia – UNIR (2015), Master in Public Administration from the Federal University of Rondônia – UNIR (2017).
- [25] Janylle Maria Araújo Silva - Graduated Undergraduate in Law at the International College of Paraíba.
- [26] Among the principles presented, we give special emphasis to the principles established in items II and VII, namely, the polluter pays and the protector-receiver; and the shared responsibility for the life cycle of the products, as it is understood that these are principles that offer the main and potential effectiveness to the general purposes legally established by the PNRS.

Design and Performance of Hybrid Solar Fish Dryer with Back Up Element Heater

M.Alfan Ansori, Berbudi Wibowo, Maimun, Gunadi Z.A

Fisheries Resources Utilization Study Program, Jakarta Technical University of Fisheries Indonesia AUP polytechnic graduate program, Indonesia

Corresponding author : alfan.anshory42@gmail.com

Received: 04 Jun 2022,

Received in revised form: 01 Jul 2022,

Accepted: 07 July 2022,

Available online: 22 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *Design, Fish Dryer, Hybrid, Solar Dryer*

Abstract— *The aim of this research was to design and construct of hybrid solar fish dryer with back up element heater . This research was conducted in the fishing area of Ciparage Jaya, Karawang Regency, West Java Indonesia. The results of the design of the dryer has dimensions of length 120 cm, width 90 cm and height 180 cm. The main part of the dryer are collector and drying chamber which consist of 4 shelves and combined by heater elements as back up heat energy. The manufacturing cost required to design this dryer until it is ready for use is Rp. 4.453.000,- .To reduce the moisture content of 20 kg of fish to 30% with this dryer it takes 7 hours with details of 4 hours using hybrid and 3 hours using solar energy maximized by a collector. The results of statistical analysis showed that 27.5% of chamber temperature was influenced by solar radiation which is maximized by the solar collector. While the rest is influenced by the other factors such as heat source of heater element and axial fan to accelerate the flow rate of hot air. The amount of heat energy needed to reduce the water content of 20 kg of fish untill 30% using this dryer is 18,112.79 kJ.*

I. INTRODUCTION

One of the food commodities which is a high source of animal protein is fish. Fish supplies approximately 6% of the total protein requirement and 16% of the total animal protein (Jain, 2006) . Fresh fish has a water content of up to 70% in the body, so fish are very easily damaged with a relatively short shelf life (Bala & Mondol, 2001) . If post-harvest fish are not processed directly into finished products, the fish will quickly undergo a process of decay and this will cause losses. So that fast, precise and correct handling is needed to maintain the quality of fish before being marketed to consumers, it is necessary to have preservation. The processing and preservation of fish is an effort to improve the quality of storage and durability of post-harvest fishery products. The purpose of processing and preserving fish in principle is to overcome excess production while maintaining the quality of fish before being marketed or

consumed, increasing the selling value of fish and extending the shelf life of fish (Imbir *et al.* , 2015) .

Some common fish preservation processes are cooling, smoking, salting, drying and curing (Handoyo & Kristianto, 2003) . Fish drying is one of the most widely used efforts to preserve fish by coastal communities. Theoretically, drying is a process of evaporation of the water content of a product until it reaches an equilibrium moisture content. The evaporated water is free water on the surface of the product and bound water in the product. Drying can also be interpreted as the process of transferring or removing the water content of the material until it reaches a certain content so that the speed of material damage can be slowed down. The process of evaporation of water requires energy. With the increase in energy in the product drying container, evaporation occurs which is followed by an increase in the water content in the drying air. In principle,

the drying process is influenced by the speed of the drying air flow, the drying air temperature and the humidity (Himawanto & Nadjib, 2015)

Drying fish technique is a method to remove or remove some of the water content contained in the fish body with the help of heat energy so as to close the opportunity for bacteria or microbes to live and develop so that the shelf life of fish is longer (BERHIMPON *et al.* , 1990) . To prevent bacteria and enzymes from working in the fish's body, in addition to reducing the water content in fish, it is also necessary to control temperature, RH and air flow rate and drying time. There are four kinds of drying techniques, namely drying openly with direct sunlight, drying by burning with fuel or firewood, drying with electricity and drying with solar power in a closed manner (Tiwari *et al.* , 2016).

Most of the business actors of capture fisheries and processing of catches in Indonesia are fishermen and small-scale fisheries business actors. Generally the fishermen and coastal communities do conventional drying of fish by utilizing direct and open sunlight as the salted fish processors in salted fish in the coastal area of Ciparage Jaya, Karawang Regency, West Java . They still dry fish conventionally, namely by placing fish products on woven bamboo to dry in direct sunlight. The drying process takes about three days if the weather is sunny and by turning the fish 4-5 times so that the drying can be evenly distributed. When the outside air is too dry and hot, drying can occur too quickly, resulting in case hardening. During the rainy season, salted fish production in the coastal salted fish processing area of Ciparage Jaya decreases drastically. On the other hand, the production cost of making salted fish has almost doubled compared to the dry season because the drying process is quite long and requires more labor because the processors only depend on unpredictable weather.

In addition, in conventional fish drying activities there are several other weaknesses, including unhygienic dried fish products, weight loss of fish products produced by being eaten by insects or other animals, drying temperature cannot be regulated and drying time cannot be predicted, the amount of solar energy cannot be fix predicted(Star *et al.* , 2013) . Therefore, it is necessary to innovate fish drying technology to improve the quality and quantity of dried fish products.

Several attempts to increase the effectiveness of solar energy-based drying of fishery and agricultural products have been carried out through several previous studies aimed at improving traditional drying systems. Among them are drying products in an indirect way that only uses a dryer with solar power or uses a combination of energy from other power sources. Research by

EkadewiA.Handoyo , et al .,(2012) design and testing system dryer fish powerful Sun From the results of the study, it took 6 hours to reduce the water content of fish from 60% to 38%.

Research by Thamrin , et al ., (2011), namely the use of a rack-type solar dryer to dry cassava, this dryer consists of five shelves with a wooden frame and a transparent cover. The results showed that efficiency tools 61.47% for lower sweet potato water content wood from 38% to 14%. There is a significant difference in drying rate on each drying rack, this is due to uneven convection in the drying chamber. Hanafi Risman , et al ., (2017) investigated the drying of anchovies using a rack-type hybrid solar energy dryer. This drying uses solar energy combined with a biomass heat source. The results showed that the drying efficiency value of the hybrid dryer was 0.695%. The small value of drying efficiency is due to the heat energy lost due to the absence of an insulator in the solar collector and the closing door in the drying chamber is not tight.

Referring to the problems mentioned above, the author will design a hybrid type fish dryer that is powered by a combination of solar energy heating element . The main power of this dryer is solar energy, the utilization of which will be maximized by using a solar collector and source power hot from heating element.

II. RESEARCH AND METHODS

The method used in this study consisted of several stages, including designing a fish dryer and testing the performance of the dryer. The activity of designing a dryer uses experiments and then proceeds with trial and learn, so in this research the design and manufacture of dryers and experiments of dryers will then evaluate and repair the equipment whether it is in accordance with the objectives to be achieved or not.

Tools and materials

The tools used in this research are tools available in the workshop such as grinding machine, electric drill, welding machine, screwdrivers, saw, pliers, elbow rulers, rivet plier, calipers and roll meters. The measuring instrument used to collect the data during performance test such as stopwatch, analog scale, luxmeter and pyranometer. While the materials needed in this research are angled iron, zinc, clear glass, wooden blocks, plywood, waring, silicone, salted fish, rivet nails, screws, welding wire.

Design

Before making a tool design, a sketch of the dryer model is needed. The dryer design model in this study was made using the Google SketchUp 8 application as shown in

fig.1

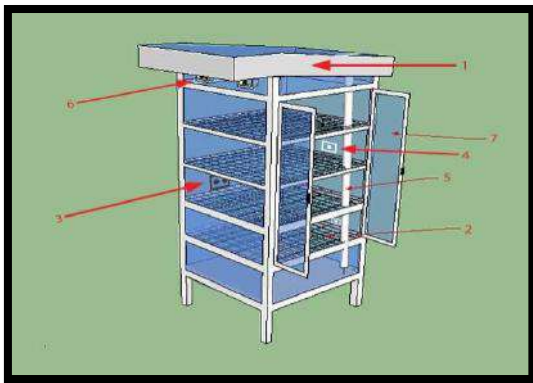


Fig 1. Design of a hybrid solar-heating element fish dryer

Description :

- | | |
|--------------------|------------------|
| 1. Solar collector | 5. Inlet Pipe |
| 2. Drying chamber | 6. Outlet |
| 3. Axial fan | 7. Dryer windows |
| 4. Element heater | |

Fish Dryer Functional Design

This dryer consists of several main components, namely:

1. Solar collector

Solar collector with dimensions of 120 x 90 cm which consists of three main components, namely absorber plate, transparent cover glass, collector frame and insulator. The collector framework uses steel slotted angle and wooden beams. The solar collector functions as a collector of solar heat converted into hot air then blown to the drying chamber. The working principle of a solar collector is that the absorber (zinc) plate receives and absorbs solar radiation energy that falls to its surface and converts it into heat energy so that it flows in the collector above the absorber plate. Heat transfer in the air collector will occur by conduction, convection and radiation. The transparent cover uses ordinary clear lime glass with a thickness of 5 mm placed above the absorber. According to M Burhan Wijaya (2007) that the most effective glass thickness for transparent covers on solar collectors is 5 mm, while the distance between the glass and the effective absorber plate is 30 mm.

2. Drying chamber

The drying chamber is the main part of the drying house consists of a drying rack to put fish products to be dried. The drying chamber consists of four drying racks which are arranged vertically. The drying rack is made of RK type fish waring material with a hollow steel frame. The dimensions of each shelf are 120 x 90 cm. The use of fish waring is intended to prevent fish products from sticking to the shelves, besides that the hot air in the drying chamber is evenly distributed on each shelf.

3. Blower (Axial Fan)

Axial fan serves to circulate heat from the collector to the drying chamber. The number of fans is two with a power of 12 watts each which is driven by electric power, on this fan a thermostat is installed to control the collector temperature, if the collector temperature is below 37°C then the fan will turn off.

4. heating element

As a back up source of heat energy, this fish dryer uses two heater elements that are driven by an electrical energy source. These two elements are mounted vertically on the second and fourth shelves. The heater element is also installed with a thermostat to control the temperature in the drying room to match the desired temperature. The maximum temperature of the drying chamber is set at 50°C. According to Abdullah (2003) the temperature of the drying chamber should not exceed 50°C because it will cause case hardening.

5. Inlet Pipe

The inlet pipe is a supporting component in the dryer which functions to channel hot air from the collector to the drying rack. The inlet pipe uses a 2 inch PVC pipe that is connected to an acrylic box where the axial fan is. The addition of this component refers to previous studies which with several existing designs resulted in temperature differences and uneven heat distribution in the drying chamber. So with the addition of this component it is possible to maximize the distribution of hot air to spread to all drying racks.

6. Control System

The control system on this fish dryer adopts the automation system used in hatching chicken eggs, namely the use of a thermostat. A thermostat is a device that functions as a temperature controller to maintain the ideal temperature according to a predetermined target value. The type of thermostat that will be used is a digital thermostat. One thermostat is placed on the surface of the collector and is connected to the axial fan and the second thermostat is placed in the drying room connected to the heater element. The way it works is that the thermostat will cut off the electricity that drives the axial fan if the collector temperature reaches the minimum limit. This is to avoid that the rate of air flowing from the collector is only hot air, if the temperature of the collector reaches the lowest temperature limit, only cold air will flow into the drying chamber. Then the way the thermostat works which is connected to the heater element is that the thermostat will cut off the flow of electricity from the heater element if the temperature of the drying room has reached the maximum temperature limit.

I. RESULT AND DISCUSSION

The results of the design of a hybrid solar dryer back-up heater element is the result of the design obtained from the collection of literature and the design deficiencies of the dryer in previous studies. In this design, several components and basic changes to the existing dryer design will be added. After the design is made, the process of making a fish dryer is carried out starting from the manufacture of collectors, dryer housing frames, drying racks, hot air ducts, back up heaters as well as manufacture and installation of axial fans and houses. The design results of this fish dryer has dimensions (*l x w x h*) 120 x 90 x 180 cm



Fig.2 Results of the design of the fish dryer

Testing of the fish dryer was carried out for 3 days from 15 to 17 June 2022. The drying trial process was carried out for 7 hours every day from 08.00 to 15.00 WIB. The parameter measured is the temperature in the drying chamber and above the collector measured using a digital thermohygrometer HTC-2 with a temperature tolerance level of 1% and a humidity tolerance of 5%. The temperature in the drying chamber is regulated using the STC-1000 thermostat with tolerance of 1°C. The temperature of the drying room is set in the range of 35°C – 50°C, meaning that when the temperature of the drying room reaches the minimum limit (35°C), the heater will automatically turn on and when it reaches the maximum temperature (50°C), the heater will automatically turn off.

Solar Radiation Intensity

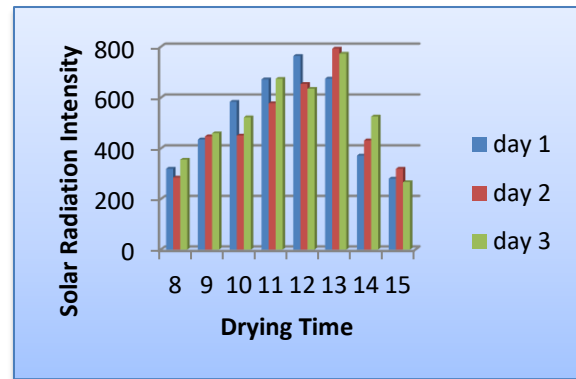


Fig 3. Drying time and solar radiation

Based on the graph in fig.3, it can be seen that during the testing process the intensity of solar radiation tends to increase from 08.00 to 12.00 am and decreases after 13.00 pm. This shows that during the process of testing the weather in the Ciparage Jaya area, Karawang Regency tends to be stable.

Moisture Content

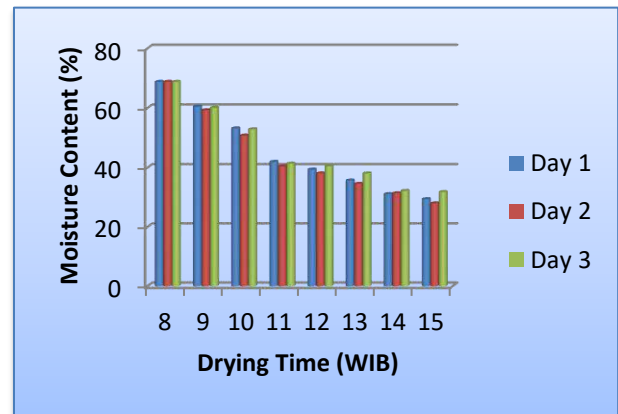


Fig 4. Comparison of drying time and moisture content

Based on the graph in Fig.4 above, after testing for three repetitions there was a relatively constant decrease in water content. The maximum decrease in water content occurred on the second day of repetition, reaching 28% wb after being dried in a dryer for seven hours. While the repetition on the 3rd day showed that the final water content only reached 31.8% but this value still met the water content value recommended by SNI, which was less than 40%.

Descriptive Analysis

The results of hybrid dryer testing that the data obtained are drying room temperature, collector temperature, solar radiation intensity and water content of dried fish. The variables of drying room temperature and solar radiation

intensity will be analyzed and tested using a simple linear regression model statistical analysis using a tool, namely IBM statistic SPSS 24, to find out how much influence of the collector has by comparing the solar radiation intensity with the temperature of the drying room. Determination of simple linear regression method because there is one independent variable and one dependent variable.

Table 1. Analysis of Dryer Room Room Temperature and Solar Radiation Intensity

Day	Time (WIB)	Dryer Room Temp (°C)	Solar Radiation Intensity (W/m ²)	Collector Temp (°C)
Day 1	08.00	36.8	320	31.2
	09.00	38.2	436	33.0
	10.00	43.5	584	37.9
	11.00	48.1	672	38.2
	12.00	51.4	764	40.5
	13.00	50.2	675	43.7
	14.00	48.7	372	38.1
Day 2	08.00	37.2	285	32.3
	09.00	39.8	448	36.7
	10.00	44.2	451	37.1
	11.00	47.1	578	39.4
	12.00	49.4	654	42.4
	13.00	52.3	793	40.3
	14.00	50.5	432	37.2
Day 3	08.00	35.5	356	31.7
	09.00	37.2	460	35.0
	10.00	44.9	523	36.6
	11.00	48.1	674	39.1
	12.00	51.4	635	38.6
	13.00	50.3	773	40.3
	14.00	48.8	526	36.4
15.00	50.1	267	37.1	

can be seen in the table above. The temperature data on the collector is influenced by the level of sunlight intensity at that time and is recorded hourly for 8 hours. So the drying chamber temperature will depend on the collector temperature. In the statistical analysis that will be used is a simple linear regression statistical analysis where to find out how much influence the collector has by comparing the level of sunlight intensity with the temperature of the drying room.

Table 2. Variables Entered

Variables Entered/Removed ^a			
Model	Variables Entered	Variables Removed	Method
1	Solar radiation ^b		Enter

a. Dependent Variable: dryer room temperature
 b. All requested variables entered.

The table above describes the variables entered and the methods used. In this case, the variables included are the sun intensity variable as the independent variable and room temperature is the dependent variable and the method used is the enter method.

Table 3. Model Summary

Model Summary				
Model	R	Adjusted R Square	Std. Error of the Estimate	
1	,524 ^a	,275	,242	4.73106

a. Predictors: (Constant), solar intensity

The model summary table above can be seen that the amount of correlation value (R) is 0.524, it means between the sunlight radiation intensites variable and the drying room temperature variable has the correlation with the correlation value is 0.524. For the test output, the coefficient of determination (R square) is 0.275 which means that the influence of the independent variable (sunlight intensity) on the dependent variable (drying room temperature) is 27.5% and the rest is

Table 4. ANOVA

ANOVA ^a						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	186,875	1	186,875	8,349	,009 ^b
	Residual	492,425	22	22,383		
	Total	679,300	23			

a. Dependent Variable: drying room temperature
 b. Predictors: (Constant), solar intensity

Anova table above can be seen that the calculated F value = 8.349 with a significance level value of 0.009 < 0.05, then the regression model can be used to predict the drying

room temperature variable or in other words there is an influence of the sunlight intensity variable (x) and chamber temperature dryer (y).

Tabel 5. Coefficients

Coefficients ^a					
Model	B	Std. Error	Beta	T	Sig.
1 (Constant)	37,104	3,177		11,678	,000
Solar radiation	,017	,006	,524	2,889	,009

a. Dependent Variable: dryer room temperature

The table above is the result of the T test or also known as the partial test, it is used to test how the influence of each independent variable individually on the dependent variable. In the coefficients table above, it can be seen that the constant (a) value is 37.104 while the sunlight intensity value (regression coefficient) is 0.017, so the regression equation can be written:

$$Y = a + bX$$

$$Y = 37.104 + 0.017X$$

The equation can be explained:

1. The constant of 37.104 means that the consistent value of the drying room temperature variable is 37.104
2. The regression coefficient X of 0.017 states that for every 1% addition of the value of the intensity of sunlight, the value of the drying room temperature increases by 0.017. The regression coefficient is positive, so it can be said that the direction of the influence of the variable X on Y is positive.

The basis for decision making in a simple linear regression test:

1. Based on the significance value of the coefficients table, a significance value of $0.009 < 0.05$ was obtained, so it can be concluded that the sunlight intensity variable (X) has an effect on the drying room temperature variable (Y).
2. Based on the t value : it is known that the calculated t value is $2.889 > 2.074$. so it can be concluded that the variable of sunlight intensity (X) has an effect on the variable temperature of the drying room Y

Heat Calculation Analysis

To calculate the total calorific value needed for the evaporation of water content in the fish's body, first it is calculated based on the following data:

Initial weight of fish	= 20 kg
Drying chamber temperature	= 45.8 C
Initial moisture content (K_{aib})	= 68% = 0.68
Drying time	= 7 hours
Specific heat of water (C_p air)	= 4.2 kJ = 1.01 kcal/kg
Air temperature (Tu)	= 35.8 C

1. Mass of water in fish (M_1)

$$M_1 = W_b \cdot M_{ib}, \text{ where:}$$

$$W_b = \text{moisture content of wet fish (68\%)}$$

$$M_{ib} = \text{Mass of wet fish (20kg)}$$

$$M_1 = 68\% \cdot 20 \text{ kg} = 13.6 \text{ kg}$$

- Heat to heat water (Q_{k1})

$$Q_{k1} = M_1 \cdot C_{Pair} \cdot (T_p - T_u), \text{ where:}$$

$$M_1 = 13.6 \text{ kg}$$

$$C_{Pair} = 1.01 \text{ kcal/kg}^\circ\text{C}$$

$$T_p = \text{T drying chamber (45.8 C)}$$

$$T_u = \text{T air (35.8 C)}$$

$$Q_{k1} = 13.6 \text{ kg} \cdot 1.01 \text{ kcal/kg}^\circ\text{C} \cdot (45.8 - 35.8)^\circ\text{C} = 137.36 \text{ kcal} = 574.71 \text{ kJ}$$

2. Evaporated water mass

$$M_2 = (W_b - W_k) \times M_{ib}, \text{ where :}$$

$$W_k = \text{Moisture content of dry fish (30\%)}$$

$$M_{ib} = \text{Mass of wet fish (20 kg)}$$

$$M_2 = (68 - 30) \% \times 20 \text{ kg} = 7.6 \text{ kg}$$

- Heat to evaporate water (Q_{k2})

$$Q_{k2} = m_2 \cdot L_{\text{water}}, \text{ where:}$$

$$M_2 = 7.6 \text{ kg}$$

$$L_{\text{water}} = 540 \text{ kcal/kg}^\circ\text{C}$$

$$Q_{k2} = 7.6 \text{ kg} \cdot 540 \text{ kcal/kg}^\circ\text{C} = 4,140 \text{ kcal} = 17321.76 \text{ kJ}$$

$$\text{Fish meat mass (} M_3 \text{)}$$

$$M_3 = (100\% - W_b) \times M_{ib}, \text{ where:}$$

$$W_b = \text{Moisture content of wet fish (68\%)}$$

$$M_{ib} = \text{Mass of wet fish (20 kg)}$$

$$M_3 = (100 - 68) \% \times 20 \text{ kg} = 6.4 \text{ kg}$$

- Heat to raise the temperature of fish (Q_{k3})

$$Q_{k3} = M_3 \cdot C_{Pikan} \cdot (T_p - T_u), \text{ where:}$$

$$M_3 = 6.4 \text{ kg}$$

$$C_{\text{pikan}} = 3.387 \text{ kJ/kg C}$$

$$T_p = T \text{ drying chamber (45.8 C)}$$

$$T_u = T \text{ air (35.8 C)}$$

$$Q_{k3} = 6.4 \text{ kg} \cdot 3.387 \text{ kJ/kg C} \cdot (37 - 33) \text{ C} = 216.32 \text{ kJ}$$

So the total heat needed to evaporate the moisture content of 20 kg of fish in this drying chamber is:

$$Q_k = Q_{k1} + Q_{k2} + Q_{k3}$$

$$= (574.71 + 17321.76 + 216.32) \text{ kJ}$$

$$= 18,112.79 \text{ kJ}$$

III. CONCLUSION

Based on the results of the study, it was shown that a hybrid solar fish dryer with solar back up heater element is highly recommended to be applied by salted fish processors because the manufacturing cost of making the tool is very affordable, which is only Rp. 4,453,000, - The dryer test results show that to reduce the water content of 20 kg of fish from 70% to 30% with this dryer, it takes only 7 hours, with details of 4 hours using hybrid power and 3 hours using solar power.

The results of statistical analysis show that 27.5% of the temperature produced by the drying chamber is influenced by solar radiation which is maximized by the solar collector, while the rest is influenced by other factors including the heat source of the heater element and axial fan to accelerate the hot air flow rate. The amount of heat needed to reduce the water content of 20 kg of fish using this dryer is 18,112,79 kJ.

ACKNOWLEDGMENTS

The authors say thank god for the presence of Allah SWT because for all the blessings and gifts of grace that are always given to the author until this good time and opportunity to finish this research. Also thank you to lectures, friends, families and all parties who participated in this research so the the writing of this journal can be completed on time.

REFERENCES

- [1] Afrizal, E., & Aziz, A. (2008). *Development of a Direct Heating Type Solar Dryer with Phase Changing Heat Storage Using Multi-storey Racks in 2008*. April 2016, 1–25. <https://doi.org/10.13140/RG.2.1.1106.7282>
- [2] Bala, BK, & Mondol, MRA (2001). Experimental investigation on solar drying of fish using solar tunnel dryer. *Drying Technology*, 19 (2), 427–436. <https://doi.org/10.1081/DRT-100102915>
- [3] BERHIMPON, S., SOUNESS, RA, BUCKLE, KA, &

EDWARDS, RA (1990). Salting and drying of yellowtail (*Trachurus mccullochi* Nichols). *International Journal of Food Science & Technology*, 25 (4), 409–419. <https://doi.org/10.1111/j.1365-2621.1990.tb01098.x>

- [4] Bintang, YM, Pongoh, J., & Onibala, H. (2013). Construction and Capacity of Solar Fish Dryer Disassembly System. *Fishery Products Technology Media*, 1 (2), 40–43. <https://doi.org/10.35800/mthp.1.2.2013.1632>
- [5] Handoyo, EA, & Kristianto, P. (2003). Solar Powered Fish Drying System. *Journal of Electrical Engineering*, 30–33.
- [6] Himawanto, DA, & Nadjib, M. (2015). Tobacco Drying with Hybrid System. *Engineering Universe*, 16 (1), 1–9.
- [7] Imbir, E., Onibala, H., & Pongoh, J. (2015). STUDY OF DRYING SALTED FISH (*Decapterus* sp) BY USING A SOLAR DRYER. *Fishery Products Technology Media*, 4 (2), 13–18. <https://doi.org/10.35800/mthp.3.1.2015.8328>
- [8] Jain, D. (2006). Determination of Convective Heat and Mass Transfer Coefficients for Solar Drying of Fish. *Biosystems Engineering*, 94 (3), 429–435. <https://doi.org/10.1016/j.biosystemseng.2006.04.006>
- [9] Supriyatno, & Crishna, M. (2010). Case Study of Alternative Energy Briquettes for Environmental Garbage POLBAN Bandung Campus. *Proceedings of the National Seminar on Chemical Engineering "Struggle" for the Development of Chemical Technology for the Processing of Indonesian Natural Resources*, 21, 1–9.
- [10] Thamrin, I., & Kharisandi, A. (2010). Design and Build a Cassava Dryer Rack Type By Utilizing Solar Energy. *9th Annual National Seminar on Mechanical Engineering SNTTM*, 1–6.
- [11] Tiwari, S., Tiwari, GN, & Al-Helal, IM (2016). Development and recent trends in greenhouse dryer: A review. *Renewable and Sustainable Energy Reviews*, 65, 1048–1064. <https://doi.org/10.1016/j.rser.2016.07.070>

Democratic Theory of Fundamental Rights as a Reference for the Inclusion of Marginalized and Invisible People

A Teoria Democrática dos Direitos Fundamentais Como Referencial Para a Inclusão das Pessoas Marginalizadas e Invisíveis

Daniela Costa Soares Mattar¹, Flávio Marcos de Oliveira Vaz²

¹Doutoranda em Proteção e Efetivação dos Direitos Fundamentais – Linha de pesquisa em Organizações Internacionais e a Proteção dos Direitos Fundamentais pela Fundação Universidade de Itaúna/MG. Mestre em Direito das Relações Econômicas Empresariais pela Universidade de Franca – UNIFRAM (2005). Especialista em Direito Processual pelas Faculdades Integradas do Oeste de Minas (2002), em Direito Processual Civil pela Universidade do Sul de Santa Catarina - UNISUL (2008) e em Direito Notarial e Registral pela Universidade Anhanguera - UNIDERP (2012). Professora no Centro Universitário UNA e na Universidade José do Rosário Vellano - Unifenas - Campus Divinópolis/MG. Cel: 37 9 9987 5053. E-mail: dcsmattar@terra.com.br. Currículo Lattes: <http://lattes.cnpq.br/0095914368301779>. Orcid <https://orcid.org/0000-0002-9459-3278>.

²Mestre em Proteção dos Direitos Fundamentais pelo Programa de Pós-Graduação da Universidade de Itaúna- MG. Professor do curso de Direito da Faculdade Pitágoras – Câmpus Divinópolis. Advogado. Especialista em Direito Administrativo. Especialista em Direito Civil. Possui MBA em Gestão de Projetos Sociais. E-mail: fmovaz@gmail.com

¹Programa Nacional de Direitos Humanos, lançado pelo Governo Federal em 13 de maio de 1996.

Received: 11 Jun 2022,

Received in revised form: 10 Jul 2022,

Accepted: 15 July 2022,

Available online: 22 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *fundamental rights; constitution; state.*

Palavras-chave— *direitos fundamentais; constituição; estado.*

Abstract— *This article addresses public policies as a way of guaranteeing and protecting fundamental rights, including to include marginalized and invisible people in the social context, fostering the real importance of the State as a guarantor of such rights and, consequently, being liable in the event of omission. It also addresses the principle of the dignity of the human person as a constitutional framework to ensure the enjoyment of fundamental rights.*

Resumo— *O presente artigo aborda as políticas públicas como forma de garantia e proteção dos direitos fundamentais, inclusive para incluir pessoas marginalizadas e invisíveis no contexto social, fomentando a real importância do Estado como garantidor de tais direitos e consequentemente podendo ser responsabilizado caso ocorra omissão. Aborda também o princípio da dignidade da pessoa humana como balizador constitucional para assegurar o gozo dos direitos fundamentais.*

I. INTRODUÇÃO

As políticas públicas devem garantir a efetividade dos direitos fundamentais por meio do Estado Democrático de Direito. Fato é que para a garantia da democracia, as políticas públicas devem pautar-se pela inclusão e, não, exclusão do cidadão. O Estado deve criar garantias para

assegurar que não haja uma afronta aos direitos fundamentais, sob pena de acarretar uma insegurança jurídica e fomentar ainda mais o preconceito e a exclusão, seja ele de raça, cor, gênero, classe social.

A função do Estado como garantidor de direitos fundamentais encontra respaldo na organização social,

modo historicamente estampado. A partir da organização social, o Estado consegue gerir as diretrizes de modo a assegurar a execução de políticas públicas para os sujeitos, sendo possível uma melhor visualização da aplicabilidade das políticas públicas e sua aplicabilidade em meio ao cenário social.

Em contrapartida, com o Estado a regulamentar e a resguardar os direitos fundamentais, compete à sociedade o dever de fiscalizar a atuação do Estado para que não ocorra deturpação de tais direitos, o que, caso aconteça, representa um grande problema para parcela da sociedade. Nesse sentido:

Logo, a atuação do Estado não deve pautar-se por uma interpretação constitucional subjetiva de quem aplica a lei, de modo que abarque todos os cidadãos.

Assim, há um enlace entre Estado, direitos fundamentais e políticas públicas, que, juntos, agem diretamente na vida do sujeito.

II. DIREITOS FUNDAMENTAIS: ESTADO LIBERAL; ESTADO SOCIAL E ESTADO DEMOCRÁTICO DE DIREITO

As consequências da problemática introdutoriamente apresentada são perceptíveis por meio de breve análise histórica dos direitos fundamentais e a sua relação com os Estados, desde a época do liberalismo.

Para análise do atual Estado Democrático de Direito e os direitos fundamentais como garantia da democracia, torna-se necessária uma breve repassada pelo contexto histórico. Não se trata de trabalhar todo o contexto histórico e as suas mínimas características, mas, traçar um parâmetro geral e específico para a discussão sobre os direitos fundamentais no Estado Democrático de Direito.

O Estado liberal tem entre suas características com relação à dissociação entre o Estado e a economia, fato este que teve como consequência o estímulo da economia com a sua regulamentação pelo mercado e, não, pela política, sendo assim, o principal objeto do liberalismo.

As limitações ao poder do soberano impostas pelo modelo de Estado Liberal são um ponto fundamental de sua natureza. Tais limitações constituem o objetivo primeiro do movimento que culminou no Estado Liberal, pois a corrente ideológica que ao fim prevaleceu no seio da Revolução Francesa objetivava a criação de um mercado

autorregulado imune a interferências estatais de qualquer gênero. Desse modo, por meio da concepção de lei “geral e abstrata” portadora de uma igualdade estritamente formal e do abstencionismo econômico, o Estado Liberal atribuiu segurança jurídica às trocas mercantis, criou um mercado de trabalho repleto de mão de obra barata (POLANYI, 1957, p. 73) e assegurou à iniciativa privada a realização de qualquer atividade potencialmente lucrativa. (MORAES, 2014, p. 272.)

Com duração durante o século XIX, o Estado liberal ajudou na produção de riquezas entre as massas. Contudo, mesmo com o fortalecimento destas, o Estado liberal foi fortemente abalado pelo capitalismo a partir da Primeira Guerra Mundial:

Em termos abrangentes, é essa perspectiva que norteará a existência do Estado Liberal durante todo o século XIX, principalmente durante seu apogeu pós-1848, momento em que a quantidade de riquezas produzidas possibilitou algumas concessões sociais que acalmaram as massas (HOBSBAWN, 1982). Esse período de ápice perdurará por mais meio século e só entrará em declínio a partir de 1880, juntamente com o ocaso dessa fase do capitalismo. O espírito liberal vai ser fortemente abalado pela Primeira Guerra Mundial, momento em que já começa a existir uma forte tendência ao Estado do Bem-Estar (LASKI, 1973, p. 172) e não mais será possível falar em um Estado Liberal nos moldes acima descritos. (MORAES, 2014, p. 273.)

Durante o Estado liberal a discussão acerca do benefício da classe burguesa já permeava entre os grandes pensadores da época. Saliente-se também que era objeto de discussão a questão de o indivíduo não ser totalmente livre, devendo *obediência ao Estado*, sendo que a vontade de uma coletividade deveria prevalecer em detrimento da vontade de somente um sujeito, conforme se vê:

Enquanto para Locke o direito do indivíduo à propriedade era natural e inegociável, para Rousseau representava a própria decadência moral da sociedade – assim, se fazia uma crítica denunciando que o liberalismo beneficiava uma determinada classe de cidadãos, a burguesia, e não a sua totalidade. Em *O Contrato Social* (1762), Rousseau afirma que o homem é livre apenas com o Estado, que para existir obriga que todo indivíduo renuncie à sua liberdade e seus interesses particulares. A vontade geral deveria prevalecer às vontades individuais: esta ideia comprova que, se o liberalismo foi individualista num primeiro momento, logo depois surgiram correntes que postulavam a superioridade do Estado em relação ao indivíduo. (MELLO, s.d.)

Muitas críticas eram emanadas do liberalismo, principalmente pelo fato de favorecer a burguesia com o domínio da maioria dos bens e das riquezas em geral. Contudo, houve uma mudança de panorama com o estabelecimento das empresas e os movimentos das massas que passaram a reivindicar seus direitos. Ainda sobre o surgimento do Estado liberal, pode-se dizer que:

O Estado liberal possuía algumas características bem marcantes: os ideais eram de liberdade e igualdade, as ideias eram iluministas e o governo não era intervencionista. Os indivíduos eram individualistas, sem medo da redundância. (...) O estado liberal surge, portanto, da luta

contra os abusos do poder da nobreza e da igreja na Idade Média e do Estado Moderno e de sua forma de organização, baseada em desigualdades, privilégios e arbitrariedades. O combate foi travado pelas ideias iluministas e revoluções liberais. Dentre estas, como mais marcantes ressaltamos a Revolução Industrial e a Revolução Francesa. (...) O Estado se manifesta, pois, como criação deliberada e consciente da vontade dos indivíduos que o compõem, consoante as doutrinas do contratualismo social. Sua existência seria, por consequência, teoricamente revogável, se deixasse de ser o aparelho de que serve o homem para alcançar na sociedade a realização de seus fins. (TEODORO, 2011, p. 21.)

Logo, vê-se que governo não era intervencionista, sendo o Estado Liberal de Direito pautado por uma filosofia individualista, acarretando uma separação entre o público e o privado, sendo uma característica determinante o respeito à propriedade (que envolve os aspectos da vida e a liberdade, como personalidade do sujeito), sendo o surgimento do Estado Liberal, “(...) influenciado pelas ideias iluministas de Hobbes, Locke, e Rousseau e fundado no princípio da legalidade como garantia de certeza dos indivíduos frente ao Estado” (TEODORO, 2011, p. 31).

Enquanto se instalava a crise pela manutenção do Estado liberal, e a discussão acerca da desigualdade social, constata-se o surgimento do movimento social. Houve também a intervenção estatal em favor do proletariado, acarretando uma mudança drástica de cenário:

Foi justamente essa tentativa de manter o modelo liberal que acabou por se tornar um dos principais fatores de sua superação. A admissão da necessidade de intervenção/regulação da economia pelo Estado ampliou os contornos da ordem liberal e deu margem, em um momento de ruptura, à passagem para um

modelo de Estado que intervém na ordem social e econômica. A crise do modelo liberal foi engendrada dentro dele e, pior, foi uma tentativa de perpetuá-lo. (MORAES, 2014, p. 274.)

E sobre a transição de Estado Liberal para Estado Social, após a instalação da crise para manutenção do Estado Liberal, Ada Pellegrinni Grinover esclarece que:

A transição entre o Estado liberal e o Estado social promove alteração substancial na concepção do Estado e de suas finalidades. Nesse quadro, o Estado existe para atender ao bem comum e, conseqüentemente, satisfazer direitos fundamentais e, em última análise, garantir a igualdade material entre os componentes do corpo social. Surge a segunda geração de direitos fundamentais – a dos direitos econômico-sociais –, complementar à dos direitos de liberdade. Agora, ao dever de abstenção do Estado substitui-se seu dever a um *dare, facere, praestare*, por intermédio de uma atuação positiva, que realmente permita a fruição dos direitos de liberdade da primeira geração, assim como dos novos direitos. (GRINOVER, 2009.)

Além da transição, José Luis Bolzan de Moraes acrescenta sobre o enfrentamento de crises no Estado Social:

Por trás da moldura do bem-estar social, vislumbra-se um projeto simbólico de rearranjo das relações intersubjetivas que está calcado não só no consenso democrático que se constrói não apenas definindo-se *quem e com quais procedimentos* está legitimado a decidir, mas e também, na ideia de um viver comunitário, onde os interesses que

atingem/afetam os indivíduos produzem inevitavelmente benefícios ou prejuízos compartilhados, desde uma perspectiva na qual o projeto democrático apresenta-se como uma utopia em constante (re) construção. Por outro lado, devemos estar atentos às transformações conceituais que atingem a compreensão tradicional da ideia de Estado, assentada, sobretudo, no seu poder incontestável – a soberania. São várias as implicações emergentes das novas configurações mundiais, seus atores etc. (MORAIS, 2011, p. 50.)

Assim, após a transição do Estado Liberal e o surgimento do Estado Social, vale ressaltar inicialmente que no Estado social “(...) tem como principal característica a intervenção do Estado na atividade econômica e na vida social e tem sua origem a partir da implantação do Welfare State” (TEODORO, 2011, p. 49).

Nesse diapasão, uma característica importante no Estado social é o auxílio de instrumentos jurídicos na direção do Estado como guia da sociedade e, conseqüentemente, obtenção da ordem. Outra característica que deve ser ressaltada é a extensão das atividades do Estado, com diversos regimes políticos. Sobre o Estado social, nota-se que:

A expressão “Estado Social”, assim como a expressão “Estado Liberal”, possui um caráter semanticamente aberto. Desde a Alemanha nazista, passando pela França da Quarta República ao Brasil pós-Revolução de 1930, temos, em todos os casos, Estados aos quais foi dada a alcunha de “social”; demonstração de que tal expressão pode ser aplicada a Estados com regimes políticos bastante diferentes, desde a democracia ao nacional-socialismo. (MORAES, 2014, p. 274–275.)

Em outras palavras, exemplificando o Estado social para o Estado Democrático de Direito, seria como se

o Estado social fizesse o planejamento e organização dos atos, e o Estado Democrático colocasse em prática o planejamento e os atos organizados. Logo, encontra-se travada a discussão sobre “(...) os debates doutrinários a respeito da aplicabilidade e efetividade das normas constitucionais, das políticas públicas, da reserva do possível, do ativismo judicial e da separação de poderes” (MORAES, 2014, p. 276).

Assim, o Estado Democrático de Direito é um conjunto histórico dos Estados liberal e social, mas não deixa de ser novo, sendo resultado de uma transformação dos institutos. Um ponto forte do Estado Democrático de Direito é a limitação do poder estatal ao mesmo tempo em que preserva a liberdade de cada indivíduo, rechaçando o favorecimento de um ou alguns.

Sobre o Estado Democrático como um instrumento de controle social, Fabrício Veiga Costa explica:

A teoria do direito democrático é uma proposição jusfilosófica que passa pela superação do entendimento clássico de que a ciência do Direito é mero instrumento de controle social e exercício do poder, considerando-se que essas novas proposições teóricas são hábeis a legitimar o entendimento de que o processo constitucional democrático deve ser visto como locus de inclusão e implementação dos direitos fundamentais previamente previstos no plano constituinte e instituinte. (COSTA, 2019, p. 21.)

José Afonso da Silva, citado por Moraes (2014, p. 279), esclarece que:

A configuração do “Estado Democrático de Direito” não significa apenas unir formalmente os conceitos de Estado Democrático e Estado de Direito. Consiste, na verdade, na criação de um conceito novo, que leva em conta os conceitos dos elementos

componentes, mas os supera na medida em que incorpora um componente revolucionário de transformação do “status quo”.

Paulo Bonavides, citado por Maria Cecília, explicita o objeto central do Estado Social, como sendo:

O Estado social é fruto da reivindicação das massas e também é fruto do medo da revolução. É ao mesmo tempo um Estado que recua, transige e promove benefícios aos trabalhadores. Ele confere direitos do trabalho, da previdência, da educação, intervém na economia como distribuidor, dita o salário, manipula a moeda, regula os preços, combate o desemprego, protege os enfermos etc. (TEODORO, 2011, p. 50.)

Trazendo modificações, é possível notar que a ideia de Estado Social é a proteção do cidadão, com a garantia de direitos, bem como estabelecer uma relação de equilíbrio de classes, como a classe trabalhadora. Vê-se, assim, que “Estado Social é um estado que se consolida pelo reconhecimento de direitos ao proletariado, notadamente direitos políticos. A concessão desses direitos é que vai permitir a penetração popular no poder e a realização de mudanças sociais” (TEODORO, 2011, p. 52).

A solidificação do Estado Social para o Estado Democrático de Direito, nas palavras de Ada Pellegrini Grinover, acontece com o alcance de objetivos fundamentais e a prevalência dos direitos humanos. Citando Oswaldo Canela Júnior, a autora esclarece que, para a efetivação de Estado Social para Democrático, se situa quando:

Para o Estado social atingir esses objetivos, faz-se necessária a realização de metas, ou programas, que implicam o estabelecimento de funções específicas aos Poderes Públicos, para a consecução dos objetivos predeterminados pelas Constituições e pelas leis (BONAVIDES, 1980). (...) “A

efetivação dos direitos fundamentais através do processo coletivo: um novo modelo de jurisdição” comando constitucional ou legal, impõe-se ao Estado promover as ações necessárias para a implementação dos objetivos fundamentais. E o poder do Estado, embora uno, é exercido segundo especialização de atividades: a estrutura normativa da Constituição dispõe sobre suas três formas de expressão: a atividade legislativa, executiva e judiciária. (GRINOVER, 2009.).

Logo, o Estado Democrático visa à junção dos mais variados grupos sociais, estabelecendo uma forma de convívio entre os demais diferentes sujeitos, preservando a individualidade de cada um, ao mesmo tempo em que fomenta a igualdade, seja ela material ou imaterial.

III. A TEORIA DEMOCRÁTICA DOS DIREITOS FUNDAMENTAIS COMO REFERENCIAL PARA A INCLUSÃO DAS PESSOAS MARGINALIZADAS E INVISÍVEIS

A Constituição brasileira preconiza a proteção integral de todos os cidadãos, independentemente de sexo, cor, raça, religião. Mesmo estabelecida essa proteção na lei maior do país, ainda há marginalização de minorias.

Trata-se de sujeitos invisíveis perante os ordenamentos jurídico, político e social, na presente dissertação especificamente, os sujeitos invisíveis como sendo os transexuais. A Constituição garante os direitos, mas os responsáveis pelo cumprimento da lei fogem da regra, aplicando um direito subjetivo que favorece ainda mais os mais fortes perante os mais fracos, sendo incluídos nesse grupo os transexuais.

A Constituição é garantidora máxima da efetividade dos direitos fundamentais pelos instrumentais como garantia dos direitos humanos. Nota-se que:

Se a Constituição nasceu para a garantia de um espaço de participação democrática – liberdade política – que superaria a Monarquia Absoluta, então uma Constituição deve ser necessariamente democrática.

E se é verdadeiro que a Constituição tem servido para a previsão de instrumentos de garantia de Direitos Humanos, então é também verdadeiro que não há Constituição sem Direitos Fundamentais. (PAGLIARINI, 2007, p. 135.)

Os direitos fundamentais, previstos na Constituição para todos, e sua extensão de aplicabilidade acabam por garantir uma segurança para o indivíduo no aspecto pessoal. Logo, direitos fundamentais são tidos como direitos de cada sujeito, direitos subjetivos:

Definimos Direitos Fundamentais como direitos subjetivos de pessoas (físicas ou jurídicas), contidos em dispositivos constitucionais – possuindo, portanto, caráter normativo supremo em âmbito estatal – cujo objetivo é limitar o exercício do poder estatal em face da liberdade individual. Esta definição indica três elementos básicos: a-) os sujeitos da relação criada pelos direitos fundamentais (pessoa vs Estado). Isto aponta a regra, mas não exclui a garantia dos direitos fundamentais por organismos supranacionais ou internacionais, que exercem um poder normativo e possuem capacidade de imposição de seus mandamentos, desenvolvendo um papel estruturalmente semelhante àquele do Estado nacional. b-) A finalidade dos direitos fundamentais: limitação do poder político – estatal para aquele do Estado nacional. c-) a posição de superioridade dos direitos fundamentais no sistema das fontes do direito estatal em razão de sua supremacia constitucional. (DIMOULIS, 2007, p. 29.)

Logo, a teoria democrática dos direitos fundamentais vem para a inclusão das pessoas marginalizadas e invisíveis, bem como uma forma de

limitação do Poder Público. Apesar de ser um direito subjetivo, o seu modo de aplicabilidade não se deve pautar pela subjetividade.

As funções da teoria dos Direitos fundamentais é a mais ampla possível, de forma a não deixar nenhum cidadão de fora, de forma a não aumentar as desigualdades, bem como evitar violências para o sujeito, seja ela física ou moral. Saliente-se que, apesar de se tratar de garantia de direitos, existe uma predileção no modo que é posto em sociedade.

Canotilho (1941, p. 408) diz que a “(...) primeira função dos direitos fundamentais, sobretudo dos direitos, liberdades e garantias, é a defesa da pessoa humana e sua dignidade perante os poderes do Estado”, o qual ainda acrescenta:

Os direitos fundamentais cumprem a função de direitos de defesa dos cidadãos sob uma dupla perspectiva: (1) constituem, num plano jurídico-objectivo, normas de competência negativa para os poderes públicos, proibindo fundamentalmente as ingerências destes na esfera jurídica individual; (2) implicam, num plano jurídico – subjectivo, o poder de exercer positivamente direitos fundamentais (liberdade positiva) e de exigir omissões dos poderes públicos, de forma a evitar agressões lesivas por parte dos mesmos (liberdade negativa). (CANOTILHO, 1941, p. 408.)

Nota-se que os direitos fundamentais são democráticos por visar à proteção do sujeito em consonância com a norma e o seu modo de exercício, um elemento basilar para a democracia. Restringir tais direitos seria o mesmo que restringir a democracia, uma vez que os direitos fundamentais não poderão ser exercidos de livre plano.

Cumprido ressaltar que a democracia alcançada pelos direitos fundamentais encontra uma aliada na norma infraconstitucional, que nada mais é, no presente caso, do que a extensão da manifestação de vontade da sociedade, que chancela a sua aplicação (aplicação que, conforme dito, pode ser subjetiva, viciando o objeto central da teoria). Nesse sentido:

Os direitos fundamentais poderiam ser considerados democráticos, pois estão sujeitos a uma concretização preferencialmente democrática e submetida à comunidade política, que delibera, escolhe e decide sobre a realização infraconstitucional dos direitos fundamentais. Também, podem ser considerados democráticos, porquanto os direitos de liberdade, de igualdade e os direitos políticos funcionam como pressupostos jurídico-institucionais da democracia constitucional, o que assegura ao processo democrático condições de igualdade entre todas as pessoas para participação no processo político. E, por fim, são democráticos os direitos fundamentais, porque os direitos de liberdade e igualdade garantem o desenvolvimento e a existência de pessoas que, em geral, são capazes de manter o processo democrático. (BARBOZA, 2007, p. 281.)

O Estado cada vez mais regula a vida privada do sujeito, resquício do Estado social, e os direitos fundamentais exigem dele cada vez mais uma prestação positiva. Cumpre dizer que a intenção do Estado é melhorar a vida das pessoas, advindo o fato de ser um Estado Democrático. O termo *democrático* aqui não se remete à democracia representativa, que é elemento do Estado de Direito.

Logo, o Estado Democrático faz promoção dos direitos fundamentais, sendo o referencial para a inclusão das pessoas marginalizadas e invisíveis, ou pelo menos deveria ser. Nesse sentido, Mazzuoli esclarece que:

O estudo dos direitos humanos das minorias e dos grupos vulneráveis excepciona o conhecido princípio da igualdade formal – “todos são iguais perante a lei” – erigido no Estado Liberal, para

consagrar o da igualdade material ou substancial (implementado a partir do Estado Social) deve se tratar os iguais de forma igual e os desiguais de forma desigual, na medida de suas desigualdades. Como consequência, todos detêm características singulares ou que necessitam de proteção especial em razão de sua fragilidade ou indefensabilidade, passam a merecer o devido amparo (também singular e especial) da ordem jurídica estatal, especialmente por meio de discriminações positivas e ações afirmativas capazes de igualá-los a todas as demais pessoas. (MAZZUOLI, 2017, p. 274.)

Na esfera internacional, pode ocorrer a responsabilização dos Estados que promovem a discriminação e a exclusão de grupos marginalizados. Contudo, em esfera nacional não se vê essa responsabilização em seu sentido literal, mas, apenas, decisões que são emitidas após uma necessidade de acionamento do Judiciário, em razão de omissão legislativa. Deve-se salientar que:

A internacionalização dos direitos humanos permite responsabilizar os Estados que discriminam e excluem categorias da população, independentemente do acionamento de mecanismos de direito interno e da vontade do Estado de fiscalizar violações de direitos fundamentais. (DIMOULIS, 2007, p. 38.)

Vê-se que a sociedade como fiscalizadora do Estado Democrático de Direito é responsável em parte pela exclusão das pessoas marginalizadas e invisíveis. Nota-se pelo exemplo a seguir, em se tratando da educação (tópico que será abordado mais adiante), que é um componente constitucional previsto no ordenamento jurídico brasileiro, o descompromisso do Estado Democrático de Direito com os direitos humanos, por não auxiliar os profissionais em

seus campos de atuação, seja público ou privado, sobre gênero e sexualidade:

A ausência da população LGBT e de temáticas relativas à sua cidadania é uma marca dos currículos tanto na educação básica quanto na educação superior, contribuindo para a conformação de uma sociedade ignorante, indiferente e descomprometida com os direitos humanos. (FEITOSA, 2017, p. 206.)

Assim, nota-se um problema na teoria democrática no que tange às pessoas marginalizadas e invisíveis. O Estado regula a vida privada do sujeito com a ideia de proteção, mas na realidade protege uns ou outros.

Não se trata de algo totalmente democrático como se espera, quando se assegura a aplicabilidade dos direitos fundamentais, tornando o homem um *prisioneiro* da manifestação de vontade estatal. Citando Arendt, Carvalho, ao expor seu pensamento sobre a concepção de liberdade, diz que:

Para os antigos: antes que se tornasse um atributo do pensamento ou uma qualidade da vontade, a liberdade era entendida como o estado do homem livre, que o capacitava a se mover, a se afastar de casa, a sair para o mundo e a se encontrar com outras pessoas em palavras e ações. Essa liberdade, é claro, era precedida da liberação: para ser livre o homem deve ter se liberado das necessidades da vida. (CARVALHO, 2013, p. 31.)

Vê-se, assim, que a teoria democrática de direitos fundamentais deveria ser o referencial para a inclusão das pessoas marginalizadas e invisíveis. Contudo, alguns entraves de ordem interpretativa dificultam a referência teórica fazer parte da regra, culminando na agregação dos sujeitos e, não, a sua exclusão, como tem ocorrido.

IV. POLÍTICAS PÚBLICAS, INCLUSÃO, CIDADANIA E GOZO DOS DIREITOS FUNDAMENTAIS

Para gozar dos direitos fundamentais, de início deve ser efetivado o princípio da dignidade da pessoa humana como um elemento de concretização de tais direitos. Trata-se de um conjunto tido como básico para que o cidadão possa ter um mínimo de vida digna. As políticas públicas encontram-se inseridas como um mecanismo de resguardar as efetividades dos direitos fundamentais, por meio da execução de atividades pelos governos, e que impactam a vida dos cidadãos como saúde, educação, cultura, lazer etc.

Analisando a condição humana de Hannah Arendt, Bethania Assy expõe que o agir humano corresponde a ações, seja no plano da ação política, seja no espaço público em particular. Os atos praticados pelo sujeito, seu comportamento, por exemplo, influencia na visibilidade, que Hannah Arendt denomina de liberdade humana. Nesse sentido:

A vida do espírito, a autora (Hannah Arendt) nos desafia a uma fenomenologização da vida contemplativa, cujo ângulo privilegiado é a visibilidade dos atos da linguagem. Redireciona o pensar, o querer, e o julgar ao âmbito da aparência – uma transposição fundamental para a formulação de uma ética da responsabilidade. Em antagonismo à sobrestima contemporânea da imagem corporal, na qual até certo ponto ser e aparecer também coincidem, aqui o que está em jogo na ética é a visibilidade do espaço público arendtiano de modo a ofertar um fórum para a liberdade humana, entendido não como um horizonte da experiência interior, mas como espaço para o exercício da virtude pública. (ASSY, 2018, p. 20.)

No mesmo prisma, o comportamento ainda se reflete na construção do que somos, numa relação causa e efeito. Assy, ao analisar a obra de Hannah Arendt, ainda acrescenta que:

A responsabilidade pessoal por quem somos, pelos outros e pela durabilidade do mundo, conflui no *espaço-entre* de

Arendt (*Zwischen-Raum*). Essa relação ética entre a ação e as atividades do espírito de modo algum significa uma relação de causa e efeito. O *espaço-entre* pode ser visto como um espaço ético que não se situa nem na pura esfera privada da interioridade (*inwardness*), nem na esfera genuinamente performática de uma exterioridade desprovida de reflexão e crítica. As atividades de pensar, julgar e querer desempenham um papel decisivo na constituição de quem somos, de como agimos e de como decidimos assumir responsabilidade pelos outros e pelo mundo. (ASSY, 2018, p. 22.)

O comportamento implica aspectos da vida do sujeito e, conforme mencionado anteriormente, impacta questões constitucionais:

Essa inserção no mundo humano, por palavras e atos, não nos é imposta pela necessidade, como a atividade do trabalho, nem desencadeada pela utilidade, como a atividade da obra. Seu impulso brota do desejo de estar na companhia dos outros, do amor ao mundo e da paixão pela liberdade. (CORREIA, 2018, p. 38.)

Nota-se que todos os elementos do conjunto básico da dignidade da pessoa humana, como saúde, educação, lazer, moradia, são entrelaçados e completam-se, não sendo possível êxito na execução do princípio aludido sem qualquer um dos elementos que o compõe:

Não há liberdade de expressão sem educação e saúde, como não há saúde sem moradia, etc. A dignidade da pessoa humana é o princípio que realiza a união dos diversos direitos fundamentais, e o IDH (Índice de Desenvolvimento Humano, da ONU) é uma tentativa de se medir o nível de dignidade das

peessoas nos mais diversos países. (MALISKA, 2007, p. 548.)

Ainda sobre a dignidade da pessoa humana, com o reconhecimento do cidadão por meio do meio em que se encontra, Araújo esclarece que:

A dignidade da pessoa humana advém de uma construção filosófica e política que reconhece o ser humano a partir de sua liberdade e autonomia no contexto em que se encontra inserido. Essa convicção advém da singularidade da pessoa, de seus aspectos essenciais que pressupõem a superioridade do ser humano. Trata-se de princípio que não se restringe a uma declaração ou postulado filosófico. (ARAÚJO, 2018, p. 27.)

A necessidade de políticas públicas é algo de muita importância para a sociedade, principalmente para os cidadãos LGBTQI+, que enfrentam dificuldades no exercício de cidadania e gozo dos direitos fundamentais. Mesmo com alguns pequenos avanços, a dificuldade ainda é algo que gera a exclusão dos sujeitos LGBTQI+.

A falta de norma que determina a preparação dos sujeitos para auxiliarem as pessoas LGBTQI+ em determinadas áreas, como na saúde, por exemplo, seja pública ou privada, é um exemplo da necessidade de políticas públicas na preparação desses agentes. Em outro caso, mesmo tendo a normativa, pelo desconhecimento do profissional que deveria aplicá-la, o agente acaba por ferir a dignidade do sujeito que necessita dessa atenção por fazer parte de um grupo minoritário:

Nos anos anteriores as pessoas tinham dificuldade no atendimento das pessoas LGBT, por falta de informação, por falta de normativas ou de conhecer as normativas que existiam sobre a temática em diversas áreas. Por exemplo: a diretora expulsa ou fala para transexual que ela não pode entrar com a roupa feminina na escola porque ela não conhece as normativas do MEC que

permitem a trans de entrar com a roupa feminina na escola, que permite ela ser chamada pelo nome social, que permite ela usar o banheiro feminino, então a gente vai saber o que os profissionais das diversas áreas influenciam essas normativas. Então a introdução do protocolo foi mais ou menos isso: divulgar essas normativas e atendimentos (entrevista com Davi, 18/05/2015). (FEITOSA, 2017, p. 194–195.)

Nota-se que, a partir do momento em que se cria um mecanismo de auxílio, facilita-se que o sujeito possa ter resguardada a sua intimidade, a sua privacidade, os seus direitos de um modo geral. Criando a normativa, é preciso que também que todos aqueles que vão dar aplicabilidade às políticas públicas estejam preparados para tal função, que pode ocorrer por meio do conhecimento, por exemplo.

A vida do sujeito como protagonista e exercício de cidadania é objeto de discussão sobre a condição humana apresentada por Hannah Arendt, ao traçar um paralelo sobre a vida no mundo moderno e os problemas decorrentes, conforme se vê:

Por mais tentador que seja atribuir, por simples questão de coerência, o moderno conceito de vida às perplexidades que a moderna filosofia cria para si própria, seria erro e grave injustiça à seriedade dos problemas da era moderna vê-los meramente do ponto de vista do desenvolvimento das idéias. (ARENDR, 2007, p. 326.)

A autora ainda acrescenta que:

O motivo pelo qual a vida se afirmou como ponto último de referencia na era moderna e permaneceu como bem supremo para a sociedade foi que a moderna inversão de posições ocorreu dentro da textura de uma sociedade cristã, cuja crença fundamental na sacrossantidade da vida sobrevivera à secularização e ao declínio geral da fé cristã,

que nem mesmo chegaram a abalá-la. (ARENDR, 2007, p. 327.)

Garantindo-se essas políticas públicas, como maior consequência, acarretar-se-iam a proteção da vida do sujeito e o mínimo de dignidade, fazendo com o que o cidadão tenha acesso à educação, à moradia, à alimentação, aos valores que, de acordo com Piovesan, constituem “(...) valores que integram a concepção de cidadania”, conforme o qual:

Atendo-se particularmente à política nacional de proteção aos direitos humanos, há que se questionarem que medida tem implementado os valores que integram a concepção de cidadania. Em outras palavras, importa investigar o modelo pelo qual essa política incorpora a natureza indivisível e universal dos direitos humanos e o processo de especificação do sujeito de direito. (...) O Programa¹ concentra um universo de propostas de ações governamentais, visando à implementação de políticas públicas para a proteção e promoção dos direitos humanos no Brasil, com especial enfoque à proteção dos direitos à vida, à liberdade e à igualdade. Apresenta ainda propostas voltadas à educação para a cidadania, como também propostas voltadas às ações internacionais para a proteção e promoção dos direitos humanos. (PIOVESAN, 2003, p. 347.)

Cidadania e gozo dos direitos fundamentais são conceitos que estão *amarrados* e fazem parte do cotidiano de todo cidadão. As políticas públicas vêm como um fator de assegurar a igualdade no gozo desses direitos. Nota-se que:

O pleno gozo dos Direitos Humanos depende, no dia-a-

dia, da capacidade de participação política – cidadania – da população. Constituição e Democracia, neste sentido, aproximam-se e se fundem em conceitos complementares um ao outros. (PAGLIARINI, 2007, p. 135.)

Torna-se clara a importância da execução de políticas públicas de forma a diminuir a exclusão de sujeitos na sociedade, principalmente do cidadão transexual, que sofre violência diária, não pode exercer sua cidadania, transgredindo, assim, os direitos fundamentais que lhes são inerentes.

V. CONCLUSÃO

O Estado para ser democrático tem que atender as demandas de sua sociedade, sempre tendo como pilar a sua Constituição. A partir do momento em que a figura estatal deixa de atender as questões sociais, temos um flagrante ultraje as garantias fundamentais.

As políticas públicas servem de ferramenta essencial para garantir a efetivação do trabalho estatal em suas diversas esferas, de modo proteger todo e qualquer cidadão, sem qualquer exclusão.

Contudo, nota-se um desrespeito, marginalização e exclusão de determinados grupos sociais, incluindo-se nesses grupos as pessoas trans, que tem os seus direitos tolhidos em decorrência de um subjetivismo arraigado no contexto social e público, sob uma “*manta*” religiosa heteronormativa pautada pela escolha de quem é considerado cidadão de bem.

Para assegurar a garantia dos elementos constitucionais básicos da dignidade da pessoa humana, entre eles saúde, educação, lazer, moradia, são necessários mecanismos que buscam assegurar a realização de projetos de inclusão, através das políticas públicas, de forma a tirar o sujeito da invisibilidade social que cresce cada vez mais.

A teoria democrática dos direitos fundamentais em seu ponto principal, respaldado pelo contexto histórico da evolução do estado conforme restou demonstrado, apresenta atualmente um contexto de proteção que não caminha com o atual cenário de exclusão e preconceito vivenciado pelas minorias invisíveis fortemente atacadas por todos os setores da sociedade.

¹ Programa Nacional de Direitos Humanos, lançado pelo Governo Federal em 13 de maio de 1996.

Em sua essência, apresenta o pilar de proteção, inclusão e garantias fundamentais, sem qualquer distinção, concretizando a validade do direito e visibilidade de todos.

REFERÊNCIAS

- [1] ARAÚJO, Dalvane Aparecida. **Direito ao corpo: a autonomia privada e a liberdade como limites à intervenção do estado na capacidade de autodeterminação da mulher**. 2018. Dissertação (Mestrado em Proteção dos Direitos Fundamentais) – Faculdade de Direito, Universidade de Itaúna, Itaúna, MG, 2018.
- [2] ARENDT, Hannah. **A condição humana**. 10. ed. Rio de Janeiro: Forense Universitária, 2007.
- [3] ASSY, Bethania. A constituição do sujeito e a ação política. **Revista Cult**, Edição Especial Hannah Arendt, um pensamento atual, São Paulo, Ed. Bregantini, n. 9, ano 21, 11 jan. 2018.
- [4] BARBOZA, Estefânia Maria de Queiroz. Jurisdição constitucional, direitos fundamentais e democracia. *In*: CLÉVE, Clémerson Merlin; SARLET, Ingo Wolfgang; Pagliarini, Alexandre Coutinho (Coord.ª). **Direitos humanos e democracia**. Rio de Janeiro: Forense, 2007.
- [5] CANOTILHO, J. J. Gomes, **Direito constitucional e a teoria da constituição**. 7. ed. Coimbra: Edições Almedina, 1941.
- [6] CARVALHO, Diego Sousa de. **O “gênero” e a ciência da saúde: produção em torno da transexualidade no portal de pesquisa da Biblioteca Virtual de Saúde**. 2014. 105 f. Dissertação (Mestrado em Saúde Pública) – Faculdade de Saúde Pública, Universidade de São Paulo, São Paulo, 2014. Disponível em: <<https://teses.usp.br/teses/disponiveis/6/6136/tde-05112014-133335/publico/DiegoSousaDeCarvalho.pdf>>. Acesso em: 15 nov. 2019.
- [7] CORREIA, Adriano. A vitória da vida sobre a política. **Revista Cult**, Edição Especial Hannah Arendt, A vitória da vida sobre a política, São Paulo, Ed. Bregantini, n. 9, ano 21, 12 jan. 2018.
- [8] COSTA, Fabrício Veiga. **Mérito processual: a formação participada nas ações coletivas**. Belo Horizonte: Arraes Ed., 2012.
- [9] COSTA, Fabrício Veiga. **Princípios regentes do processo civil no estado democrático de direito: ensaios de uma teoria geral do processo civil**. Belo Horizonte: D’Plácido, 2019.
- [10] DIMOULIS, Dimitri. Estado nacional, democracia e direitos fundamentais. Conflitos e aporias. *In*: CLÉVE, Clémerson Merlin; SARLET, Ingo Wolfgang; Pagliarini, Alexandre Coutinho (Coord.ª). **Direitos humanos e democracia**. Rio de Janeiro: Forense, 2007.
- [11] FEITOSA, Cleyton. **Políticas públicas LGBT e construção democrática no Brasil**. Curitiba: Appris, 2017.
- [12] GRINOVER, Ada Pellegrini. Judiciário pode intervir no controle do Executivo. **Revista Eletrônica Consultor Jurídico**, 8 maio 2009. Disponível em: <<https://www.conjur.com.br/2009-mai-08/judiciario-intervir-executivo-controlar-politicas-publicas?pagina=2>>. Acesso em: 14 nov. 2019.
- [13] MALISKA, Marcos Augusto. A concretização dos direitos fundamentais no estado democrático de direito. Reflexões sobre a complexidade do tema e o papel da jurisdição constitucional. *In*: CLÉVE, Clémerson Merlin; SARLET, Ingo Wolfgang; Pagliarini, Alexandre Coutinho (Coord.ª). **Direitos humanos e democracia**. Rio de Janeiro: Forense, 2007.
- [14] MAZZUOLI, Valério de Oliveira. **Curso de direitos humanos**. 4. ed. rev., atual. e ampl. Rio de Janeiro: Forense; São Paulo: Método, 2017.
- [15] MELLO, Thiago de. Estado liberal. s.d. Disponível em: <<http://educacao.globo.com/sociologia/assunto/organizacao-social/estado-liberal.html>>. Acesso em: 6 jun. 2019.
- [16] MORAIS, José Luís Bolzan de. **As crises do estado e da constituição e a transformação espaço temporal dos direitos humanos**. Porto Alegre: Livraria do Advogado Ed., 2011.
- [17] PAGLIARINI, Alexandre Coutinho. Manifesto em favor da democracia (e dos direitos humanos) no estado nacional, na comunidade internacional e na sociedade civil. *In*: CLÉVE, Clémerson Merlin; SARLET, Ingo Wolfgang; Pagliarini, Alexandre Coutinho (Coord.ª). **Direitos humanos e democracia**. Rio de Janeiro: Forense, 2007.
- [18] PIOVESAN, Flávio. **Temas de direitos humanos**. São Paulo: Max Limonad, 2003.
- [19] TEODORO, Maria Cecília Máximo. **O juiz ativo e os direitos trabalhistas**. São Paulo: LTr, 2011.

Municipal councils for sustainable development and their relationship with agroecology

Os conselhos municipais de desenvolvimento sustentável e sua relação com a agroecologia

Samuel Cronemberger Caffé¹, Lucia Marisy Souza Ribeiro de Oliveira², Marcia Bento Moreira³, Samuel Horácio de Oliveira⁴, Nilo Ramos Moreira de Souza⁵

¹Graduado em Administração pela Faculdade Ruy Barbosa. Licenciado em Sociologia Segunda Graduação Curso Prodocente – Faculdade Regional de Filosofia, Ciências e Letras de Candeias. MBA Executivo em Gerenciamento de Projetos Curso de Pós-Graduação pela Faculdade Ruy Barbosa Grupo Devry. Especialista em Educação, Contemporaneidade e Novas Tecnologias pela UNIVASF. Mestre em Extensão Rural pela UNIVASF. Integra o Instituto de Desenvolvimento Social e Agrário do Semiárido (IDESA). Doutorando pelo Programa de Pós-Graduação em Agroecologia e Desenvolvimento Territorial – PPGADT em Associação Ampla UNIVASF, UFRPE e UNEB. samuel.caffe@discente.univasf.edu.br.

²Dra. Desenvolvimento Socioambiental. Docente dos Mestrados Interdisciplinares de Extensão Rural e Ciências da Saúde e Biológicas e do Doutorado Profissional em Agroecologia e Desenvolvimento Territorial da UNIVASF. lucia.oliveira@univasf.edu.br.

³Dra. em Medicina Veterinária, Docente do Mestrado em Extensão Rural e Docente do Mestrado em Ciências da Saúde e Biológicas e Coordenadora do Doutorado Profissional em Agroecologia e Desenvolvimento Territorial da UNIVASF. marcia.moreira@univasf.edu.br.

⁴Graduado em Direito pela Universidade Católica de Pernambuco (UNICAP). Advogado ambientalista. Integra a comissão jurídica de agroecologia do Sindicato da Agricultura Familiar de Petrolina (SINTRAF). Especializado em Gestão Pública Municipal pela Universidade Federal do Vale do São Francisco (UNIVASF). Mestre em Extensão Rural na Universidade Federal do Vale do São Francisco (UNIVASF). Doutorando pelo Programa de Pós-Graduação em Agroecologia e Desenvolvimento Territorial – PPGADT em Associação Ampla UNIVASF, UFRPE e UNEB. samuelhoracio.adv@gmail.com. samuel.horacio@discente.univasf.edu.br.

⁵Graduação em Engenharia Agrônoma pela Universidade do Estado da Bahia (UNEB). Mestre em Extensão Rural pela UNIVASF. Especializado em Especialização em Gestão de Sistemas Agroindustriais pela UNIVASF. Especializado em Extensão Rural e Desenvolvimento Sustentável pela UNIVASF. Doutorando pelo Programa de Pós-Graduação em Agroecologia e Desenvolvimento Territorial – PPGADT em Associação Ampla UNIVASF, UFRPE e UNEB. nilo.agronomo@gmail.com.

Received: 11 Jun 2022,

Received in revised form: 09 Jul 2022,

Accepted: 14 July 2022,

Available online: 24 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *Municipal Councils. Agroecology. Sustainable development. Democracy. Publicpolicy.*

Abstract— *This article discusses the institutionalization of Municipal Sustainable Development Councils and their relationship with the emergence of agroecology in family farming, taking as a cut the approach to the theme in the State of Bahia and specifically in the municipality of Jaguarari. The sources of evidence for data collection were based on a bibliographic and documental review, as well as an approach by the qualitative method. For its elaboration, it was necessary to go through routes of consultations and detailed readings that endorsed that the mobilizations and popular social struggles in Brazil were the way to arrive at institutionalized councils as spaces for decisions taken before exclusively within the scope of the Public Power. Another aspect of the article that is intertwined with the achievements of participation of collegiate decisions in the municipalities and in the sphere of family agriculture is the recognition of agroecology as a relevant support for the structuring and organization of an alternative form of democratic society,*

Palavras-Chave— *Conselhos Municipais. Agroecologia. Desenvolvimento Sustentável. Democracia. Políticas Públicas.*

environmentally sustainable and responsible for the current and future generations.

Resumo— *Este artigo consiste em problematizar a institucionalização dos Conselhos Municipais de Desenvolvimento Sustentável e sua relação com a emergência da agroecologia na agricultura familiar, tendo como recorte a abordagem do tema no Estado da Bahia e, em específico, no município de Jaguarari. As fontes de evidências para coleta de dados tiveram como base uma revisão bibliográfica e documental, bem como uma abordagem pelo método qualitativo. Para sua elaboração foi preciso transitar por percursos de consultas e leituras circunstanciadas que avalizaram ter sido as mobilizações e as lutas sociais populares no Brasil o caminho de chegada aos conselhos institucionalizados enquanto espaços de decisões tomadas antes exclusivamente no âmbito do Poder Público. Outra vertente do artigo que se entrelaça com as conquistas de participação das decisões colegiadas nos municípios e na esfera da agricultura familiar é o reconhecimento da agroecologia como um suporte relevante para a estruturação e organização de uma forma alternativa de sociedade democrática, ambientalmente sustentável e responsável pelas gerações atuais e futuras.*

I. INTRODUÇÃO

Inicia-se o artigo apresentando fatos históricos que revelam a origem dos conselhos com participação popular no mundo a partir do século XVIII e no Brasil contemporâneo, para situar o leitor sobre os registros históricos relevantes sobre o tema. Os conselhos assumiram configurações variadas em muitos países do mundo, mas guardaram semelhanças como instrumentos de descentralização e de participação em conflitos de interesse nas políticas econômicas ou mesmo no domínio político, envolvendo representantes de organizações da sociedade civil e do estado.

A pesquisa em tela concentra sua reflexão de caráter teórico e histórico sobre o aparecimento dos conselhos municipais no cenário brasileiro contemporâneo como fruto das lutas populares pela democratização da gestão pública, havendo ampla consideração que a Constituição de 1988 contribuiu positivamente para a participação direta dos cidadãos na tomada de decisões públicas.

Com referência ao papel dos CMDS no país, surgidos a partir dos anos 1990, tem-se a destacar, entre outros aspectos, a contribuição estratégico Programa Nacional de Fortalecimento da Agricultura Familiar (PRONAF) na modelagem institucional e na estrutura de funcionamento deles, que, a partir daí, se tornaram um instrumento básico de gestão dos recursos transferidos aos municípios pelo governo federal e estadual.

Outra frente de abordagem e reflexão deste artigo está situada na relação dos conselhos municipais com a

agroecologia, cujo destaque se baseia em 4 (quatro) eixos integradores, a saber: 1) Princípio da vida; 2) Princípio da diversidade; 3) Princípio da complexidade e 4) Princípio da transformação. Esses princípios se relacionam conceitualmente com papel dos Conselhos Municipais de Desenvolvimento Sustentável (CMDS), porque eles criam espaços públicos para o exercício do planejamento participativo, monitoramento das ações, controle e gestão compartilhados com ênfase no fortalecimento da agricultura familiar e na transição agroecológica, tendo seu objetivo principal pautado na construção, priorização, adequação e aprimoramento das políticas públicas.

Igualmente, reconhece-se a relevância da educação popular em seu papel integrador com a gestão participativa e os conselhos municipais, sendo estes instrumentos de efetivação da democracia direta, da participação popular na gestão pública de resultados sociais na conquista da cidadania plena. Do mesmo modo, identifica e incorpora a necessidade de mudança de paradigma na gestão pública municipal, em razão, sobretudo, da emergência da Agenda 2030 da ONU, depositando nos conselhos municipais um papel a desempenhar com responsabilidade social e ambiental.

Nessa lógica, reconhece-se no trânsito dos levantamentos bibliográficos e documentais, segundo o que teoriza Frey (2001, p.2), que a trilogia para o alcance do desenvolvimento municipal sustentável, considerando seus elementos constitutivos são a saber: os conselhos municipais, o desenvolvimento sustentável e os processos agroecológicos que se apresentam como um desafio político e de exercício de poder, que põe em pauta a questão das

instituições político-administrativas, da participação e do processo político.

BREVE HISTÓRICO DO SURGIMENTO DOS CONSELHOS POPULARES NO MUNDO

Durante a revisão bibliográfica, realizada sobre o surgimento dos conselhos com participação popular, identificou-se que eles tiveram sua origem perpassando por diferentes conjunturas no mundo, com especial destaque no levantamento da realidade histórica de países da Europa, a partir do aparecimento de movimentos de revolta violenta, como estruturação da organização revolucionária que conjugava dentro desses espaços aparatos de poder e sistema alternativo de repressão.

Segundo Vieira (2017), pode-se citar épocas emblemáticas de estruturação de organizações de lutas populares entre os séculos XVIII e XX, tais como: a primeira fase da Revolução Francesa (1789), os Conselhos da Comuna de Paris (1871); a Revolução Russa de 1917 e os soviét. de Petrogrado (1905), de ação ampla, que se colocavam como organização alternativa de poder: “todo poder aos soviète”.

Outro fato do passado que revela também a origem de conselhos na Europa é a formação de instâncias coletivas de poder nos lugares de trabalho, que se organizavam em assembleias operárias em sistemas de representação por meio de delegados de seção de fábrica, superando a exigência de filiação sindical e expressando um poder efetivo dos operários enquanto produtores com ação econômica e política. Dessa corrente surgiram os chamados “Conselhos Populares”. A Europa torna-se um manancial dos movimentos operários com a evolução das forças produtivas do capitalismo.

Assim, na Itália, já no século XX, os conselhos constituíram-se em 1906, a partir de comissões de fábrica de caráter espontâneo e reivindicatório de direitos, transformados, em 1919, em Conselhos de Fábrica, como instrumento de defesa dos interesses operários e como semente de um novo tipo de Estado. Em 1920, na greve geral em Turim, houve a derrocada pelo isolamento em relação ao resto do País e a falta de articulação com outras organizações, inclusive do Partido Comunista Italiano (PSI).

Em referência à Espanha, surgiram formas embrionárias de comissões no final do século XIX; e durante a Guerra Civil (1936/1939) elas se aliaram ao anarco-sindicalismo até serem reprimidas e dizimadas pela ditadura Franquista. As Comisiones Obreras da Catalunha (CCOO) ressurgem em 1955, com sede em Barcelona, como movimento espontâneo de trabalhadores espanhóis.

Fora da ordem capitalista europeia, surge o sistema de conselhos operários durante o regime comunista na União Soviética na Alemanha Oriental, em Berlim (1953), na Hungria e na Polônia (1956) sob a forma de levante de operários dissidentes ao regime soviético. Na Iugoslávia (1950), os conselhos de autogestão surgiram dos comitês de libertação que faziam a mediação entre a fábrica, o governo e outras unidades sociais; os quais funcionavam com maior poder no Conselho Popular da Comuna.

Assim, os meios de produção deixavam de ser formalmente propriedade do Estado, passando a ser propriedade social. Na Polônia, os “Conselhos de Fábrica” surgem nas greves de 1956, evoluindo em 1980 para o sindicato “Solidariedade”, importante e contraditório para as mudanças políticas que o país sofreu. Já em 1981, por meio de uma violenta intervenção dos militares, a democracia, que começava a surgir na Polônia, foi achatada.

Bonato (2001, p.35) argumenta que observando sobre outra ótica, pode-se constatar, também, que “os Conselhos surgiram nos países de capitalismo avançado como arranjos neocorporativistas voltados para negociar demandas de trabalhadores e outros grupos de interesse e reduzir conflitos distributivos, e ainda como grupos de pressão em demandas ligadas ao consumo e uso de bens coletivos”.

Dando sequência aos acontecimentos dos meados do século XX, no Brasil, com o fim da ditadura do Estado Novo de Vargas, começam a ganhar relevo as agitações populares por meio dos movimentos de camponeses, de trabalhadores urbanos da indústria, negros, feministas. A fermentação popular perde seu ímpeto com a instalação do regime militar, em 1964, e a partir daí o exercício da violência, repressão e a censura são promovidos pelo estado sobre os movimentos sociais e a sociedade brasileira como um todo.

Emerge desse contexto de crise econômica e política as lutas do ABCD paulista no final dos anos de 1970. Esta experiência revela ao país, segundo Nascimento; Barreto (2010, p.15), a “emergência de novas sociabilidades constituídas fora da ordem estatal, instituídas por subjetividades sufocadas que, autorizadas pela própria consciência de si e do mundo e apoiadas na força de seus semelhantes, lançaram-se na cena pública reivindicando o direito de ter direitos”. Na década de 1970, a sociedade brasileira passa a se organizar na luta por seus direitos políticos e de organização civil e pela descentralização do poder, culminando em 1984 com o movimento “Diretas Já!”, extraordinário marco da participação popular brasileira.

Em 1988 é promulgada uma nova Constituição Brasileira, que assegura, como princípio orientador que

"todo poder emana do povo, e que o exerce por meio de representantes eleitos ou diretamente, nos termos da Constituição" (art. 1º, Parágrafo Único). Em contexto local, registra-se como exemplo a Lei Orgânica do Município de Jaguarari-BA¹ que também promoveu expressivos avanços, sobretudo no que diz respeito à descentralização, fortalecimento do poder legislativo e ampliação da participação popular.

Do exposto, a participação popular no Brasil, enquanto país periférico do capitalismo internacional, segue um caminho de conquistas precedidas por muitas lutas, sacrifícios e retrocessos democráticos.

SURGIMENTO DOS CONSELHOS POPULARES NO BRASIL CONTEMPORÂNEO

A concepção da idealização dos conselhos com participação popular no Brasil surgiu mais fortemente antes da promulgação da Constituição Federal de 1988, e se concretizou enquanto fruto da efervescência de constantes discussões e mobilizações sociais populares para reivindicar a institucionalização da participação da sociedade civil organizada nos espaços de decisões tomadas antes exclusivamente no âmbito do Poder Público. Esse cenário certamente influenciou o processo constituinte que aprofundou a questão colocada pelos movimentos sociais ao final da década de 1970 e início dos anos 1980 sobre a democratização do Estado e os mecanismos necessários para torná-lo público.

A esse respeito, Moroni (2005), na condição de membro do Colegiado de Gestão do Instituto Nacional de Estudos Socioeconômicos (INESC), em seu artigo: *Participamos, e daí?* publicado pelo Observatório da Cidadania, em dezembro de 2005, identifica cinco dimensões trazidas pelo movimento popular para a assembleia constituinte:

O movimento traz para o processo constituinte, além da democratização e publicização do Estado, a necessidade de controle social, em cinco dimensões: formulação, deliberação, monitoramento, avaliação, financiamento das

políticas públicas. (MORONI, 2005, p. 1).

É relevante observar, que "o aparecimento dos conselhos municipais no cenário político brasileiro é uma novidade em relação às formas tradicionais de gestão das políticas públicas. Esses conselhos se institucionalizaram na década de 1990, mas são resultados de lutas populares pela democratização da gestão pública". (TÓTORA; CHAIA, 2002, p.60).

Totoras e Chia (2002) ainda afirmam que:

No Brasil, o debate sobre conselhos e federalismo ganhou importância nos anos 1990 como resultado da Constituição de 1988, que inovou ao adotar mecanismos de participação direta dos cidadãos nas tomadas de decisões públicas. Os conselhos constituem um novo espaço de participação política. Porém, cabe uma problematização sobre o avanço e/ou limites dessas experiências na sua efetivação. (TÓTORA; CHIA, 2002, p. 60).

Recuperar a história e o debate teórico sobre federalismo e conselhos nos permite avaliar a experiência brasileira dos anos 1990. Considerando a larga tradição autoritária brasileira, não se pode desprezar uma cultura política baseada numa concepção de cidadãos apáticos e passivos ante o monopólio das ações políticas concentradas em elites minoritárias. (TÓTORA; CHIA, 2002, p. 60).

Diante desse fato registrado pela história política recente no País, Abramovay e Veiga (1999) constatam que a abundância de conselhos gestores² podem ser entendida como a mais vultuosarenovação institucional para a

¹Art. 9º - Além das diversas formas de participação popular previstos nesta Lei orgânica, fica assegurada a existência de Conselhos populares, cuja composição, competência, organização, objetivos e funcionamento serão definidos em Lei, por este legislativo. (Lei Orgânica do Município de Jaguarari-BA, em 02/12/2009. D.O.M. em 09/02/2010, grifo nosso.)

²De fato, existem mais conselheiros no Brasil do que vereadores e, em alguns casos, como o do orçamento participativo, a participação em alguns anos alcançou a marca de quase 180 mil pessoas. (AVRITZER, 2007, p. 433).

construção e implementação de políticas públicas no Brasil democrático, porque encerram em si um enorme potencial de transformação sociopolítica, propiciando a entrada de temas políticos na vida de indivíduos ou grupos organizados que até então se encontravam às margens desta discussão.

Verificam ainda esses autores citados que os conselhos gestores ocupam papel fundamental no processo de municipalização, representando a descentralização do papel do estado, inclusive possuindo importância essencial no processo de transformação da realidade rural brasileira, visto que são instâncias deliberativas, consultivas e fiscalizadoras mais próximas da população local.

CONSELHOS MUNICIPAIS DE DESENVOLVIMENTO SUSTENTÁVEL NA HISTÓRIA RECENTE DO BRASIL

Os Conselhos Municipais de Desenvolvimento Sustentável (CMDS) foram criados para serem fóruns de discussões e decisões deliberadas coletivamente, visando promover o desenvolvimento sustentável do município, sobretudo com destaque aos rumos do setor rural, em decorrência das amplas reivindicações dos movimentos sociais pertencentes a cadeia produtiva da agricultura familiar e a importância do setor agrícola no país.

Para Azevedo e Pessôa (2011), a condição relevante de participação popular continua sendo de que ela seja efetiva e legítima e que, para tanto, envolva os múltiplos segmentos sociais e movimentos de comunidades rurais e urbanas por meio de suas associações, cooperativas, sindicatos, constituindo esse espaço colegiado imperativo para validar o exercício dos mecanismos de democracia direta considerando a sociedade civil organizada e o poder público. Mesmo validado o motivo da importância do setor agrícola/rural para a economia do Brasil, fica evidente que ao longo da história a agricultura familiar, em particular, sempre foi muito carente de atenção das políticas públicas que abrangessem a realidade desse segmento.

Argumentos variados são utilizados a esse respeito, inclusive àqueles que indicam que

[...] a novidade da ruralidade brasileira consiste no reconhecimento social e político do chamado “setor de subsistência”, formado por milhares de pequenos agricultores que teriam sua origem histórica como remanescentes do regime colonial e do escravismo, não tendo sido eliminados nem

mesmo pela industrialização e modernização conservadora da agricultura, que, na década de 1990, foram contemplados com a universalização dos direitos previdenciários. (SCHNEIDER, S. 2003, p. 13).

Entretanto, a importância aos novos rumos do setor rural no âmbito dos municípios na contemporaneidade se deu pela influenciada criação expressiva dos chamados CMDS, surgidos a partir dos anos 1990, como condição para que os municípios no país pudessem receber recursos do Programa Nacional de Fortalecimento da Agricultura Familiar (PRONAF), principalmente na linha de Infraestrutura. É consensual, por consequência, na literatura especializada, que o PRONAF se acomodou em uma virada significativa nas políticas públicas voltadas ao meio rural no Brasil.

Não obstante a importância do PRONAF enquanto instrumento de política pública para o meio rural, segundo Abramovay (2001) os conselhos foram constituídos estritamente como contrapartida à exigência legal para a obtenção de recursos públicos federais por parte dos municípios e não expressam uma dinâmica local significativa.

Como destacado anteriormente, os conselhos municipais a partir de então assumiram e assumem um papel fundamental para a agricultura familiar do Brasil. Entretanto, esse segmento, historicamente negligenciado pelos órgãos governamentais, possui uma importância socioeconômica muito maior do que comparativamente a outros segmentos frequentemente privilegiados pelos governos que se sucederam no País.

CONSELHOS MUNICIPAIS DE DESENVOLVIMENTO SUSTENTÁVEL (CMDS): EXPERIÊNCIAS E VIVÊNCIAS NO MEIO RURAL DA BAHIA

No estado da Bahia, o que confirma esse contexto emergente é que os CMDS possuem a sua estruturação central apoiada na implantação do PRONAF, programa de amplo espectro de apoio à agricultura familiar e igualmente uma fundamental estratégia de cunho nacional, criado em 1995, que possibilitou o estabelecimento de alicerces para a formulação de políticas públicas de desenvolvimento rural, como também para que essas políticas estimulassem uma dinâmica de participação de representantes de diferentes segmentos sociais dos municípios. Assim, as consequências desse arranjo institucional local conduziram à formulação de programas e projetos direcionados às diversas cadeias

produtivas regionais e locais integrantes do Plano Municipal de Desenvolvimento Sustentável (PMDS), objeto de planejamento participativo, que preza pela multiplicidade dos diversos pontos de vista dos integrantes do conselho.

Na verdade, o que se verifica da imersão na pesquisa bibliográfica é que os conselhos, na maioria dos municípios da Bahia³, funcionam fortemente com atribuições específicas de um Conselho Municipal de Desenvolvimento Rural (CMDR), isto é, se constituiu em um órgão de caráter permanente, consultivo, deliberativo e de aconselhamento, com a finalidade de estabelecer diretrizes e prioridades para as políticas de desenvolvimento das atividades agropecuárias do município, visando proporcionar meios para assegurar ao produtor e trabalhador rural condições de trabalho, renda, mercado, rentabilidade econômica nos empreendimentos e sustentação da qualidade de vida para a família rural que labutam com as atividades agrícolas e pastoris.

Na concepção de Neves (2008), a problematização sobre a importância e o papel da agricultura familiar no desenvolvimento brasileiro ganhou atenção ao passar do tempo, impulsionado, especialmente, pela compreensão de desenvolvimento permanente, geração de emprego e renda, segurança alimentar e desenvolvimento local.

A marco afirmativo dos fatos pesquisados é que o governo da Bahia, de pronto, vislumbrou a relevância do protagonismo dos CMDS, e entendeu que eles se constituem em espaços coletivos de participação e representação social para o planejamento, monitoramento e gestão de políticas públicas dirigidos ao desenvolvimento sustentável dos mais de 400 municípios do Estado.

Deste modo, já em 2003, o poder executivo estadual promoveu, de forma articulada com suas diversas instâncias administrativas, o lançamento de uma cartilha⁴ com o objetivo de orientar gestores públicos e representantes de organizações, entidades e movimentos sociais sobre o processo de implantação e/ou reestruturação dos CMDS e correlatos, além de apresentar as orientações para se buscar a homologação desses mesmos conselhos junto ao Conselho Estadual de Desenvolvimento Rural Sustentável (CEDRS), para que sejam reconhecidos, valorizados e fortalecidos.

De conseguinte, no início do ano de 2020, com o crescimento das desigualdades econômicas e sociais nos

municípios da Bahia, agravadas com as crises econômica global e de saúde pública, essa última provocada pela pandemia da COVID-19, a Secretaria de Desenvolvimento Rural (SDR) da Bahia, por meio do Conselho Estadual de Desenvolvimento Rural Sustentável (CEDRS), atualizou a cartilha lançada inicialmente em 2013, porém mantendo o objetivo original de orientar gestores públicos e representantes de organizações, entidades e movimentos sociais sobre o processo de instauração ou regularização dos CMDS. Esta atualização ocorreu em articulação com outras instâncias do governo estadual para o aperfeiçoamento da governança das políticas públicas do desenvolvimento sustentável e solidário, iniciado em 2011⁵.

Paralelo a isso, o executivo estadual promove um curso de formação de quadros para operarem os conselhos municipais, denominado “Formação CMDS 2021: Governança, Território e Educomunicação”, que consistiu em um processo pedagógico envolvendo educação, comunicação, interação, tecnologias, compartilhamento de conhecimento e produção em forma de autorias coletivas, com o objetivo central de fortalecer os CMDS na totalidade dos 417 municípios do estado da Bahia. Esta formação foi ofertada como uma ação do Plano Estadual de Governança da Estratégia ‘Parceria Mais Forte’, com financiamento do Projeto Bahia Produtiva, que mantém acordo de empréstimo firmado entre o Estado e o Banco Interamericano de Reconstrução e Desenvolvimento (Banco Mundial), com vistas ao empoderamento das instâncias de governança municipais, com atenção central aos CMDS.

É importante observar que o referido recurso permitiu o desenvolvimento de quadros de conselheiros gestores dos CMDS e conselheiros não gestores, denominados pelo DFOC⁶, das localidades âncoras da Rede Educom nos conselhos municipais. Deste modo, cada CMDS inscreveu 6 membros, sendo 3 gestores e 3 âncoras. Esses membros (gestores e âncoras) foram escolhidos autonomamente por cada CMDS, que definiram coletivamente os melhores perfis representativos indicados como âncora da Rede Educom em seus respectivos municípios. Ao final do curso, os participantes que obtiveram aproveitamento igual ou superior a 75% tiveram direito ao certificado. Todo material didático ofertado no curso, dividido por módulo, foi disponibilizado na Plataforma Moodle. A formação Educomunicativa também introduziu novas pautas: Território de Identidade, Diferença, Redes, Subjetividade, Etnia, Gênero,

³ De acordo com o IBGE, 2021, o estado da Bahia possui 320 municípios com população abaixo de 30 mil habitantes, representando em torno de 77% do total de 417 municípios.

⁵ Em 2 de julho de 2011 foi publicada a Resolução CEDRS 07/2011 e em 04 fevereiro de 2021, a Resolução CEDRS

052/2021, que retomou o processo de apoiar a dinamização dos CMDS.

⁶ Departamento de Formação de Órgãos Colegiados (FOC) da Cia de Desenvolvimento e Ação Regional (CAR) do governo da Bahia.

Multiculturalismo (CARTILHA DEFOC EDUCOM, 2018).

No entanto, há que se fazer ressalvas com relação ao alcance e o caráter das posturas decorrentes da massificação da capacitação de conselheiros, promovida pelo governo estadual, na totalidade dos municípios baianos, como alerta Abramovay (2001):

A alocação de recursos governamentais por parte de representações que extrapolam o círculo da política profissional não tem por si só o condão de alterar o cotidiano de qualquer organização ou localidade: os conselheiros podem ser mal informados, pouco representativos, indicados pelos que controlam a vida social da organização ou localidade em questão, mal preparados para o exercício de

Tabela1: Confronto Tradição Conservadora versus Educomunicação

Elementos da modelagem	Tradição conservadora (Elitismo)	Educomunicação (Redes)
Centro	Programa de controle centralizado. Púlpitos: <ul style="list-style-type: none"> Político (palanque, mesa diretora, gabinete) Padre, pastor (altar) Professor (sala de aula) 	Programas descentralizados <ul style="list-style-type: none"> Roda de conversa Grupos em rede Autorias coletivas
Emissão - recepção	Grande mídia. Um emissor, vários receptores. <ul style="list-style-type: none"> Rádios (locutor) Tv (apresentador) Jornais (repórter) 	Todo receptor é também um emissor potencial <ul style="list-style-type: none"> Radio comunitária Sítio online (blogue, fanpage) Roda de conversa
Mobilização	Massas como objeto de política <ul style="list-style-type: none"> Marchas Colunas Desfiles 	Indivíduos livres, com autonomia para criar e recriar e para contestar a realidade
Especialidade	Produção de agentes especializados <ul style="list-style-type: none"> Especialista da ciência Especialista das artes Especialista da cultura 	Autorias coletivas <ul style="list-style-type: none"> Agenciamento dos saberes Interação dos participantes Produção de ecossistemas
Gestão	Gerenciamento <ul style="list-style-type: none"> Proprietário Burocrata "Pau mandado" 	Auto-organização <ul style="list-style-type: none"> Direção colegiada Produção coletiva Revezamentos

Fonte: Cartilha DEFOC - EDUCOM, 2018.

CONSELHO MUNICIPAL DE DESENVOLVIMENTO SUSTENTÁVEL DO MUNICÍPIO DE JAGUARARI-BA: REPRESENTAÇÃO E PARTICIPAÇÃO

O município de Jaguarari-BA foi desmembrado do município de Senhor do Bonfim-BA, conquistando sua emancipação política por meio da Lei Estadual 1.905, de 06 de agosto de 1926. Ele está inserido no Território de

suas funções ou, o que parece tão frequente, uma mistura de cada um destes elementos. Mas o simples fato de existirem conselhos abre o caminho para que se amplie o círculo social em que se operam as discussões sobre o uso dos recursos públicos. (ABRAMOVAY, 2001, p. 121, grifo nosso).

Por outro lado, de acordo com Freitas (2011) e considerando as práticas da Rede Educom, pode-se aprofundar que a formação de conselheiros, nesse caso, se mostra de suma relevância para ampliar funcionamento pragmático do CMDS, isso porque os conselheiros quando inseridos nos conselhos municipais de desenvolvimento passam a ser um agente social informado e capacitado. É importante destacar que a formação Educomde conselheiros confronta práticas elitistas versus personalistas, conforme sistematização exposta na Tabela, a seguir:

Identidade Piemonte Norte do Itapicuru, na macrorregião do Semiárido Baiano. Compreende áreas sob influência predominante de clima Árido e Semiárido, com precipitações médias anuais variando de 400 a 650 mm e 500 a 800 mm, respectivamente. Em termos demográficos, apresenta uma população total estimada em 33.915 habitantes e uma densidade de 12,35 hab./km², em 2021.

Jaguarari-BA possui uma economia de base agropecuária, predominado a agricultura familiar de alimentos básicos e pastoril de rebanhos caprinos, ovinos e bovinos. Também tem em seu território um enclave minero-industrial de cobre, conduzido pela empresa Caraíbas Metais no distrito de Pilar, além de apresentar um agregado de serviços e comércio varejista de alcance local.

Na esfera da economia agrícola familiar, o Território Piemonte Norte de Itapicuru possui comunidades de fundo e fecho de pasto, cuja maioria das famílias agropastoris encontra-se localizada no município de Jaguarari-BA, além daquelas residentes nos municípios vizinhos de Andorinha e Campo Formoso. Essas comunidades rurais enfrentam dificuldades para agilizar os processos de reconhecimento de seus territórios, objetivando-se o título formal das terras que ocupam, já que, na maior parte dos casos, se constituem em terras devolutas do estado⁷. Apresentam formas de vida singulares, destacando a relação da socio-biodiversidade e as alternativas para viver de forma mais sustentável, orientada pela subjetividade, cultura e saberes tradicionais que contribuem para a manutenção da biodiversidade dos ecossistemas locais.

Pelo menos duas forças antagonicas se apresentam para conjurarem contra a economia ancestral de fundo e fecho de pasto, em particular, e contra à agricultura familiar extrativista de frutos nativos da caatinga, a exemplo do umbu, maracujá do mato, licuri entre outros, conduzidas nas posses comunitárias. São elas: 1) a grilagem, que sempre se afigura violenta sobre a vida e o patrimônio da comunidade rural; 2) a exploração mineral do subsolo, onde há presença sobretudo do cobre e outros minerais não metálicos (granitos e assemelhados). Por hora essas duas frentes de conflito estão passivamente contidas pela imposição das

lutas cotidianas das associações pastoris existentes⁸ e do apoio de seus aliados, seja no âmbito da igreja, seja dos sindicatos e eventualmente no poder local em face do seu alinhamento político e econômico do momento.

Apesar das comunidades de determinados distritos e povoados que conformam o município de Jaguarari-BA trazer em histórias com tempero de sangue⁹ e lutas¹⁰ cotidianas de manutenção da posse de terras, a instalação dos conselhos municipais, e a consequente participação das organizações comunitárias, teve sua gênese por meio das iniciativas exógenas decorrentes da implantação da estrutura e modelagem das políticas públicas do governo federal e estadual, com rebatimento no município, que atraíram os produtores e trabalhadores locais para participarem da dinâmica dos colegiados municipais. Constituindo-se, portanto, em um processo que se originou de fatores externos, que impuseram uma obrigação político-institucional, em vez de uma pura conquista da comunidade organizada, como daqueles momentos históricos de luta e resistência experimentados pelas comunidades locais.

Nesse contexto específico do município de Jaguarari-BA, a atuação do PRONAF, como visto anteriormente no domínio do Estado como um todo, foi fundamental para consagrar o processo de participação das comunidades organizadas do município no CMDS, e para sua consolidação e aperfeiçoamento na sua condição de instância colegiada ativa até os dias atuais.

Assim, em 2013 criou-se o Conselho Municipal de Desenvolvimento Sustentável (CMDS) do município de Jaguarari-BA, que foi estabelecido com base na lei municipal nº 849/2013, de 23 de setembro de 2013. De acordo com essa lei, integram o CMDS de Jaguarari-BA¹¹ os representantes de entidades da sociedade civil organizada que defendem, assessorem, estudem e/ou promovam ações voltadas para o apoio e desenvolvimento sustentável, cidadania e promoção de direitos; os representantes de organizações e movimentos da agricultura familiar; os representantes de órgão do poder público municipal e representantes de organizações para-governamentais, conforme composição determinada pela referida lei.

⁷São áreas remanescentes de sesmarias não colonizadas e transferidas ao domínio do Estado. Também são definidas como terras públicas sem destinação pelo poder público e que em nenhum momento integraram o patrimônio de um particular. (Art. 64 da Constituição Federal de 24/02/1891).

⁸A Comissão Pastoral da Terra (CPT) levantou um total de 23 associações em 2015, que congregam 509 famílias. Deste total de associações, oito são gerenciadas pela Central das Associações de Fundo e Fecho de Pasto de Senhor do Bonfim (CAFFP).

⁹Em 1988, foi assassinado um líder comunitário do povoado Jabuticaba. Esta ocorrência foi precedida da morte de um advogado de camponeses, em razão dele ter defendido pequenos

agricultores na grilagem ocorrida no povoado de Santa Rosa de Lima, em Jaguarari-BA. (SILVA, 2017. p. 118).

¹⁰Em 1986, ocorreu um levante da população do povoado de Flamengo contra a instalação de fornos, por parte de grileiro, voltados para produção de carvão, na fazenda Flamengo. (SILVA, 2017. p. 120).

¹¹Em 2022, integram o CMDS de Jaguarari-BA: representante da Secretaria da Agricultura do Município de Jaguarari-BA, da Associação da Comunidade de Alagadiço (que atualmente preside), do Instituto de Desenvolvimento Agrário do Semiárido (IDESA), do Centro Técnico de Educação Profissional (CETEP) e da Associação dos povoados Traíra, Lajedo e Volta (LEVANTAMENTO DO AUTOR, MAIO DE 2022).

A lei municipal que instituiu o CMDS de Jaguarari-BA assegura ampla participação de representante da agricultura familiar em face das suas características primordialmente rurais, além facultar a indicação dos representantes às próprias entidades que congregam as variadas ocupações/povos originários dentro da agricultura familiar do município, havendo, portanto, uma correlação de forças favorável a formação de consenso para o segmento da agricultura familiar. Os parágrafos 1º e 2º do artigo 5 da lei que instituiu o CMDS garantem isso:

§1º Em virtude da predominância de características rurais do município e da representatividade da Agricultura Familiar, será garantido ampla participação de membros representantes dos agricultores (as) familiares, trabalhadores (as) assalariados(as) rurais, agroextrativistas, pescadores, indígenas, assentados de reforma agrária e outras populações e comunidades, associações, sindicatos e demais entidades representativas.

(PREFEITURA MUNICIPAL DE JAGUARARI-BA, 2013).

§2º Todos os/as Conselheiros/as Titulares e Suplentes devem ser indicados formalmente, em documento escrito, pelas instituições/entidades que representam. (PREFEITURA MUNICIPAL DE JAGUARARI-BA, 2013).

É importante ressaltar que os processos de participação na esfera do CMDS de Jaguarari-BA se pautam, geralmente, sem incidência velada de elementos que comprometam o processo democrático do colegiado, notadamente os casos de cooptação e práticas clientelista por parte do poder local. Os resultados da pesquisa assinalaram, contudo, problemas no quesito participação de conselheiros em assembleias gerais ordinárias por eventual falta de quórum, sendo nesse caso necessária uma nova

convocação do conselho municipal. Nos seus quase 10 anos de funcionamento, o CMDS de Jaguarari-BA evidenciou que possui potencial de funcionamento alinhado a sua finalidade.

De acordo com a Resolução do Conselho Estadual de Desenvolvimento Rural Sustentável (CEDRS/Ba) nº 052/2021, todos os CMDS deverão enviar à Secretaria Executiva do CEDRS¹² do respectivo Território de Identidade ao qual pertence, até 31 de março de 2021, a documentação completa referente ao processo de instauração ou regularização (CARTILHA CMDS: CONSELHOS MUNICIPAIS DE DESENVOLVIMENTO SUSTENTÁVEL, 2021).

O CMDS de Jaguarari-BA por meio do Decreto nº 30/2021, de 03 de fevereiro de 2021, já havia nessa data nomeado todos os seus membros efetivos, demonstrando agilidade e interesse em seu pleno funcionamento. A partir daí foi celebrada uma parceria com a SDR, por meio do projeto “Parceria Mais Forte”, que visava a integração das ações do Governo do Estado com prefeituras municipais, consórcios públicos intermunicipais e demais parceiros do poder público e de organizações que representam ou atuam no segmento da agricultura familiar.

EDUCAÇÃO POPULAR E CONSELHOS MUNICIPAIS: DIÁLOGOS E POSSIBILIDADES

As incongruências e autoritarismos da democracia representativa encontraram na instituição dos conselhos municipais um instrumento de efetivação da cidadania plena, dotando tais órgãos de mecanismos para efetivação de uma gestão pública participativa. Importante registrar que as bases ideológicas para efetivação desse sistema na Constituição de 1988 (BRASIL, 1988) foram as diversas lutas sindicais, movimentos sociais e a formação crítica de enfrentamento ao modelo de educação formal e dominante nas décadas de 1960 e 1970.

Por tal sentido, de forma analógica, cita-se a perspectiva de Cruz et al (2012) que abordando os conselhos municipais de saúde, insere no debate o enfoque problematizador, transformador e democrático da educação popular como espaço para intensificar o campo democrático nos conselhos municipais: “Devido à sua tradição no trabalho pedagógico problematizador, a Educação Popular emerge, portanto, como espaço cultural e formativo capaz de intensificar o potencial humanizador e democrático dos conselhos de saúde”. (CRUZ et al, 2012, p. 1090).

¹²Vinculada a Secretaria de Desenvolvimento Rural (SDR), através do Serviços Territoriais de Apoio à Agricultura Familiar (SETAF).

Nesse sentido, resta claro as conexões, diálogos e possibilidades entre a educação popular e a atuação dos conselhos municipais como instrumentos de efetivação da democracia direta, da participação popular na gestão pública de resultados sociais na conquista da cidadania plena.

CONSELHOS MUNICIPAIS E PERCURSO DOS OBJETIVOS DE DESENVOLVIMENTO SUSTENTÁVEL

Numa perspectiva da sustentabilidade social, ecológica e econômica não se concebe uma gestão pública municipal participativa sem um olhar para as pautas e dilemas do mundo globalizado. Nesse contexto, os impactos ecológicos não poderão ser abordados de forma particularizadas, cartesianas e setorializadas. Por essa lógica, necessário se faz uma consciência planetária integrando ações globais sustentáveis com as atividades administrativas locais.

Posta assim a questão, sabe-se que “a ONU lançou em 2015 a agenda 2030 que traça 169 metas incluídas em 17 objetivos, os Objetivos de Desenvolvimento Sustentável (ODS), que visam melhorar as relações entre os sujeitos e desses com o Mundo. Apesar de os países membros da ONU atuarem em um conjunto de ações comuns, cada país vem utilizando, ao seu modo, estratégias diversas para tentar atingir essas metas e, tudo leva a crer, que a educação será o caminho mais eficaz na promoção dos ODS entre as pessoas” (RAMINELI; ARAUJO, 2019, p.2).

De forma esclarecedora, Nações Unidas Brasil (2022) estabelece o sentido global e a finalidade desses objetivos para um mundo melhor, a partir de ações locais:

Os Objetivos de Desenvolvimento Sustentável são um apelo global à ação para acabar com a pobreza, proteger o meio ambiente e o clima e garantir que as pessoas, em todos os lugares, possam desfrutar de paz e de prosperidade. Estes são os objetivos para os quais as Nações Unidas estão contribuindo a fim de que possamos atingir a Agenda 2030 no Brasil. (NAÇÕES UNIDAS BRASIL, 2022).

Nessa lógica, evidencia-se uma mudança de paradigma na gestão pública municipal com a citada agenda 2030, tendo os conselhos municipais um papel fundamental

com essa responsabilidade social e ambiental. O instrumento para consecução desses objetivos é a articulação entre educação popular na visão freireana e as ações do conselho integrando cidadania e a gestão pública participativa. Nesse percurso, os conselhos municipais são o elo entre a democracia representativa e a democracia direta.

CONSELHOS MUNICIPAIS DE DESENVOLVIMENTO SUSTENTÁVEL E OS PRINCÍPIOS INTEGRADORES EM AGROECOLOGIA

O sistema da agroecológica conforma a produção de alimentos ecologicamente sustentável, economicamente viável e socialmente justo, capaz de integrar o homem ao meio ambiente (COSTA,2006). Grande parte dos agricultores familiares desenvolveram ao longo do tempo conhecimento na compreensão ecológica e cultural no manejo dos sistemas alimentares, pois quando eles os manejam tem um componente cultural implícito nas tecnologias “tradicional”.

Sendo a Agroecologia um referencial teórico, que serve como orientação geral para as experiências de agricultura, o caráter local é que dará a feição concreta daqueles princípios. Sem a consideração das condições locais, o conceito de Agroecologia cai no vazio. É a realidade socioeconômica e ecológica local que define a melhor forma de aplicação da teoria, exigindo ajustes finos a cada situação. (EMBRAPA, 2006, p.3).

A formação de massa crítica dos quadros profissionais para trabalharem com os paradigmas agroecológicos é decisivo para sua sustentação. A esse respeito, a Embrapa assim se manifesta:

Para que o modelo agroecológico se consolide, é premente a revisão dos paradigmas dos cursos ligados às ciências da terra, tanto os relacionados ao ensino médio como ao ensino superior. Se continuarmos formando profissionais com a lógica do modelo convencional e agroquímico teremos mais

dificuldades para formar massa crítica para impulsionar esse processo.(EMBRAPA, 2006, p.27).

Fazendo-se referência ao importante debate coletivo sobre educação em agroecologia de âmbito nacional, promovido de maneira inédita pelo I Seminário Nacional de Educação em Agroecologia (I SNEA), em Pernambuco, em 2013, o seu conteúdo se constituiu numa extraordinária síntese dos trabalhos aí desenvolvidos, cujos

esforços foram consolidados pelo grupo de coordenação do evento, que procurou manter a coerência com a “matéria prima” das distintas contribuições dos participantes.

Em decorrência disso, a seguir são apresentados os resultados a partir de princípios em 4 (quatro) eixos integradores, com o objetivo de aprofundar a reflexão sobre o tema: 1) Princípio da Vida, 2) Princípio da Diversidade, 3) Princípio da Complexidade e 4) Princípio da Transformação.



Esses princípios integradores em agroecologia estabelecem convergência conceitual com o papel dos conselhos municipais, porque eles são espaços de planejamento participativo, monitoramento das atividades, controle e gestão de políticas públicas com destaque ao fortalecimento da agricultura familiar sustentável, tendo seu objetivo principal pautado na construção, priorização, adequação e aprimoramento dessas políticas. Na realidade, são espaços coletivos voltados para o desenvolvimento sustentável e solidário a partir das demandas estabelecidas nos municípios/territórios. “Para dar conta desse importante papel, esses espaços colegiados visam, antes de tudo, buscar a qualificação de sua estrutura e funcionamento, estabelecendo condições objetivas de atuar como instrumento consultivo/deliberativo.” (CARTILHA CMDS: CONSELHOS MUNICIPAIS DESENVOLVIMENTO SUSTENTÁVEL – BAHIA, 2021, p.1).

A seguir, é apresentado o primeiro princípio do conjunto dos 4 (quatro) eixos integradores em agroecologia, sacado dos debates do I SNEA:

1) Princípio da Vida

Inicia-se com Princípio da Vida, que diz que é na natureza onde se reproduzem e se realizam todas as formas de vida, inclusive a dos seres humanos. “Esta, portanto, deve ser respeitada integralmente na sua existência e na manutenção e regeneração de seus ciclos vitais, estruturas, funções e processos evolutivos.”(I SEMINÁRIO NACIONAL DE EDUCAÇÃO EM AGROECOLOGIA. 2013. p.7).

Igualmente, devem-se aprender com as lições da natureza, a partir da observação das interrelações da diversidade dos seres vivos nos diversos ecossistemas, para superar a visão antropocêntrica em direção a uma consciência planetária. Assim, a formação do ser humano se exige integral, na qual a racionalidade, espiritualidade, ética e dimensões artísticas são um todo que criam valores que orientam processos de transformação da realidade. “O acesso aos bens da natureza como terra, água, floresta, sementes, alimentos, trabalho e cultura garantem aprendizagens fundamentais, que possibilitam a

sustentabilidade". (I SEMINÁRIO NACIONAL DE EDUCAÇÃO EM AGROECOLOGIA, 2013, p.7).

Este princípio tem sua orientação assentada em 6 (seis) processos listados no quadro a seguir, que podem aprovisionar as ações dos conselhos municipais de

Fonte: I SEMINÁRIO NACIONAL DE EDUCAÇÃO EM AGROECOLOGIA, 2013, p.7-8.

Eixos integradores	Processos educativos em agroecologia
<p>1) Princípio da Vida</p>	<ol style="list-style-type: none"> 1. Cuidado e afetividade com a vida, considerando a sua otimização e valorização. 2. Sustentabilidade nas dimensões ecológica, econômica, social, cultural, política e ética. 3. Processos endógenos, locais e comunitários. 4. Valorização e garantia à livre reprodução das sementes e raças locais de animais, reconhecendo-os como patrimônio da humanidade. 5. Aplicação da Ecologia na produção e no manejo dos agroecossistemas. 6. Economia ecológica e solidária.

Além desse primeiro princípio abordado, é oportuno constatar ainda a existência de mais três princípios integradores da agroecologia com potencial de instrumentalizar as funções dos CMDS, como demonstrado a seguir:

2) Princípio da Diversidade

Este princípio se contrapõe às concepções totalizadoras, homogêneas, padronizadoras, universais e excludentes presentes na educação. A diversidade deve ser reconhecida nos diferentes ecossistemas, agroecossistemas e paisagens, na riqueza de bens naturais, nas distintas práticas sociais, saberes (locais e acadêmicos), valores,

desenvolvimento sustentável no que se refere aos temas como sustentabilidade, processos de governança local, valorização dos costumes e tradições locais no uso de sementes e raças crioulas, manejo de agrossistemas economia solidária.

cultura e formas de organização social e produtiva, que determinam a relação dos seres humanos com a natureza.

O território onde se inserem os processos educativos é visto como o espaço da diversidade e da construção do conhecimento por excelência. "É também no território diverso onde se estabelecem as relações entre o campo e a cidade, que merecem ser vistas como potencializadoras de processos endógenos e de complementaridade." (I SEMINÁRIO NACIONAL DE EDUCAÇÃO EM AGROECOLOGIA, 2013, p.8).

Este princípio indica que os processos educativos em agroecologia devem estar orientados por 4 (quatro) processos a seguir numerados no quadro abaixo:

Fonte: I SEMINÁRIO NACIONAL DE EDUCAÇÃO EM AGROECOLOGIA, 2013, p. 9.

Eixos integradores	Processos educativos em agroecologia
<p>2) Princípio da Diversidade</p>	<ol style="list-style-type: none"> 1. Reconhecimento do território onde estão inseridos, considerando toda a sua complexidade e diversidade ecossistêmica e social e como espaço em disputa e conflito entre os diferentes setores socioeconômicos. 2. Valores e conhecimentos dos povos e comunidades tradicionais como fonte de ensinamentos ecológicos e culturais essenciais para a conservação da biodiversidade e a construção da sustentabilidade. 3. Reconhecimento e valorização dos povos e comunidades tradicionais do campo e da cidade, especialmente o/a agricultor/a familiar e camponês/a (quilombolas, pescadores artesanais, ribeirinhos, extrativistas, moradores de fundo de pastos, faxinalenses, marisqueiras, quebradeiras, indígenas e outros) e os diferentes movimentos e organizações sociais, considerando as questões de gênero, diversidade sexual, étnica e geracional e reafirmando o território como espaço de identidades e de culturas. 4. Reconhecimento das especificidades das mulheres trabalhadoras, suas formas de interpretar e atuar sobre a realidade e suas formas de organização.

3) Princípio da Complexidade

"A realidade é complexa e requer um pensamento também complexo." Desenvolver um pensamento complexo implica fugir da simplificação, da fragmentação, da compartimentação, da hiperespecialização, do dualismo, da certeza e do reducionismo, colocando em prática a religação dos saberes, numa perspectiva transdisciplinar. Implica também reconhecer a multidimensionalidade das coisas, suas relações, associações e interações. Assim, os processos educativos e de construção do conhecimento agroecológico devem primar pelo pluralismo metodológico e epistemológico. E estes processos podem adquirir maior pertinência se consubstanciados em ações e atitudes multidisciplinares, interdisciplinares e transdisciplinares, mas fundamentalmente no diálogo dos diversos saberes e áreas do conhecimento, considerando os seus contextos sócio-históricos (I SEMINÁRIO NACIONAL DE EDUCAÇÃO EM AGROECOLOGIA, 2013, p.9).

Morin (2003), no seu livro *A Cabeça Bem Feita*, afirma que:

HÁ INADEQUAÇÃO cada vez mais ampla, profunda e grave entre os saberes separados, fragmentados, compartimentados entre disciplinas, e, por outro lado, realidades ou problemas cada vez mais polidisciplinares, transversais, multidimensionais, transnacionais, globais, planetários. (MORIN, 2003, p.11).

Ainda com relação ao princípio da Complexidade, cuja característica basilar está colada na educação e na cultura popular, Morin (2003) assevera que os processos educativos em agroecologia devem ser orientados por uma gama de 11 processos indicados no quadro abaixo:

Fonte: I SEMINÁRIO NACIONAL DE EDUCAÇÃO EM AGROECOLOGIA, 2013, p.11.

Eixos integradores	Processos educativos em agroecologia
<p>3) Princípio da Complexidade</p>	<ol style="list-style-type: none"> 1. Desenvolvimento de análises da realidade a partir de uma abordagem sistêmica e holística. 2. Valorização, sistematização e socialização participativa de processos e práticas agroecológicas, valorizando os conhecimentos, as culturas populares e as suas formas de expressão. 3. Indissociabilidade entre extensão-ensino pesquisa. 4. Relevância das pessoas, da comunidade e das relações sociais na construção do conhecimento agroecológico. 5. Conhecimentos e práticas dos/as agricultores/as como questão central no currículo. 6. Leitura crítica da realidade e adoção de instrumentos metodológicos participativos. 7. Construção participativa dos Projetos Políticos Pedagógicos, considerando as especificidades locais, com a participação da comunidade e dos movimentos sociais. 8. Formação inicial e continuada em Agroecologia para educadores/as e técnicos/as administrativos/as. 9. Perspectivas alternativas de organização tempo-espço, a exemplo da Pedagogia da Alternância. 10. Reflexão e promoção de processos de inovação participativos envolvendo estudantes e agricultores/as, que respeitem a racionalidade da produção camponesa. 11. Formação numa perspectiva de rede de aprendizagem, conectando diferentes sujeitos e instituições.

4) Princípio da Transformação

A educação deve ser adotada como uma ferramenta de conscientização e libertação das estruturas ideológicas de dominação que sustentam a sociedade hegemônica, para formar profissionais críticos e criativos, com capacidades

para compreender e atuar com autonomia para a promoção da vida e da sustentabilidade do planeta. Este princípio recomenda que os processos educativos em agroecologia devem ser orientados por 10 processos listados no quadro abaixo:

Fonte: I SEMINÁRIO NACIONAL DE EDUCAÇÃO EM AGROECOLOGIA, 2013, p. 13.

Eixos integradores	Processos educativos em agroecologia
<p>4) Princípio da Transformação</p>	<ol style="list-style-type: none"> 1. Promoção de práticas emancipatórias, visando à autonomia e o protagonismo dos sujeitos na construção de relações sociais justas e solidárias e da consciência planetária. 2. Preparação de profissionais para atuar segundo os princípios da Economia solidária popular e ecológica, baseada na cooperação, na reciprocidade e nos valores das culturas locais. 3. Prática pedagógica comprometida com a transformação social, visando formar profissionais que coloquem os seus conhecimentos a serviço das classes populares e da conservação da natureza. 4. Processos de aprendizagem coletivos que promovam a auto-organização, a autogestão e o empoderamento dos sujeitos, visando o bem comum no campo e nas cidades; 5. Processos educativos voltados para a compreensão, o fortalecimento e o empoderamento das coletividades que atuam na transformação da realidade agrária e agrícola do país. 6. Promoção da soberania e segurança alimentar e nutricional e saúde integral, interligando produção e consumo de produtos ecológicos. 7. Atuação crítica sobre todas as formas de dominação e desigualdades sociais, particularmente sobre aquelas de gênero, raça, etnia, diversidade sexual e geração. 8. Relações de ensino aprendizagem horizontais entre educandos/as-educadores/as, rompendo com a perspectiva bancária e alienadora de educação. 9. A escola como o lócus para reflexão e ação transformadora sobre os problemas sociais e ecológicos geradores da insustentabilidade do planeta. 10. Formação referenciada na realidade, tomando a vivência das comunidades como conteúdos problematizadores para o processo de ensino aprendizagem.

Face o exposto, é possível compreender que o processo de transição agroecológica é sistêmico, holístico, interdisciplinar e multidimensional, além disso se apresenta como um enfoque científico que fornece princípios, diretrizes conceituais e metodológicas para a orientação de processos voltados à refundação da agricultura na natureza, aproximando os agrosistemas dos ecossistemas naturais. Por ser uma perspectiva científica aberta ao diálogo de saberes, a agroecologia vai ao encontro da capacidade mental criativa de agricultores familiares com o intuito de fortalecer suas habilidades de inovação nos processos de gestão da base de recursos de que dispõem para o processo produtivo.

Assim, constituem-se de ações voltadas para a promoção da sustentabilidade do ente município, dentro de uma perspectiva mais ampla, como a questão do desenvolvimento rural sustentável que se lançam luzes

sobre a necessidade de reflexões acerca de estratégias mais amplas que possam contribuir no processo de transição para modelos produtivos sustentáveis, sem deixar de reconhecer a relevância dos princípios da agroecologia para que tal processo, de fato, venha a se consolidar.

De forma sintética, o processo de transição agroecológica pode ser feito interna e externamente ao sistema. Internamente, quando agricultores familiares e suas organizações agropastoris buscam acessar as políticas públicas de ATER com foco em: (a) reduzir e racionalizar o uso de insumos químicos, (b) substituir insumos químicos, (c) manejar adequadamente a biodiversidade e redesenhar os sistemas produtivos de maneira sustentável. Externamente ao sistema produtivo, quando: (i) expande a consciência pública, (ii) organiza os mercados e infraestruturas, (iii) provoca mudanças institucionais (pesquisa, ensino, extensão) e (iv) ajuda na formulação de

políticas públicas integradas e sistêmicas sob controle social, geradas a partir de organizações sociais conscientes e propositivas.

Assim, mantendo um paralelo entre agroecologia e agricultura familiar conjetura-se simplificada-mente as seguintes similaridades entre ambas: preocupação com a preservação ambiental, utilização consciente dos recursos naturais, preservação dos costumes e de práticas agrícolas de baixo impacto e preservação do solo: consórcio de culturas, sucessão de culturas, utilização de cobertura morta, adubação orgânica, controle alternativo de pragas e doenças etc. Esse tipo de manejo agricultura familiar sustentável, contribui para que o meio ambiente fique em equilíbrio em relação ao ecossistema e à saúde do ser humano.

TRILOGIA PARA O ALCANCE DO DESENVOLVIMENTO MUNICIPAL SUSTENTÁVEL: CONSELHO MUNICIPAL, DESENVOLVIMENTO LOCAL E AGROECOLOGIA

Os ingredientes para alcançar o desenvolvimento municipal sustentável é real, porém requer um contexto de muita luta dos atores envolvidos com ela. Com esse propósito, deve-se buscar implementar propostas e estratégias sob o ponto de vista micro ou local, considerando a máxima de “pensar global, agir local.”

Com relação especificamente ao desenvolvimento rural sustentável, entende-se que ele deva ser implementado em base local, porque é nessa instância que se pode contrapor à capacidade de influência do capital ou do poder instituído através de alguma espécie de controle social legitimamente instituído, (p. ex. a participação efetiva nos conselhos municipais e em reuniões abertas ao público é crucial para o alcance desse objetivo).

Por sua vez, os conselhos municipais já estão consagrados como instâncias que operam as políticas públicas das esferas diferentes governamentais com a participação das representações da sociedade civil. “Mas é praticamente unânime o reconhecimento do potencial de transformação política que os conselhos encerram”. [...] “o simples fato de existirem conselhos abre o caminho para que se amplie o círculo social em que se operam as discussões sobre o uso dos recursos públicos”. (ABROMOVAY, 2001, p. 121).

Outro fator de grande potencial em favor do desenvolvimento rural sustentável é a agroecologia¹³, em

razão dela proporcionar uma produção agrícola que não expõe o meio natural aos danos provocado pela agricultura convencional, além de resgatar os *modos de vida* e sobretudo os conhecimentos das comunidades que trabalham e vivem basicamente da agricultura e atividades extrativas vegetais e pastoris, agregando as propostas agroecológicas ao desenvolvimento da agricultura familiar. A readequação tecnológica para a transição agroecologia ocorre através da introdução de práticas que requerem basicamente a reorientação do trabalho dos agricultores familiares, portanto de baixa capacidade de investimento.

[...] A agroecologia não se limita ao enfoque técnico que dá base para o desenho de sistemas sustentáveis de produção orgânica de alimentos, ele procura evidenciar a agroecologia como uma ciência de caráter plurimetodológico e que se abre epistemologicamente, ressaltando as suas potencialidades para a elaboração de programas de desenvolvimento rural sustentável. (MOREIRA et. al. 2007, p. 513).

[...] A pesquisa agroecológica, juntamente com o ensino e a extensão rural agroecológica, devem articular as diversas forças sociais dos setores público e privado para consolidar a urgência de se aumentar o espaço da agroecologia na construção do desenvolvimento rural sustentável. (MOREIRA et. al. 2007, p. 513).

As atuações da pesquisa, ensino e ATER de cunho agroecológico unidos aos agricultores familiares se expressam por meio da construção do conhecimento agroecológico, conservação e o uso sustentável da biodiversidade, protagonismo das mulheres, abastecimento alimentar e construção social de mercados, soberania e segurança alimentar, reforma agrária e direitos territoriais

tendo como princípio a conservação e a ampliação da biodiversidade dos sistemas agrícolas como base para produzir autorregularão e, conseqüentemente, sustentabilidade. (Desenvolvimento rural sustentável no Brasil, ASSIS. 2006, p.77).

¹³A agroecologia é uma ciência surgida na década de 1970, como forma de estabelecer uma base teórica para esses diferentes movimentos de agricultura não convencional. É uma ciência que busca o entendimento do funcionamento de agroecossistemas complexos, bem como das diferentes interações presentes nestes,

de povos e comunidades tradicionais, acesso e gestão das águas, questão dos agrotóxicos e dos transgênicos, normas sanitárias para produtos da agricultura familiar, crédito para financiamento da agricultura familiar (PRONAF), entre outros. (ANA, 2018).

Isto posto, o desafio do desenvolvimento sustentável é, inicialmente, um problema político e de exercício de poder, que coloca em pauta a questão das instituições político-administrativas, da participação e do processo político (FREY, 2001, p. 02).

II. METODOLOGIA UTILIZADA NA PESQUISA

A presente pesquisa em seus objetivos se classifica como descritiva e realizada pelo método qualitativo. Quanto às técnicas utilizados para realização da pesquisa, a coleta qualitativa de dados se deu por pesquisa bibliográfica e documental.

Cabe preterir que a pesquisa bibliográfica e documental, segundo Marconi; Lakatos (1992), é o alicerce do trabalho em questão, como descrito anteriormente: levantamento da bibliografia já publicada sobre o objeto de estudo, em forma de livros, revistas, publicações avulsas e imprensa escrita em situações específicas. O intuito desta metodologia é trazer luz ao pesquisador, a pesquisadora, e que adquiram conhecimentos sobre os materiais já publicados sobre um determinado assunto, bem como pode ser considerada como o primeiro passo de toda a pesquisa científica.

Neste sentido, foram revisadas algumas literaturas referentes ao objeto de estudo dos pesquisadores autores (analisar a efetividade do funcionamento de conselhos municipais de desenvolvimento sustentável), e dentre as literaturas utilizou-se de livros, artigos publicados na internet, leis e atos normativos publicados em site e diário oficial, dissertações, teses e cartilhas, possibilitando que esse trabalho constituísse esse escopo.

III. RESULTADOS ALCANÇADOS

Por assim constatar, de acordo com a revisão bibliográfica e documental realizada para preparação desse artigo, a partir da análise da legislação estadual da Bahia, cartilhas do CEDRS¹⁴ e atas do Conselho Municipal de Desenvolvimento de Jaguarari-BA, além da legislação municipal, os conselhos se apresentam de formas variadas em muitos países no decorrer do contexto histórico,

constituindo-se em instrumentos de descentralização e de participação em conflitos de interesse nas políticas econômicas ou mesmo no domínio político, envolvendo representantes de sindicatos, associações de trabalhadores, governo e diversas outras organizações da sociedade civil.

Ademais, ainda vale ressaltar que os conselhos surgiram sempre em momentos de crise institucional e revolucionária, a partir de insuficiência de legitimidade das organizações dos trabalhadores e de crise do Estado. Estes assumiram tanto o papel de organismo de luta pelo poder e de organização econômica, quanto de mecanismo de gestão, substituindo o aparato administrativo anterior e construindo novas relações de poder.

Dito isto, constata-se na pesquisa um liame ideológico e integrador entre gestão pública participativa, educação popular e conselhos municipais no Brasil, por ser uma obra dessas lutas sociais, completando-se em seus caminhos epistemológicos, pela mesma base democrática e popular, eis que o modelo de educação popular foi forjado nessas lutas sociais, como contraponto de resistência e numa pauta contra hegemônica ao governo militar implantado em meados no século passado.

Nesse quadro, a pesquisa revela a devida relação entre Conselho Municipal, Desenvolvimento Sustentável e Agroecologia, considerando que os conselhos municipais são espaços de planejamento participativo, monitoramento das atividades, controle e gestão de políticas públicas com finalidade de fomentar o desenvolvimento sustentável local, destacando-se que as experiências agroecológicas e seus princípios norteadores elencados no I SNEA dialogam com os objetivos da agenda 2030 da ONU e as bases democráticas dos conselhos municipais.

No que concerne ao CEDRS e seu calibre deliberativo, verificou-se as atribuições mais específicas relacionadas com o setor rural que estão sob a sua responsabilidade, a exemplo das atividades de planejar e monitorar a aplicação dos recursos do PRONAF, estabelecendo negociações com os agentes financeiros para equacionar a oferta em relação à demanda local e acompanhando a emissão de Declaração de Aptidão ao PRONAF (DAP), realizada pelos órgãos autorizados pelo Ministério da Agricultura, Pecuária e Abastecimento (MAPA), ex-MDA.

Além dessas atribuições, os CEDRS também têm a competência de:

estabelecem as condições para a homologação destas instâncias colegiadas.

¹⁴Cartilha elaborada com base nas resoluções CEDRS 07/2011, de 02 de junho de 2011 e CRDRE 13/2013, de 14 de março de 2013, os quais dispõem sobre a criação e ou unificação dos conselhos e

- 1) analisar e aprovar a lista de beneficiários do Programa Garantia Safra, contribuindo para o seu efetivo funcionamento;
- 2) elaborar e exercer a gestão do Plano Municipal de Assistência Técnica e Extensão Rural (PLATER-M), em consonância com o Colegiado Territorial e o Plano Territorial de Assistência Técnica e Extensão Rural (PLATER);
- 3) divulgar, articular, acompanhar e apresentar demandas junto aos Programas e Projetos operacionalizados pela Companhia de Desenvolvimento e Ação Regional (CAR), empresa pública vinculada a SDR;
- 4) exercer o controle social de outras políticas executadas por instituições governamentais cujos interesses sejam mútuos e que antes sejam submetidas à aprovação, observando o papel e a capacidade do CMDS e/ou instituições partícipes, tais como: PAA, PNAE, Selo da Agricultura Familiar, distribuição de sementes, mudas e animais, dentre outros.

De outra parte, no plano municipal, os achados da pesquisa evidenciaram que o CMDS de Jaguarari-BA se constitui em um espaço colegiado em funcionamento nesse município que cumpre seu papel de mediador entre os agricultores familiares e as entidades de apoio ao segmento da agricultura familiar, constatando-se que as principais pautas tratadas pelo referido conselho, em resumo, foram as seguintes: PRONAF, PROMER, Garantia Safra, Acesso de Cisternas de Consumo Humano/Produção e DAP, entre outros assuntos de interesse mais imediatos dos agricultores locais.

Dessa forma, o CMDS de Jaguarari-BA se apresentou apto a deliberar e conseqüentemente homologar as demandas de aplicação dos recursos do Crédito Rural no âmbito do PRONAF, realizar o acompanhamento da emissão de Declaração de Aptidão (DAP) ao PRONAF, analisar e aprovar a lista de beneficiários do Programa Garantia Safra, contribuindo para o seu efetivo funcionamento, elaborar e exercer a gestão do Plano Municipal de Assistência Técnica e Extensão Rural (PLATER-M), em consonância com o Colegiado Territorial do Piemonte Norte do Itapicuru, e o Plano Territorial de Assistência Técnica e Extensão Rural (PLATER).

Além dessas atividades relacionadas anteriormente, o CMDS de Jaguarari-BA tomou para si as tarefas de divulgar, articular, acompanhar e apresentar demandas junto aos programas e projetos do estado. Portanto, foi ampliado o espaço social em que se operam os debates sobre o uso dos recursos públicos que são transferidos ao município por meio de políticas, programas e projetos governamentais para a agricultura familiar sustentável. Como exemplo, tem-se o Projeto de Mecanização Rural do Estado da Bahia (PROMER), que garante a limpeza e a requalificação de aguadas, além de outras políticas públicas e de atividades de apoio produtivo que são submetidas à aprovação do colegiado do CMDS, mas sempre observando o seu papel institucional e a sua capacidade operacional.

Nesse contexto tem-se: o Programa de Aquisição de Alimentos (PAA)¹⁵, o Programa Nacional de Alimentos Escolar (PNAE)¹⁶, o Selo Nacional da Agricultura Familiar (SENAF)¹⁷, a ação de distribuição de sementes crioulas (conservação da biodiversidade e a garantia de alimentação com potencial nutricional natural e saudável), mudas e animais (diversidade genética de mudas e raças tradicionais adaptadas a caatinga), dentre outras políticas públicas e de atividades de apoio ao desenvolvimento rural sustentável.

Outra importante ação identificada na pesquisa documental, foi participação dos membros do CMDS de Jaguarari-BA no curso denominado: Formação CMDS 2021: Governança, Território e Educomunicação, que teve a finalidade de atualizar e reforçar a formação dos agricultores familiares que compõem o quadro do referido colegiado, dando-lhes ênfase de protagonistas na comunidade.

Entretanto, não foi verificada a temática agroecologia na agenda do CMDS de Jaguarari-BA de forma dirigida e explícita em processos educativos populares que valorizem os princípios norteadores elencados no I SNEA, a cultura campesina e o campo como lugar de vida e de trabalho, pois, na prática, a agricultura de base agroecológica é vivida cotidianamente pelos agricultores familiares, mas sem convergência objetiva e consciente com as ações do CMDS.

Complementando essa observação, Pinheiro (2004) afirma que:

A construção deste projeto de vida se configura em uma reivindicação de uma vida na

¹⁵O Programa de Aquisição de Alimentos (PAA) possui duas finalidades básicas: promover o acesso à alimentação e incentivar a agricultura familiar. (BRASIL, 2003).

¹⁶O Programa Nacional de Alimentação Escolar (PNAE) oferece alimentação escolar e ações de educação alimentar e

nutricional a estudantes de todas as etapas da educação. (BRASIL, 2020).

¹⁷O Selo Nacional da Agricultura Familiar (SENAF) identifica a origem e fornece as características dos produtos da agricultura familiar. (BRASIL, 2019).

qual é possível relacionar a racionalidade econômica as subjetividades dos anseios individuais dos atores. A agroecologia contém os elementos necessários a esta construção, que pode ser entendida como uma confrontação ao processo de constante racionalização econômica de diferentes esferas da vida social, que se expressa no meio rural pela tecnificação da agricultura. (PINHEIRO, 2004, P. 108).

IV. CONSIDERAÇÕES FINAIS

Após as pesquisas, bibliográfica e documental, ficou evidente a relevância do Conselho Municipal de Desenvolvimento Sustentável e da prática agroecológica como instrumentos transformadores da realidade social. O primeiro, por se constituir em espaços de exercício da democracia participativa e deliberativa de políticas públicas em nível local ou municipal onde vive a população. O segundo, pelo seu caráter transformador e de enfrentamento ideológico contra o *establishment*. Porque, como se consagrou perceber nas pesquisas realizadas, a agroecologia impõe uma mudança da matriz produtiva moderna atual para uma matriz que privilegie alimentos limpos e proteção ambiental. A esse respeito, declara Pinheiro (2004):

A agroecologia é entendida como um ideal a ser conquistado, uma utopia que funciona mais como um referencial a ser alcançado do que algo que possa ser encontrado no presente. A importância deste projeto utópico é através deste referencial futuro orientar as práticas do presente, de forma que se torna possível à realização em diferentes graus deste ideal coletivo, através da construção de projetos de vida dos atores sociais que o compõe. (PINHEIRO, 2004, p. 108).

O presente artigo expressa também um estímulo necessário para se fazer uma imersão mais profunda nos acervos pesquisados a fim de identificar e compreender a

existência de confirmações empíricas do desenvolvimento rural e a convivência no semiárido nordestino de acordo com o preconizado nas teorias e na atuação, de fato, dos CDMS nessa macrorregião brasileira.

Com relação ao fenômeno da agroecologia, percebeu-se nas pesquisas realizadas para preparação desse artigo que ela é um processo lentamente em construção no território e na realidade dos agricultores familiares do município de Jaguarari-BA, porque ela impõe uma mudança de grande esforço multidimensional na matriz produtiva moderna atual para uma matriz que privilegie alimentos limpos, economia solidária e proteção ambiental, não constando efetivamente na agenda do CDMS local.

Por fim, evidencia-se que os Conselhos Municipais de Desenvolvimento Sustentável podem e devem construir uma ponte de ligação com a agroecologia, pois ambos são espectros diretamente ligados ao mesmo processo social e em cujo cerne encontra-se o(a) agricultor(a) familiar.

REFERÊNCIAS

- [1] ABA-Agroecologia. **I. Seminário Nacional de Educação em Agroecologia (SNEA)**. Recife, 2013. 15 p. Disponível em: <https://drive.google.com/file/d/1EEnZksofLR01N4ROSS7iWpg3nsvfVF26/view>. Acesso em: 13/05/2022.
- [2] ABRAMOVAY, R. **Conselhos além dos limites**. Estudos Avançados 15 (43), 2001.
- [3] ABRAMOVAY, R.; VEIGA, J. E. **Novas instituições para o desenvolvimento rural: o caso do Programa Nacional de Fortalecimento da Agricultura Familiar (PRONAF)**. Texto para discussão nº 641. Convênio FIPE/IPEA 07/97. Brasília, abril de 1999.
- [4] ANA. Articulação Nacional de Agroecologia. **O que é a Ana?** Rio de Janeiro, RJ, jul. 2018. Disponível em: <https://agroecologia.org.br/o-que-e-a-ana/>. Acesso em: 09/05/2022.
- [5] ASSIS, R. L. **Desenvolvimento rural sustentável no Brasil: perspectivas a partir da integração de ações públicas e privadas com base na agroecologia**. Economia aplicada. V.10, n. 1. Ribeirão Preto, 2006.
- [6] AVRITZER, L. **DADOS. Sociedade Civil, Instituições Participativas e Representação: Da Autorização à Legitimidade da Ação**. Revista de Ciências Sociais, Rio de Janeiro, Vol. 50, n.3, 2007, p. 443 a 464.
- [7] AZEVEDO, F. F.; PESSÔA, V. L. S. (2011). **O Programa Nacional de Fortalecimento da Agricultura Familiar no Brasil: uma análise sobre a situação regional e setorial dos recursos**. Soc. & Nat., 23(3), p. 483-496.
- [8] BAHIA. Secretaria de Desenvolvimento Rural. **Cartilha CDMS Bahia**. 2021. 5p.- Google Drive. Disponível em: <https://drive.google.com/file/d/1EEnZksofLR01N4ROSS7iWpg3nsvfVF26/view>. Acesso: 13/05/2022.
- [9] BRASIL. **Constituição da República Federativa**. 5 de outubro de 1988.

- [10] _____. EMPRAPA. **Marco Referencial em Agroecologia**. Grupo de Trabalho em Agroecologia. 2006. 31 p.
- [11] _____. Ministério da Agricultura, Pecuária e Abastecimento. **Selo Nacional da Agricultura Familiar (SENAF)**. 2019. Disponível em: Selo Nacional da Agricultura Familiar — Português (Brasil) (www.gov.br) Acesso em: 11/04/2022.
- [12] _____. Ministério da Cidadania. **Programa de Aquisição de Alimentos (PAA)**. 2003.
- [13] Disponível em: Programa de Aquisição de Alimentos (PAA) — Português (Brasil) (www.gov.br). Acesso em: 13/04/2022.
- [14] _____. Secretaria de Governo. **Programa Nacional de Alimentação Escolar (PNAE)**. 2020. Disponível em: PNAE – Programa Nacional de Alimentação Escolar — Português (Brasil) (www.gov.br). Acesso em: 13/04/2022.
- [15] BONATTO, G. Porto Alegre. **Participação dos Agricultores Familiares nos Conselhos Municipais de Desenvolvimento Rural na Encosta Superior do Nordeste do Rio Grande do Sul**. UFRGS/PGDR-ASCAR/EMATER-RS, 2001, 104 p. Disponível em: <https://www.https/www.participação dos Agricultores nos conselhos tese.pdf> - Google Drive. Acesso em: 10/05/2022.
- [16] CÂMARA MUNICIPAL DE JAGUARARI. **Diário Oficial do Município de Jaguarari, BA**, 02 fev. 2010, ano III, n. 030. Disponível em: <blob:https://www.tcm.ba.gov.br/965ec8b7-19a5-4907-be2f-d5c6a973df49>. Acesso em: 12/04/2022.
- [17] COSTA, G. **A alta modernidade e a revolução socioambiental: Indivíduo e coletividade na reprodução sociometabólica do desenvolvimento e da sustentabilidade na Amazônia**. Belém, tese de doutorado, NAEA/UFGA, 2009.
- [18] CRUZ, P. J. S. C. et al. **Desafios para a participação popular em saúde: reflexões a partir da educação popular na construção de conselho local de saúde em comunidades de João Pessoa, PB**. Saúde e sociedade, v. 21, p. 1087-1100, 2012.
- [19] FREITAS, A. F. **Desenvolvimento territorial e inovações institucionais no Território Serra do Brigadeiro**. 2011. 192 f. Dissertação (Mestrado em Extensão Rural). Universidade Federal de Viçosa, Viçosa, MG, Brasil, 2011.
- [20] FREY, K. **A dimensão político-democrática nas teorias de desenvolvimento sustentável e suas implicações para a gestão local**. Ambiente & Sociedade. Ano IV, n. 9, 2º sem. 2001.
- [21] IBGE, 2021. **Diário Oficial da União**. Publicado em 27/08/2021. ed. 163, seção 1ª p. 61. Disponível em: <https://www.in.gov.br/en/web/dou/-/portaria-341037671>. Acesso em: 20/05/2022.
- [22] MARCONI, M.A.; LAKATOS, E. M. **Metodologia do trabalho científico**. São Paulo: Editora Atlas, 4ª ed. 1992.
- [23] MARQUES, P.E.M.; FLEXOR, G. **Conselhos municipais e políticos públicas de desenvolvimento rural: Indagações em torno dos papéis sociais e ambientais da agricultura**, 2006.
- [24] MOREIRA, R. M.; CARMO, M. S. do. **A agroecologia na construção do desenvolvimento rural sustentável**. Resumos do II Congresso Brasileiro de Agroecologia, Rev. Bras. Agroecologia, v.2, n.1, fev. 2007.
- [25] MORIN, E. **1921-A cabeça bem-feita: repensar a reforma, reformar o pensamento / Edgar Morin; tradução Eloá Jacobina**. - 8a ed. -Rio de Janeiro: Bertrand Brasil, 2003,128p.
- [26] MORONI, J. A. **Participamos, e daí?**- artigo publicado pelo Observatório da Cidadania, membro do Colegiado de Gestão do Instituto Nacional de Estudos Socioeconômicos (INESC), dezembro de 2005.
- [27] NASCIMENTO, A. D.; BARRETO, R. UNEB. Revista da FAEBA. Educação e contemporaneidade. **Educação e Movimentos Sociais**. 2010, v.19, n. 34.jul./dez. 2010.
- [28] NEVES, D. P. (2008). **O Desenvolvimento de uma outra agricultura: o papel dos mediadores sociais**. In A. D. D. Ferreira & A. Brandenburg (Orgs.). Para pensar outra agricultura. 2 ed. Editora UFPR.
- [29] ONU. **Os Objetivos de Desenvolvimento Sustentável no Brasil**. Nações Unidas Brasil, [s.n.] 2022. Disponível em: <<https://brasil.un.org>>. Acesso em:19 maio 2022.
- [30] PREFEITURA MUNICIPAL DE JAGUARARI-BA. **LEI Nº 849/2013, de 23 de setembro de 2013,Dispõe sobre a instituição do Conselho Municipal de Desenvolvimento Sustentável (CMDS) e dá outras providências**. Diário Oficial do Município de 03 de outubro de 2013.
- [31] _____. **LEI Nº 0969/2017, de 06 de novembro de 2017,Institui o Fundo Municipal de Apoio a Agricultura Familiar – FUMAC e dá outras providências** . Diário Oficial do Município de 10 de novembro de 2017.
- [32] PINHEIRO, G S.R. **Agricultor Familiar e Projeto Agroecológico de Vida**. 2004, 134 f. Dissertação (Mestrado em Sociologia). Universidade Federal do Paraná. Curitiba, PR, Brasil, 2004. Disponível em:<https://www.acervodigital.ufpr.br/handle/1884/1400>. Acesso em: 12/06/2022.
- [33] RAMINELI, Jorge Luiz Ferreira; ARAUJO, Magnólia Fernandes Florêncio de. **Os Objetivos de Desenvolvimento Sustentável (ODS) sob o olhar da práxis Freiriana**. ENCONTRO NACIONAL DE PESQUISA EM EDUCAÇÃO EM CIÊNCIAS, v. 12, 2019.
- [34] ROSA, P. P. V.; FREIRE, J. M. **Agroecologia: Saber Científico e/ou Saber Popular**. Universidade de Brasília (UNB), 2010, 22 p.
- [35] SCHNEIDER, S. **A pluriatividade na agricultura familiar** [online]. 2nd ed. Porto Alegre: Editora da UFRGS, 2003. Estudos Rurais series, 252 p.
- [36] SILVA, A. O da. **Território Tradicional de Fundo de Pasto de Bruteiro e Traíra: Territorialidades Contemporâneas e as Lutas pela Reapropriação Social da Natureza**. 2017. 261 f. Dissertação (Mestrado em Educação, Cultura e Territórios Semiáridos). UNEB. Campus III. Juazeiro. Ba. 2017.
- [37] TÓTORA, S.; CHAIA, V. **Conselhos Municipais: descentralização, participação e limites institucionais**. Cadernos Metrôpole n. 8,p. 59-86, 2º sem. 2002.
- [38] VIEIRA, J. Q. **O Exercício da Cidadania Ativa e da Gestão Democrática Participativa de Políticas Públicas no Conselho de Educação do Município de Juazeiro do Norte-Ce**. Universidade de Santa Cruz – RGS. 2017, 192 p.

Descriptive analysis of COVID-19 cases and deaths among traffic professionals in a Brazilian Amazon metropolis, between 2020 and 2021

Vanessa de Almeida Batista¹, Marcelo Coelho Simões¹, Layse Gomes Furtado¹, Ana Lúcia da Silva Ferreira², Natalia Kiss Nogueira da Silva², Altem Nascimento Pontes¹, Silvia Cristina Santos da Silva¹, Elzianne Pires de Souza², André Carvalho Matias³, Cléa Nazaré Carneiro Bichara²

¹Department of Natural Sciences and Technology, State University of Pará, Brazil
Email: vanessa.batista@aluno.uepa.br

²Department of Biological and Health Sciences, State University of Pará, Brazil

³Nurse Specialist in Urgency and Emergency, Esamaz, Brazil

Received: 10 Jun 2022,

Received in revised form: 08 Jul 2022,

Accepted: 14 July 2022,

Available online: 24 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— COVID-19, Coronavirus Infections, Sars-CoV-2, Epidemiology, Transport.

Abstract— The transport service was considered essential during the new coronavirus pandemic, leaving professionals exposed to contagion by the Sars-Cov-2 virus. Cases and deaths from COVID-19 reported in the state of Pará, Brazil, among professionals in the transit and transport sector were analyzed. A descriptive observational epidemiological study was carried out with official data from the Pará state health department, available from March 2020 to May 2021. The case fatality rate was estimated and a map of the spatial distribution of COVID-19 was produced. There were 3 028 cases and 63 deaths, of which 95% were male. Most cases were reported in the municipalities of Parauapebas, Belém and Marabá, respectively. Transport services have not completely stopped, leaving professionals vulnerable due to daily contact with users, needing to prioritize preventive measures against COVID-19 in the group.

I. INTRODUCTION

The World Health Organization (WHO) on March 11, 2020 declared the new coronavirus a pandemic due to the rapid spread of the Sars-CoV-2 virus around the world [1]. The first case of COVID-19 in the country was reported on the 26th. of February 2020, and in the state of Pará on March 18 of the same year, from then until the month of May 2021, 543 807 were counted, and of these, 15 186 died. Given this scenario, the North region, which is already marked by the vulnerability of social groups, was the most affected in the country, coming to be considered

the epicenter of the disease in the country, representing a challenge for public health [1].

In several cities, with the rapid spread of the disease, one of the first control measures taken was the suspension of some activities related to traffic and transport. In Pará, the population's mobility through transport services was compromised, especially during the first months of the pandemic, this sector with its app drivers, taxi drivers, motorcycle taxi drivers, complementary alternative transport and especially public transport continued to work, being considered one of the essential activities, even with the reduction in the supply of services due to decrees

that determined the restriction of the movement of people, in order to avoid agglomerations [2]. However, the most populous municipalities in the state felt the effects of the pandemic even more, registering cases and deaths by COVID-19 among transit and transportation professionals [3].

In Brazil, many people rely on public transport to get around on a daily basis. In 2020, a mapping was carried out by researchers from the Federal University of Rio de Janeiro in order to know the risk of contamination of the different classes of Brazilian workers by the new coronavirus related to their professional activities. It was observed that in the country, professionals who work in "transport" are part of a category with an infection risk index greater than 60% [4]. They are vulnerable even when wearing protective masks, due to daily contact with several people in vehicles, crowded, and it is not possible to adequately comply with the social distance of at least one meter, recommended by the competent health bodies.

Knowing the distribution of COVID-19 among these professionals is of great relevance to science and society in general, to better face the pandemic. In addition to the occurrence of underreporting, for an adequate monitoring of diseases and actions aimed at their prevention and control, it is important to complete the data in the notification form, generating reliable data that contribute to the characterization of the epidemiological profile of the population, as well as the elaboration of public policies aimed at collective health [5]. Thus, it is necessary to quantify the professionals who had contact with the virus, thus, taking into account the issues and problems presented, the objective of this study was to analyze confirmed cases and deaths by COVID-19 among transit and transport workers in the state of Pará, Brazil.

II. METHOD

A descriptive observational epidemiological study was carried out with a quantitative approach. The population of interest in the study were traffic and transport professionals who work in the state of Pará. Secondary data were extracted from the database of the COVID-19 monitoring system of the Secretary of Health of the State of Pará (SESPA), in May 2021.

The COVID-19 case definition criteria followed the clinical, clinical-epidemiological, clinical-imaging, laboratory, laboratory criteria mm asymptomatic individual, as established by SESPA.

The notifications of cases and deaths followed the criteria (clinical, clinical-epidemiological, clinical-imaging or clinical-laboratory) established by the Ministry of

Health. For the present study, the notifications registered according to the date were used, which were from March 1, 2020 to May 18, 2021, throughout the State of Pará, and those who belonged to the professional category of traffic worker were selected. and transport. Data collection took place on only one occasion, which was on May 18, 2021.

The epidemiological profile was analyzed according to the following variables: sex, age group, main comorbidities and the municipality in which the case was reported. The fatality rate of COVID-19 was determined by dividing the number of deaths by the number of diagnosed cases among the population studied and then multiplied by one hundred so that the value was expressed as a percentage.

The Geographic Information Systems (GIS) QGIS 3.10 was used to georeference the number of confirmed cases and deaths by COVID-19 by municipalities, generating a thematic map. To classify the cases among the professionals studied, the Jenks algorithm was used, which consists of minimizing the sums of variance within each class through the natural breaks method, so that there is no duplication of data for each municipality [6].

Data were tabulated in the Microsoft Excel 2019 program and the relative and absolute frequencies of the variables studied were calculated. The Chi-square test with a significance level of 5%, performed in the BioEstat 5.3 software, was used to verify differences between the calculated frequencies.

Taking into account resolution nº 466/2012, all ethical aspects in research with human beings were respected in this study. Due to the fact that it is an analysis of secondary data, without identifying the individuals, there was no need for submission to the CEP/CONEP system.

III. RESULTS

Of the 543 807 cases reported in the population by SESPA, in the period from March 1, 2020 to May 18, 2021, 3028 were registered as traffic and transport professionals, which represents 0.5% of the total cases in the State. Among the 15 186 deaths reported in the State in the same period, 63 deaths were from traffic and transportation professionals, representing 0.4% of the total number of deaths in the State. Considering the same period, the fatality rate by COVID-19 of the general population of the State of Pará and the national one was 2.8%, while for the category of traffic and transport professionals it was 2.1%.

Considering the total number of cases reported as traffic and transport professionals, the municipality with the highest number of reported cases was Parauapebas

(n=1,321), followed by Belém (n=274) and Marabá – (n=241). The cities with the highest number of deaths in this same professional group were Belém (n=32), Paragominas (n=3) and Tailandia (n=3) (Fig. 1).

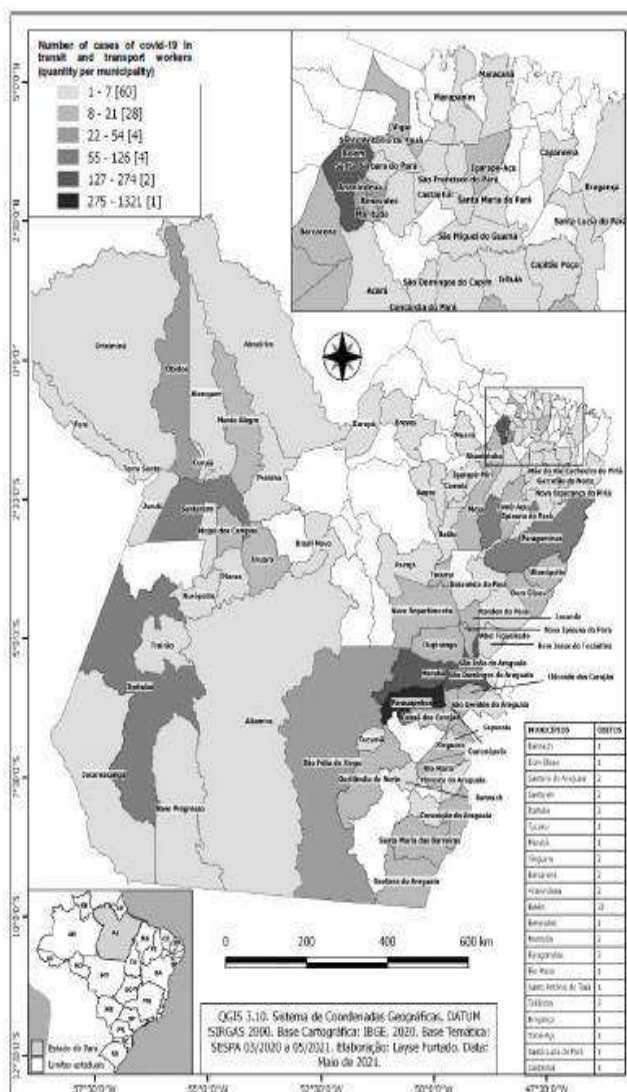


Fig. 1: Spatial distribution of cases and deaths by covid-19 classified as traffic and transport professionals in the state of Pará, notified between March 1, 2020 and May 18.

The study population is mostly male, representing 95% (n=2 875) of the cases.

The most affected age group was 30-39 years old, constituting 94.7% (n=1 041) in males and 5.3% (n=58) in females (Fig. 2).

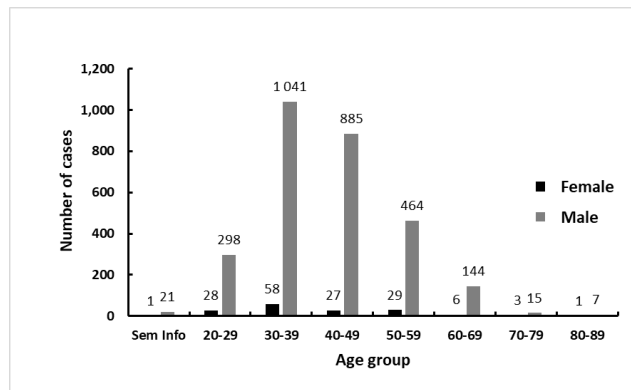


Fig. 2: Confirmed cases of COVID-19 among traffic and transport professionals according to sex and age group in the state of Pará, reported between March 1, 2020 and May 18, 2021.

Of the total number of deaths, 90.5% (n=57) occurred in males. Deaths were more frequent in the age group of 50-69 years (n=38) among men representing 60.30% of deaths, and in the age group of 70-79 years (n=3), among women with 4, 8% (Fig. 3).

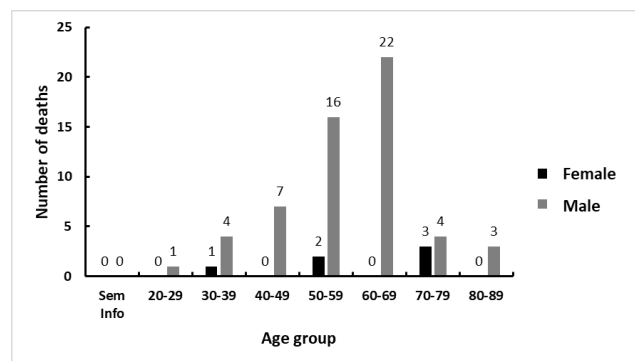


Fig. 3: Deaths from COVID-19 among traffic and transport professionals according to sex and age group in the state of Pará, from March 2020 to May 2021.

The chi-square test showed a significant difference between cases and deaths in the age groups (p-value <0.001). In the general total of cases, the most affected age group was 30-39 years old with 36.3% (n=1 099), followed by 40-49 years old with 29.9% (n=905). The test also showed a significant difference between cases and deaths in the registered comorbidities (p-value <0.002). The most frequent comorbidity among cases was heart disease, which occurred in 3.4% (n=104) of the total cases, of which 20.6% (n=13) died from COVID-19. Diabetes mellitus was recorded in 3.2% (n=99) of the total cases, of which 19% (n=12) died (Table 1).

Table.1: COVID-19 deaths by age group and comorbidities in traffic and transport professionals in the state of Pará, from March 2020 to May 2021.

	Deaths				Total N	p-value
	No		Yes			
	n	(%)	n	(%)		
Age group						<0,0001*
No information	22	100	0	0	22	
20-29	325	99,7	1	0,3	326	
30-39	1 094	99,5	5	0,5	1 099	
40-49	905	99,2	7	0,8	912	
50-59	475	96,3	18	3,7	493	
60-69	128	85,3	22	14,7	150	
70-79	11	61,1	7	38,9	18	
80-89	5	62,5	3	37,5	8	
Comorbidities						<0,0002*
Diabetes	87	87,9	12	12,1	99	
Immunodeficiency	4	80	1	20	5	
Heart disease	91	87,5	13	12,5	104	
Lung disease	7	70	3	30	10	
Neurological disease	0	0	1	100	1	
Kidney disease	0	0	2	100	2	
Obesity	0	0	1	100	1	

*Chi-Square Test

IV. DISCUSSION

The fatality rate for COVID-19 can be considered high when compared to the fatality rate for the H1N1 virus, which is around 0.02% [7]. Two factors that added together contribute to its increase, one of which is the underreporting of cases, which is high throughout the country, as a result of the difficulty in testing patients, which is generally carried out in the most severe cases, and the scarcity of material resources for testing, another factor is the precarious care and the difficulty of accessing public health services, which often does not supply the large number of serious cases, a fact that is not surprising since the poor infected by covid-19 are the ones who die the most in all countries. countries in the world [8, 9, 10]. This highlights the importance of notifications for effective epidemiological surveillance of COVID-19 throughout the country [11].

The municipality of Parauapebas, which belongs to the southeastern mesoregion of Pará, where the largest open-pit iron ore mine in the world is located, had the highest number of confirmed cases (n=1 321), representing 0.2% of the total cases. confirmed in the state. It was the first in the country to carry out mass testing in partnership with the city hall and the company Vale S.A., a factor that certainly contributed to the high confirmation of cases and to the decrease in the fatality rate of professionals compared to the rate of the general population. The strategy applied in the first months of the pandemic made it possible to trace the epidemiological profile of the

disease in the municipality and identify the most affected locations so that action could be taken to isolate those who tested positive, also minimizing cases of underreporting [12,13].

With mining activity considered essential, and maintained during the pandemic, with intense migratory flow in the region, Parauapebas saw COVID-19 cases jump, occupying the fourth place in the highest number of cases in the entire state, possibly due to the interaction population among the municipalities in the region and even people who come from outside the state, thus collaborating with the spread of the virus [14].

Belém, the capital of Pará, ranked second in the number of cases (n=274) representing 9% of cases in the population studied and 0.05% of cases in the general population of the state. The other municipalities that make up the metropolitan region together add up to 123 cases. In the metropolitan region before the COVID-19 pandemic, around 1 000 000 public transport users circulated daily [15], since many people work in the capital and live in the surrounding cities, contributing to a high traffic of people in the region. Taking into account the number of people who need to travel and for this they use public transport every day, it is natural that scenes of agglomeration at bus stops are common, increasing the risk of contagion by COVID-19 for both users and professionals working in the area. pandemic, this number of users was reduced during the periods of social isolation and lockdown enacted in the state [16].

The municipality of Marabá, in southeastern Pará, ranked third with 241 cases, representing 7.95% among the professionals studied and 0.04% among the cases of the general population of the state. It is the fourth most populous municipality in the state and is located near Parauapebas, for this reason the region's economic activities favor intercity displacement, a situation that can contribute to the spread of the virus in the region [17,18].

Humanity faced a great challenge with its reduced mobility during the pandemic, probably increasing the perception of risk of public transport. It was already expected that the municipalities indicated above would have a more expressive number of cases since they have a high population density. Local economic activities also contribute to greater mobility of the population through public transport, with inter-municipal displacements being characteristic. It is known that these professionals are more exposed and the means of public transport has possibly contributed to the contagion by COVID-19 [19].

According to a study carried out by the Pólis Institute in the city of São Paulo, which sought to identify the occupational activities of victims, using data on death by

COVID-19 from February 2020 to March 2021, the passenger transport sector is one of the most affected. by the pandemic, with 3.2% of the total deaths in the state. The authors also suggest that the proportion may be underestimated since the victim's occupation is rarely indicated in the notification or death certificate [20]. An observational study was carried out in 6 Asian countries: China, Japan, Singapore, Taiwan, Thailand and Vietnam, where the transmission of COVID-19 was linked to work, with cases reported between January 23, 2020 and March 14, 2020, with health professionals being the first category with the most risks, followed by drivers and workers in the traffic, pointing to the need to protect these workers by implementing specific control measures [21].

In the entire state, confirmed cases are predominant in females, representing 53% [22], while in the group studied, women represent only 5% of cases, which is probably related to the fact that the professions related to traffic and transportation are occupied mostly male [23]. According to the data presented, the age group most affected by COVID-19 was 30-39 years old in both sexes. It is important to note that this is the range in which the population is most economically active and needs to go out to work. This information is reinforced with the data found for the state of Pará and other Brazilian states [24, 25].

In the cases registered in the general population of Pará, although women represent the majority, it is men who most progress to the outcome of death in all age groups, with 59.1% mainly from 60 years old, indicating that there is an association between age and death, as has already been observed in the literature [22, 26]. One of the possible explanations may be related to the fact that the elderly develop comorbidities more frequently, making them more vulnerable to more severe forms of COVID-19 [27].

In this study, the age groups 50-59 and 60-69 were the ones with the highest number of deaths in the population studied (n=40), following the pattern observed throughout the country [22]. The literature indicates that men seek health services less when compared to women, but genetic and hormonal factors must also be taken into account, as well as a higher prevalence of chronic diseases [28].

In general, the cases of the studied population followed the same pattern found in the general population of the state of Pará, with cardiovascular diseases and diabetes mellitus being the most reported comorbidities. Such comorbidities are related to a greater possibility that the patient will need intensive medical care, aggravating the clinical process and can significantly affect the prognosis of COVID-19 [29,30].

V. CONCLUSION

The COVID-19 scenario in the state of Pará reached alarming numbers, a situation that reflected on professionals working in the transit and transport category, since the service was not interrupted during the pandemic, leaving them extremely vulnerable. A strong point of the study is to analyze the data on cases and deaths by covid-19 in a specific population, verify the association between deaths and comorbidities, in addition to the elapsed time of the data that comprise the first year of the pandemic. One of the limitations of the study is the incompleteness of the data provided by the Health Department, which can make it difficult to extrapolate the data to the entire state. The descriptive study is limited to describing the cases and deaths in the population of interest and, therefore, the representative sample is not random.

In general, the epidemiological profile of the studied group followed the profile observed in the national population. Traffic professionals have great social importance in the country, since they transport a significant part of the population that depends on these services daily, especially in large urban centers. In this way, it is recommended that the SUS give priority care to professionals who are symptomatic, reinforce the adoption of individual and collective prevention measures in the daily lives of professionals who are more vulnerable due to COVID-19, as well as encourage them to carry out the vaccination schedule. complete.

ACKNOWLEDGEMENTS

An acknowledgement section may be presented after the conclusion, if desired.

REFERENCES

- [1] Freitas CM, Barcellos C, Villela DAM (2021). Covid-19 no Brasil: cenários epidemiológicos e vigilância em saúde [online]. Rio de Janeiro: Observatório Covid-19 Fiocruz; Editora Fiocruz, 418 p. Informação para ação na Covid-19 series. ISBN: 978-65-5708-049-8. <https://doi.org/10.7476/9786557081211>
- [2] Bernhardt J (2020). Decline in ridership, adapted timetables and disinfection-robots – The impact of Corona/ Covid-10 on public transport. Urban Transport Magazine. Retrieved from <https://www.urban-transport-magazine.com/en/decline-in-ridership-adapted-timetables-and-disinfection-robots-the-impact-of-corona-Covid-10-on-public-transport/>
- [3] Lima GCLS, Schechtman R, Brizon LC, Figueiredo ZM. Transporte público e COVID-19. O que pode ser feito?. Centro de Estudos em Regulação e Infraestrutura da Fundação Getúlio Vargas (FGV CERI). Rio de Janeiro. Abril de 2020. Retrieved from

- https://ceri.fgv.br/sites/default/files/publicacoes/202005/covid_e_mobilidade_urbana_0.pdf
- [4] Lima YO, Costa DM, Souza JM (2020). Risco de Contágio por Ocupação no Brasil. Impacto COVID-19, Rio de Janeiro, Retrieved from <https://impactocovid.com.br/atividade.html>
- [5] Marques CA, Siqueira MM de, Portugal FB (2020). Avaliação da não completude das notificações compulsórias de dengue registradas por município de pequeno porte no Brasil. *Ciência & Saúde Coletiva* [online]. v. 25, n. 3. <https://doi.org/10.1590/1413-81232020253.16162018>
- [6] Mello JAVB (2019). "Policentralidade e mobilidade na Região Metropolitana do Rio de Janeiro". *Bitácora Urbano Territorial*, 29 (3): 11-20. <https://doi.org/10.15446/bitacora.v29n3.62420>
- [7] Van Kerkhove MD, Hirve S, Koukounari A, Mounts AW (2013). H1N1pdm serology working group. Estimating age-specific cumulative incidence for the 2009 influenza pandemic: a meta-analysis of A(H1N1) pdm09 serological studies from 19 countries. *Influenza Other Respir Viruses*.7(5):872-86. doi: 10.1111/irv.12074
- [8] Noronha PH (2020). Fundação Oswaldo Cruz. Letalidade por Covid-19 no Rio está acima da média mundial. Retrieved from <https://portal.fiocruz.br/noticia/letalidade-por-covid-19-no-rio-esta-acima-da-media-mundial>
- [9] Oliveira TM, Araújo ACO (2020). Consequências da subnotificação dos casos de COVID-19 para a saúde pública no Brasil. *InterAm J Med Health* 2020;3:e202003062. DOI: <https://doi.org/10.31005/iajmh.v3i0.150>
- [10] Bosquerolli AM, Fajarra BH, Kessey GABR, Colaço HM, Oliveira HV, Santos LCG, Sarres LS, Alencastro MF, Tao MIC, Vieira NP, Niro RC, Castro D (2020) PET Economia UFPR. Brasil e o mundo diante da crise econômica e da Covid-19. Retrieved from <https://www.ufpr.br/porta/ufpr/wp-content/uploads/2020/07/Brasil-e-o-mundo-diante-da-Covid-19-e-da-crise-economica.pdf>
- [11] Corrêa PLR, Ishitani LH, Abreu DMX, Teixeira RA, Marinho F, França EB (2020). A importância da vigilância de casos e óbitos e a epidemia da COVID-19 em Belo Horizonte, 2020. *Revista Brasileira de Epidemiologia* [online]. v. 23 e200061. <https://doi.org/10.1590/1980-549720200061>
- [12] Gomes K (2020). Prefeitura de Parauapebas. Parauapebas é o primeiro município do Brasil a fazer testagem em massa com PCR. Retrieved from <https://parauapebas.pa.gov.br/index.php/ultimas-noticias/3129-parauapebas-e-o-primeiro-municipio-do-brasil-a-fazer-testagem-em-massa-com-pcr.html>
- [13] Silveira MC & Costa EA (2020). Comunicação breve. Busca ativa ou testagem em massa? *Cad. Ibero-amer. Dir. Sanit., Brasília*, 9(4): out./dez. <https://doi.org/10.17566/ciads.v9i4.741>
- [14] Souza MVM & Ferreira Júnior DB (2020). Rede urbana, interações espaciais e a geografia da saúde: análise da trajetória da Covid-19 no estado do Pará. *Espaço e Economia* [Online], 18. <https://doi.org/10.4000/espacoeconomia.13146>
- [15] Moraes RCM, Bordalo CVS, Meyer EA, Silva UR, Lima GG, Damasceno LO, Cardoso MS (2018). Qualidade do Transporte Urbano da Região Metropolitana de Belém. *Revista Científica Multidisciplinar Núcleo do Conhecimento*. Ano 03, Ed. 02, Vol. 03, pp. 147-156, ISSN: 2448-0959
- [16] Moraes RCM, Bordalo CVS, Meyer EA, Silva UR, Lima GG, Damasceno LO, Cardoso MS (2018). Qualidade do Transporte Urbano da Região Metropolitana de Belém. *Revista Científica Multidisciplinar Núcleo do Conhecimento*. Ano 03, Ed. 02, Vol. 03, pp. 147-156, ISSN: 2448-0959
- [17] Ferreira SBF, Lima ATO, Silva MLN (2020). Breves reflexões sobre desenvolvimento urbano, ocupações e a pandemia da COVID-19 em Marabá (PA). *Ambiente: Gestão e Desenvolvimento*, [S. l.], v. 1, n. 1, p. 55-80. 10.24979/ambiente.v1i1.820
- [18] Pacífico Filho M, Borges TP, Iwamoto HM, Caçado AC (2020). Dinâmica de contágio da COVID-19 em cidades médias da Amazônia Legal: Araguaína (TO), Imperatriz (MA) e Marabá (PA). *Revista Brasileira de Gestão e Desenvolvimento Regional G&DR*. V. 16, N. 4, P. 270-283, (Ed. Especial), Taubaté, SP, Brasil. Retrieved from <https://www.rbgdr.net/revista/index.php/rbgdr/article/view/5985>
- [19] Rios R (2020). *Correio Braziliense*. Aglomeração diária nos transportes públicos põe pessoas em risco. Retrieved from <https://www.correio braziliense.com.br/app/noticia/brasil/2020/08/03/interna-brasil,877852/aglomeracao-diaria-nos-transportes-publicos-poe-pessoas-em-risco.shtml>
- [20] Klintowitz D, Nisida V, Cavalcante L, Faustino D, Luiz O, Kayano J (2020). Trabalho, território e covid-19 no msp. Instituto Pólis. Retrieved from <https://polis.org.br/estudos/trabalho-territorio-e-covid-no-msp/>
- [21] Lan FY, Wei CF, Hsu YT, Christiani DC, Kales SN (2020). Work-related COVID-19 transmission in six Asian countries/areas: A follow-up study. *PLOS ONE*. 15(5): e0233588. <https://doi.org/10.1371/journal.pone.0233588>
- [22] Sespa (2021). Vigilância Epidemiológica. Coronavírus No Pará. Retrieved from <https://www.covid-19.pa.gov.br/#/>
- [23] Feitosa CMMC, Belo RP, Amaral EB, Lima TO (2013). Trabalho e gênero: um levantamento sobre as profissões e gênero na cidade de Parnaíba-PI. *Perspectivas em Psicologia*, Vol. 17, N. 1, p. 83-100. Retrieved from <http://www.seer.ufu.br/index.php/perspectivasem psicologia/article/view/27668/15148>
- [24] Almeida JS, Cardoso JA, Cordeiro EC, Lemos M, Araújo TME, Sardinha AHL (2020). Epidemiological characterization of COVID-19 cases in Maranhão: a brief analysis. *Rev Pre Infec e Saúde* [Internet]. 6:10477. <https://doi.org/10.26694/repis.v6i0.10477>
- [25] Pacheco ES, Silva, VR, Soares LS (2020). A brief epidemiological analysis of COVID-19 in Piauí, Brazil. *Rev Pre Infec e Saúde* [Internet]. 6:10690. <https://doi.org/10.26694/repis.v6i0.10690>
- [26] Sousa HM de, Torres NMF, Moura MCL de, Silva RP da, Araújo VLL, Sousa RA de (2020). Comparison of data on

- deaths by Covid-19 between three sources of information, Maranhão. *Research, Society and Development*, [S. l.], v. 9, n. 9, p. e94996894. 10.33448/rsd-v9i9.6894
- [27] Oliveira MC, Eleuterio TA, Corrêa ABA, Silva LDR, Rodrigues RC, Oliveira BA, Martins MM, Raymundo CE, Medronho RA (2021). Fatores associados ao óbito em casos confirmados de COVID-19 no estado do Rio de Janeiro. *BMC Infect Dis* 21,687. <https://doi.org/10.1186/s12879-021-06384-1>
- [28] Caló RS, Assis JMV, Guenkka TM, Pires JCS, Andrade ACS, Souza RAG (2020). Perfil epidemiológico dos óbitos por Coronavírus (COVID -19) em Mato Grosso. *Saúde coletiva*. (10) N.56. p. 3044-3055. DOI: <https://doi.org/10.36489/saudecoletiva.2020v10i56p3044-3055>
- [29] San Roman JA, Uribarri A, Amat-Santos I J, Aparisi A, Catalá P, Gonzalez-Juanatey J R (2020). La presencia de cardiopatía agrava el pronóstico de los pacientes con COVID-19. *Carta científica. Rev Esp Cardiol*. 73(9):769–782. DOI:10.1016/j.recesp.2020.05.022
- [30] Wang B, Li R, Lu Z, Huang Y (2020). Does comorbidity increase the risk of patients with COVID-19: evidence from meta-analysis. *Aging (Albany NY)*. 12:6049-6057. <https://doi.org/10.18632/aging.103000>

Historical-Social and Legal Aspects of People with Disabilities (PCD): A necessary discussion

Giselle Feliz Santiago¹, Olavo Bilac Quaresma de Oliveira Filho²

¹ PhD student in Law, Postgraduate Program in Master, and Doctorate in Law, UNICEUB, Brasília, Brazil

Email: giselle.santiago@sempreub.com

² PhD of Biotechnology Applied on Agriculture, Department of Environmental Engineering, UEAP, Macapá, Brazil

Email : olavo.filho@ueap.edu.br

Received: 17 Jun 2022,

Received in revised form: 13 Jul 2022,

Accepted: 19 July 2022,

Available online: 24 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

Keywords — *PCD, Persons with
Disabilities, Historical, Social, Legal.*

Abstract — *This article focuses on addressing the contextualization of Persons with Disabilities (PCD). The historical-social and legal contexts of the disabled will be presented from a broad analysis from a scientific, cultural, and medical point of view - permeating social movements, representation initiatives in organizations and the creation of specific legislation that deals with the social rights of the person with disabilities, including in Brazil. It is noteworthy that since the beginning of humanity, the origin of man and the distinctions between races, creeds and civilizations were part of the construction and formation of the social base, from the distinctions between men and women, rich and poor, strong, and weak.*

I. INTRODUCTION

The person with a disability obtained, within the constitutional scope, a representation and protection that aims to guarantee their social rights. All this construction erupted from the strengthening of public policies and the need observed by the legislator to protect this minority group. The fight against discrimination is part of the construction of institutional and legal policies in the fight against discrimination and in the search for social guarantees; in addition, social integration and the protection of the human person were guidelines of great relevance for the development of the Brazilian constitution, thus strengthening the aspects of guaranteeing collective and diffuse rights.

It is important to highlight that the appreciation of the physical capacity of man has always been linked, in short, to his physical strength and his ability to develop skills and perform tasks to achieve something. Thus, the manifestation of majority groups, to the detriment of minority groups and with a certain limitation, was evident in the structural formation of society - it can then be

observed and verified that the greatest civilizations in the world were built on the basis of a culture of eugenics, with prevalence of greater capacity in contrast to those who were in a state of vulnerability^{1,2}, which justifies the social, biological and legal discussion of people with disabilities.

II. THE SUBJECT WITH DISABILITIES AND HISTORICITY

Since ancient times, People with Disabilities have been present in the social context of civilization. In Ancient Egypt, serious illnesses related to physical and mental problems were directly related to evil spirits and religion. It was believed that the disabled were cursed and that there was a need for spiritual intervention, so the context of disability was intertwined with the culture and religion of the people. The presence of religiosity was quite frequent in the construction of the imagination of the disabled as an individual who was observed as a sinner or cursed, since in Greek culture, for example, deformity was presented because of the wrath of the gods³.

However, Greece is seen as the first western civilization to start a process of assistance based on a movement of support to the civilian population and the physically disabled – as they were called. However, Greek culture did not allow the extension of this support to the child with a disability, because according to the eugenics culture of civilization itself, the destiny of the disabled child, when observed at birth, was sacrifice. This cultural extension was also observed in Roman society precisely because of Eugenia's policy, in which the child should not be born with any blemish and the practice of throwing children into abysses and performing sacrifices were part of the culture^{2,3}.

The social context of people with disabilities changed from the establishment of Christianity, mainly with the arrival of Christian movements in western society and the cultural transformation from the reduction of eugenics policies observed during antiquity. The presence of the Catholic Church together with religious leaders began to provide a practice of protection and assistance to the disabled, whether from birth or adult. This entire religious movement changed the social context of the Disabled Person in society, the figure of the disabled individual is linked to the need for care, assistance, and support on the part of social actors, including public authorities and civil society^{4,5}.

The emergence of the religious context of support for people with disabilities was merged with the conception of medicine and medical assistance that culminated in the creation of religious institutions with the support of medicine for the reception of marginalized groups. This historical context denotes an important period for the emergence of the first movements in medicine to study disability. During the Byzantine Empire, the church and the State came together to guarantee basic care and health promotion for the less assisted strata of society, including shelters and monasteries, which were transformed into specific spaces for the accommodation of people who had no conditions to support themselves financially or who were abandoned by their families^{3,4}.

During the 15th and 17th century there was a great period of discoveries in medicine, mainly driven by philosophical currents and by the diffusion of the ideals of human rights and citizenship. This context brought to the fore social issues and the need to expand care for disabled people with some physical limitation. The Renaissance period can be seen as one of the most revolutionary for the diffusion of science in the treatment of people with disabilities, as it broke barriers of prejudice with the development of medical practice⁴.

The creation of charitable entities and groups to assist people with disabilities in Europe can also be seen as a milestone in the development of social policy. In the spotlight, the so-called “Poor Law” enacted by King Henry VIII guaranteed the so-called “charity fee” that required the people to pay a fee to guarantee the creation of charities and hospitals to care for people who had physical problems and health limitations. The Renaissance movement also acted on the manifestation of the Church, because from the progress of science and the spread of new medical techniques, it collaborated so that the sacrifice and prejudice of people with disabilities were mitigated in society³.

The diffusion of scientific knowledge and the advancement of medicine were fundamental for the emergence of shelters and support societies for people with disabilities. The growth of corporate initiatives among civil society, the church and donors brought a reality of greater protection for these people, whose work was autonomous in nature with the support of the academic and scientific community. A highlight during the late 18th century was the creation of the Society and Home for the Disabled, created in Denmark by an autonomous group of collaborators, whose purpose of the institution was to shelter people with disabilities in conditions of social vulnerability, which in many cases, abandoned by family members⁴.

However, the formation of society was also marked by social movements in defense of minority and vulnerable groups. The institutionalization of the protection of groups with social vulnerability was guided by organizations such as the church and social defense groups, which expressed their protection to social groups displaced from the protection of the State. The presence of social movements in the defense of these groups has been observed since the mid-14th century with the presence of civil society to defend groups considered excluded from society^{2,6,7}.

At the end of the 19th century until the beginning of the 20th century, support for people with disabilities was expanded due to the emergence of the formation of the Welfare State, whose movement was initiated in Europe with a great appeal from society to create public policies to support the most socially vulnerable groups, including people with disabilities³. In his work, Silva⁸ argues that the need to create welfare policies emerged with greater force after the end of the 1st World War and, later, with the end of the 2nd World War, whose number of physically and mentally disabled people grew dramatically, accentuated not only by the disasters of the war, but also by the spread of communicable diseases, mainly the Black Death and the Spanish Flu.

According to Maior², the process of the emergence of initiatives to protect minority social groups from the 20th century began to trigger a process of welfarism on the part of the government and society. The social marginalization of vulnerable groups, including people with disabilities (called at the time as "physically disabled or indigent") began to be adopted by social strata, among them, the disadvantaged strata, whose need for visibility began to be demanded in the face of to social and public neglect. The UN presented Resolution n° 37/52 - called World Action for Persons with Disabilities, whose proposal was to present a postulate on equality and the rights of people with disabilities worldwide, ensuring that there were equal rights for this group. of people, at all social levels: transport, education, basic sanitation, rights, civil rights^{4,9}.

Maior² notes that the Post-War period was a crucial period for the expansion and propagation of the rights of people with disabilities in the modern world, considered one of the pillars of the creation of later specific legislation. In 1919, the UN created the Central Commission for the Care of the Disabled, considered an important step to discuss the guidelines and actions of countries to ensure the protection of people with disabilities. Subsequently, in 1975, the UN established the Declaration of the Rights of Persons with Disabilities, and then the year 1981, known to this day as the International Year of Persons with Disabilities - legitimized as an act of great relevance to solidify the struggle for the social rights of people with disabilities. people with disabilities around the world.

During the 1990s there was considerable progress in legislation and measures to protect people with disabilities worldwide. In 1992, the UN promoted the Day of the Disabled and institutionalized, together with some countries in Europe, a General Assembly to guarantee the standardization of procedures to equalize social rights in defense of the protection of people with disabilities - this initiative was called Procedures- Standards for the Equalization of Opportunities for Persons with Disabilities focuses on the struggle to guarantee basic rights in favor of persons with disabilities at a global level⁴. According to Pereira and Saraiva³, after the initiative of the UN with the General Assembly, the so-called "Declaration of Salamanca" was established in 1994, considered until then and by many analysts, to this day, as a major milestone of social inclusion. of people with disabilities, being the most important document that supported the creation of other future initiatives on the subject.

In the early 2000s, other important treaties were created on the protection and struggle of social rights and equal guarantees for people with disabilities, among them the Amsterdam Treaty, which was important for the

legitimation of rights, among them other social areas, that of equal access to the labor market based on the establishment of guidelines that would guarantee equality of conditions. In 2000, the Council of the European Union, in a meeting with leaders of the allied countries at the UN, voted for the establishment of rules and conditions that establish measures to combat direct and indirect discrimination in the labor market for people with disabilities. This measure was widely accepted by the European community, serving as a model for other countries that began to adopt the measure and intensify the fight against discrimination and prejudice in the work environment^{4,9}.

Currently, the initiatives of movements to support the protection and guarantee of social rights of people with disabilities have expanded the space for the main social and decision-making fields: politics, economy, public power, private initiative, and movements in civil society. According to the most recent data from the UN, from 2012, the process of expanding public policies to serve people with disabilities in the world went from 21% to 45% in a decade, which proves that the institutionalization of legal measures of protection was adopted within the construction of public policies of the State^{2,3}.

III. THE HISTORICAL CONTEXT OF PEOPLE WITH DISABILITIES IN BRAZIL - SOCIAL AND LEGAL ASPECTS

The beginning of the historical context of people with disabilities in Brazil emerged in the mid-sixteenth century with Father Anchieta and with the Jesuits' religious movement, whose teaching development already allowed a specific work to help students who were disabled, especially in the help with those with mobility difficulties. From the 18th century onwards, there was the development of projects aimed at the blind and the deaf, coming from France, with the purpose of guiding children and young people towards learning through the creation of a specific language system that would serve the blind and deaf. – this system itself was the basis of which the Braille system was created¹⁰.

In mid-1854, the National Institute for the Education of the Deaf was created, based on the presentation of specific knowledge aimed at blind and deaf youth and adults; whose project was presented to Emperor D. Pedro II with the proposal to serve this public with a more specialized service. Then, through Imperial Decree n° 428, in Rio de Janeiro, the Instituto dos Meninos Cegos was founded, currently known as the Benjamin Constant Institute - considered until then as one of the precursor institutions and of great importance for the development of specific

actions for the education of the blind and deaf in Brazil^{2,3,10}.

From the 19th century onwards, driven mainly by special education for the blind and deaf, the Braille writing system for the blind was introduced during the 1880s. disabilities in Brazil were still infrequent in society, which can be related to the lack of interest of society itself in developing actions for this audience². The role of the church and the community was fundamental for the basic formation of public policies and has a collective aspect and is based on the claim of rights and the achievements of equality, especially in access to basic education and specialized health care.

According to Pereira and Saraiva³ Brazil was heavily influenced by the social movements of Europe in the 19th century, and the movements formed in the country sought to develop a culture of acceptance and adaptability to start an inclusion movement in the country. One of the first aspects, in addition to the creation of the Braille system, was the creation of special schools, and then a process of reordering education in Brazil began with the development of special education based on the applied and specific methodology for people with disabilities. Perhaps one of the pioneer schools for special education in Brazil was the Association of Exceptional Parents and Friends (APAE) which was established by the Pestalozzi Associations - a philanthropic institution to support special education through the pedagogical application of the inclusive method in basic education, mainly for work with children and young people².

At the beginning of the 20th century, from the 1920s, the first welfare policies were developed in the country based on the repercussion of European social movements, mainly from the UN manifesto in favor of people with disabilities. After World War II, the government began to adopt a campaign for the rehabilitation and support of people with disabilities, with the creation of rehabilitation centers and hospitals with specialized care to treat this type of public. The integration of efforts between the government and society triggered the need to standardize care and ensure a more comprehensive care model, as there were still not enough professionals to work with people with disabilities^{2,3}.

In the late 1950s, integration centers for people with disabilities were established. A very important aspect for the development of assistance policies came from the need to expand support activities, whose service niche was still very restricted to the medical aspect, with the need to integrate with social and economic development. This period of inclusion established a renewing moment for the social scenario of people with disabilities in Brazil, since

from the 1970s and early 1980s onwards, large urban centers, such as São Paulo and Rio de Janeiro, adopted public support policies in addition to the emergence of collaborative actions arising from civil society^{2,10}.

Popular initiatives and the formation of a political-social basis for the defense of people with disabilities establish the need to broaden the debate on specific public policies for this group. In the 1990s, the creation of associations and institutionalization based on UN treaties and international movements made it possible for the 1st Convention on the Rights of Persons with Disabilities to take place in Brazil. All this social and political movement culminated in the creation of the National Policy for the Integration of Persons with Disabilities, which originated the National Council for the Rights of Persons with Disabilities (CONADE) and which, later, was transformed into the National Secretariat for the Promotion of Human Rights. People with Disabilities – linked to the Presidency of the Republic and responsible for proposing policies, actions, laws, and decrees about this group in Brazil².

The institutionalization of the protection of people with disabilities also resulted in the creation of specific legislation aimed at protecting and guaranteeing social rights for this social niche. The first federal law created in 1989 stands out, law n° 7.853, whose provision of the law deals with social integration and governmental and social support for people with disabilities. Another important law highlighted in Brazil that deals with the protection of people with disabilities was the creation of Law n° 10.098/2000, which was also established in Decree n° 5.296/2004, was essential to address a topic that was heavily demanded by movements for the defense of people with disabilities, which was the issue of guaranteeing priority in care due to its special condition¹⁰.

Regarding the socio-educational emphasis, law n° 10.436/2000 was of paramount importance to assist the deaf person. This law deals with the officialization of the Brazilian Sign Language - Libras, so the written Portuguese language is maintained as a second language. This officialization brought an important redesign of Brazilian education within the aspect of inclusion and accessibility, as the deaf could be assisted based on the regulation of the public power, something that was not yet treated as regulated in the Brazilian educational system. Later, through Decree n° 5626/2005, there was a bilingual definition with the training of translators and interpreters of languages, making it mandatory for these professionals to work in educational institutions in Brazil, whose profession was later regulated by law n° 12.319/2010².

The development for the social assistance field in Brazil was foreseen from the enactment of law n°

8.742/1993, which established the care of people with disabilities in different types of specialized services for personal, emotional, and professional support through Social Assistance. Law n° 8.742/1993 expanded the service to cases that, until then, did not have any support for people with disabilities, such as: domestic violence, physical aggression, child abuse, moral abuse, among others. In addition, this law was also important for the definition of a basic income through the granting of the continued benefit (BPC), which is a guaranteed minimum income for people with disabilities in a situation of social vulnerability in a state of poverty and misery^{2,3}.

A constitutional landmark in Brazil was the institutionalization of the denomination of “people with disabilities” in the official nomenclature of the country, since previously there was still the denomination “people with disabilities” and “people with physical disabilities”. This legitimization of terminology came to meet a global standardization established by the UN during the World Convention of Persons with Disabilities, whose proposal presented was to guarantee the universalization of terminology and the distancing of expressions with a pejorative content^{2,11}.

Given the advances in discussions on the rights of persons with disabilities in the world, Brazil participated in the promulgation of the International Convention on the Rights of Persons with Disabilities and Optional Protocol, in 2007, signed in New York City in the United States. This convention was fundamental to deepen the discussions between the countries mediated by the UN to debate on the promotion of the guarantee and the full and equitable exercise of all human rights and freedom for people with disabilities in the world. Brazil participated as one of the participating States in the convention, with the objective of aligning its participation with the fulfillment of objectives and obligations adopted to meet the legal, administrative, and social measures to comply with and strengthen the reduction of crime and the promotion of people's human rights. with disabilities¹².

Movements in support of people with disabilities within the political and legal spectrum have been strengthened by the need to develop actions for equality and combating discrimination. According to Bezerra¹¹, Brazilian society has undergone numerous social and cultural transformations for years from the perspective of coexistence with people with disabilities, which can be clearly observed in the gradual construction of public policies and the creation of specific legislation that meets the needs of people with disabilities. to this minority public in society. Also, according to the author, even though late, social, and legal reconstruction in support of people with disabilities in Brazil has been more present in

the country's legislative spectrums, despite the inequality and discrimination that are still present today.

IV. DEFINITION OF THE PERSON WITH A DISABILITY - SCIENTIFIC AND LEGAL CONCEPT

The concepts about the terminology “disability” have been observed in the scientific, political, and social context for years, since the first manifestos about regulation and the struggle for the social rights of people with disabilities. This concept can be defined in two aspects: scientific and legal. From a scientific point of view:

Scientific concept of disability today can be found in the UN Convention itself: “Persons with disabilities are those who have long-term impairments of a physical, mental, intellectual, or sensory nature, which, in interaction with various barriers, may hinder their participation. fully and effectively in society on equal terms with other people (art. 1)⁵.”

Science has determined the use of the terminology for “disability” to designate any impediment or limitation of a physical, mental, or intellectual nature, so that there is a barrier, that is, that there is a natural difficulty in carrying out actions commonly performed by people without disabilities. According to Madruga⁵, the resignification in the use of terminology to designate the person with a disability came from a social context, not merely a scientific one. The use of the nomenclature was determined, within the scientific aspect, to characterize this group of people based on their identification from the perspective of characterizing the types of disabilities, which are distinct and can be deferred for each case^{5,13}.

The scientific approach to disability started from the definition of a medical protocol established by the UN and determined by the International Classification of Functioning, Disability and Health (ICF/WHO) through an analysis in a biopsychosocial scope that understands disability as a limitation of the individual from the corporal and mental structure in view of a series of influences that determine its limitation in social and environmental character. The conceptual development of disability in a scientific way was an important step to dissipate the incorrect and prejudiced use of certain terminologies that were used without any single characterization, even making the legal process of inclusion of the term in the legal system of the countries difficult^{5,14}.

The ICF consolidated the term within the scientific and social character, but changed the terminology, which was previously determined only for “disability” and started to

include the terminology on disability for acquired diseases classified within "health components". The 1st classification presented in 1980 was criticized for having a medical connotation, without considering the social aspects of the disabled, in addition, this terminology had to be changed by the UN and considered. The determinations for terminologies started to be adopted in a single character, considering the social and environmental aspects¹⁴.

According to art. 2 of the International Declaration of the Right of Persons with Disabilities and, in Brazil, under Federal Law n° Art. 2 A person with a disability is one who has a long-term impairment of a physical, mental, intellectual, or sensory nature, which, in interaction with one or more barriers, may obstruct his or her full and effective participation in society on an equal basis with other people. other people.

The Basic Guidelines Guide developed by the Federal Senate in 2005 also characterizes the person with a disability based on Federal Law No. to perform one or more essential activities of daily living¹⁵. The characterization of disability as a scientific term and linked to the medical field was important to determine the typology of disability and individualize the types of symptoms, limitations, and particularities for each disabled person, which was necessary for the process of social and legal regulation^{5,16}.

However, the use of terminologies in their temporal context has changed according to their use. According to Nishiyama¹⁶, the conceptual definition of people with disabilities comes from a historical path, in which their conception was built based on a trajectory of changes stimulated by the social, political, and medical context itself. One of the first terms used was "physically disabled", in which its characterization limited the typology to only people who had some disability in their physical structure, not observing then for the other types of limitation. This nomenclature was changed in the UN Convention, in which it was pointed out that the term, in addition to isolating only a characteristic of disability, also advocates an adjective character for the person, since the "physically disabled" deals more with the disability than with the person, observed as prejudiced¹⁶.

In the 1980s and 1990s, the term "person with a disability" began to be widely used to represent people with disabilities. The term, in addition to being used in society, was also presented in some medical reports and research in the areas of public health and psychology. However, even in the late 1990s, the term was contested for not meeting the requirements for characterizing people with disabilities and for presenting, through the term

"carrier" a false representation, since the use of this term can indicate that the person has a disability. temporary, which is not an absolute truth, since in most cases there is a permanent deficiency of a congenital nature, that is, with no outlet for healing^{5,14}.

Madruga⁵ notes that: Note that the disability is inherent to the person who has it. You don't carry it, you don't carry it, you don't carry it with you, as if it were something spare or with an object. Neither does disability bring any synonymy with disease and is not an antonym for disability (which has its opposite in inefficiency)⁵.

Madruga⁵ then points out that the terminology "carrier", in addition to referring to an expression of "someone who carries something" or "has something temporary that they carry" brings an illusion that the disability can be fleeting, bringing to the use of the term a feeling of prejudice and distinction between those who, by chance, have a disability on a transitory basis and those who have a disability on a permanent basis. The use of inappropriate terminology, according to Atique and Veltroni¹⁴, can bring a less humanized perspective to the person who has a disability, so, from a legal point of view, the inappropriate use of terminology can result in sanctions, as it brings a sense of stigmatization and exclusion of this subject in relation to another.

The attempt to conceptualize the person with a disability, also addressed by Araújo¹³, shows the use of the nomenclature through some expressions: individual with limited capacity, handicapped, lessened, invalid, disabled, exceptional, disabled person, among others. This lack of standardization of the term and the misuse of terms with a prejudiced connotation was banned from common and legal use, as in addition to opening a list of interpretations, it also gave rise to the inappropriate use of the term in relation to the type of disability of the person. According to Maximiliano¹⁷ the use of the terminology "person with disability" tries to characterize the person not by the type of disease or limitation that he has, but by the definition of a group that he is a part of, so that there are no interpretations. dubious and imprecise that characterize it.

Madruga⁵ notes the use of the term "special" for people with disabilities. This term in question was widely used in the psych pedagogical structure to meet the demands of special education, especially in working with children and young people. The nomenclature "people with special needs" was widely used as a way of characterizing the person with a disability as "special", with the purpose of alleviating or euphemizing their disability. However, the term came to be seen as subjective, because in the common point of view, anyone can be "special". Thus, the term "special rights" was also used to characterize the

social rights of people with disabilities, but it had a connotation of speciality or privilege⁵.

There is also a need to dissociate terms such as “disability” and “disability”. According to Madruga⁵ there is a differentiation for each term: the first refers to the work character, that is, limitations or lack of work capacity; while the second refers to a characteristic of the person, regardless of the environment in which he finds himself. For Araújo¹³ the denominations cannot be observed in a static way, as they evolve according to social demand and the need to adapt the person with disability to society.

Gaudenzi and Ortega¹⁸ note that: The debates on the meaning of “disability” did not end with the approval of the ICF. Furthermore, as we can see, the term disability disappears in this classification and the terms functionality and disability gain prominence. The WHO proposal is that the ICF is not just for those with disabilities but is about all people. What is at stake, therefore, is the relationship of the individual to society.

The use of inappropriate terminology provides, in addition to a semantic distortion, a difficulty in establishing a legal standard. For Madruga⁵ the language and vocabulary attributed can relate the person with a disability to medical or social identification. From a legal point of view, Gaudenzi and Ortega¹⁸ argue that the definition “person with a disability” establishes a more accurate characterization of the term, as it manages to relate the person with the disability without overlapping the context, that is, there is no understanding dubious or that gives vent to prejudice in using inappropriate terminology or without really defining the social and average issue of the individual.

Thus, the standardization of terminology and the standard suitability from a social, medical, and cultural point of view was the reason why the study chose to use the term “people with disabilities”. In this sense, the use of standard language is inherent to the topic addressed, observed in the legal and academic field the use of placement in the face of the subject addressed, whether in the identity aspect or merely punctual in some statement. In this way, the presentation of the term by Madruga⁵ guides the use of “people with disabilities” in a uniform, comprehensive and appropriate way for the issues of public debate.

The typology of disability is divided into the following characteristics: congenital and acquired. The first concerns a disability that the individual has at birth, that is, he is born with that disability since birth, it was not acquired; the second concerns a disability acquired during life, that is, after birth, the same disability not acquired at birth.

Another deficiency that can be related to congenital deficiency is hereditary, in which the individual acquired the disease through gene transmission, that is, he already has it¹⁹.

Regarding the types of disabilities, they can be classified as follows: physical (motor), visual, mental (intellectual), auditory, multiple, and cerebral palsy. According to Xavier and Oliveira²⁰ the types of disability are defined according to the specificity of the individual's limitation or barrier, in which they differ from one to another, so there is no unilateral characteristic that interconnects the types of disability, other than the fact that they have different characteristics from an ordinary person without a disability.

Physical disability according to Brasil²¹ is a type of disability that affects the individual in terms of mobility impairment, motor coordination, speech control and motor impairment in general. This deficiency may arise from congenital or acquired formations, from neurological, neuromuscular, or orthopedic injuries. Physical disability or – also called motor – refers to the impairment of the locomotor system, which can be compromised to the Neurological System and the Muscular System, observed jointly or separately, being variable and defined according to the degree of limitation²⁰.

The main types of physical disability are: paraplegia (loss of all motor functions), paraparesis (partial loss of motor functions of the lower limbs), monoplegia (partial loss of motor functions of only one type of limb), quadriplegia (total loss of upper and lower limbs), tetraparesis (partial loss of motor functions of the upper and lower limbs), triplegia (total loss of motor functions of the three limbs), triparesia (partial loss of motor functions of the three limbs), hemiplegia (total loss of the motor functions of a zone of the body) and the hemiparesis (partial loss of the motor functions of a zone of the body)¹⁹.

Mental or intellectual disability is characterized by a certain reduction in intellectual capacity compared to the normal capacity of the Intelligence Quotient (IQ). This variation to a below-normal standard can be identified even as a child or adolescent and, depending on the case, in adulthood and its association is directly linked to limitations of behaviors and capacities to demand normal aspects of daily life: communication, socializing, social and cognitive skills, aspects of social relationships at home and at work^{19,20}. There is a sub-specification of the types of mental disability: mild, profound, severe, and moderate – in which it is crucial to note that there is a distinction between mental disability and mental illness – as the former refers to an insufficiency of intellectual capacity,

the second concerns a present pathology that can compromise the individual's global performance.

Visual impairment is the gradual or permanent loss of basic eye functions, it can be sudden or severe, congenital, or acquired. This type of disability can be present in both eyes or just one, corrected using lenses, glasses, or a surgical procedure - in the case of a type that can be corrected by procedures. It can be of the following types: low vision (distortion of the visual functioning of the eyes), partial blindness (distortion in visual perception more often) and total blindness (total loss of vision and ability to see)¹⁹.

Deafness or hypoacusis – is characterized by the total or partial loss of the individual's hearing capacity. The degree of loss for hearing impairment of forty-one decibels or more (dB) and the disabled cannot optimally hear sounds between 25 to 90 dB, compared to people with the normal auditory system. It is basically classified into two types: conductive deafness, sensorineural deafness, mixed deafness, and central deafness – subclassified by degrees of disability. A topic about the deaf and the more specific definitions of deafness, from a medical and legal point of view, will be discussed later.

Multiple disability, as the terminology of the name defines “multiple”, refers to a combination of one or more disabilities in an individual. These combinations of disabilities may be present concurrently or both may be lifelong acquired, diagnosed during the individual's lifetime. They can be classified as follows: sensory and physical, sensory, and psychic, physical, and psychic or sensory, physical, and psychic. As observed by Xavier and Oliveira²⁰, multiple disabilities are usually composed of deficiencies present in the individual, of one that has a more present frequency, that is, from a clinical point of view, there is, among the deficiencies, the one that stands out the most. limits a person's ability, whether physical, psychic, or sensory.

V. CONCLUSION

Social inclusion and the fundamental guarantee of individual rights are pillars of Brazilian constitutional formation. It is observed that the inclusion of people with disabilities is positive and guaranteed by law from the guarantee of housing, education, access to the job market, among others. This entire process of formation in the Federal Constitution of 1988 aims to reduce the discriminatory practice in society, mainly in meeting the needs of the most vulnerable public by guaranteeing social rights - which includes the feasibility of instruments that reduce the degree of disparity in actions of legal law.

The Brazilian legal system, despite the historical advances in its construction and formation from the social achievements made over the decades, still presents legal inconsistencies from the doctrinal and material point of view, which can be observed in the absence of regulations and in the uncertainties. legal provisions on certain aspects of social inclusion in terms of the law, particularly about persons with disabilities.

ACKNOWLEDGEMENTS

We thank UNICEUB and UEAP for the structure made available in the preparation of this article.

REFERENCES

- [1] DINIZ, Debora; BARBOSA, Livia e SANTOS, Wederson Rufino dos. Deficiência, direitos humanos e justiça. *Rev. int. direitos human.* v.6, n.11, 2009, p.64-77.
- [2] MAIOR, Izabel. Breve trajetória histórica do movimento das pessoas com deficiência. 2015. Disponível em: <http://violenciaedeficiencia.sedpcd.sp.gov.br/pdf/textosApoi o/Texto2.pdf>. Acesso em: 18 ago. 2020.
- [3] PEREIRA, Jaqueline de Andrade; SARAIVA, Joseana Maria. Trajetória histórico social da população deficiente: da exclusão à inclusão social. *SER Social, Brasília*, v. 19, n. 40, p. 168-185, jan.-jun./2017.
- [4] PESSOTTI, L. Deficiência mental: da superstição à ciência. São Paulo: Edusp, 1984.
- [5] MADRUGA, Sidney. Pessoas com Deficiência e Direitos Humanos: Óticas da diferença e ações afirmativas. São Paulo: Saraiva, 2. ed., 2016.
- [6] GOHN, Maria da Gloria. Movimentos Sociais no início do século XXI: antigos e novos atores sociais. Petrópolis: Vozes, 2007.
- [7] RESENDE, Ana Paula C. e VITAL, Flavia M. P. (Orgs.) A Convenção sobre os Direitos das Pessoas com Deficiência Comentada. Brasília: CORDE/ SEDH, 2006.
- [8] SILVA, Jaqueline Mielke. Os novos mecanismos de efetivação do direito fundamental à tutela jurisdicional executiva efetiva e tempestiva previstos no NCPC (Lei 13.105/15). *Revista Novos Estudos Jurídicos*, v.22, n.1, 2017.
- [9] SILVA, O. M. da. A epopéia ignorada: a pessoa deficiente na história do mundo de ontem e de hoje. São Paulo: Cedas, 1987.
- [10] LANNA JUNIOR, Mário Cléber Martins (Comp.). História do Movimento Político das Pessoas com Deficiência no Brasil. - Brasília: Secretaria de Direitos Humanos. Secretaria Nacional de Promoção dos Direitos da Pessoa com Deficiência, 2010.
- [11] BEZERRA, Rebeca Monte Nunes. Artigo 9. Acessibilidade. In DIAS, Joelson et al. (Orgs.) Novos Comentários à Convenção sobre os Direitos das Pessoas com Deficiência, Brasília, Secretaria de Direitos Humanos da Presidência da República, Secretaria de Promoção dos Direitos da Pessoa com Deficiência, 2014.

- [12] BRASIL. Decreto nº 6.949, de 25 de agosto de 2009. Promulga a Convenção Internacional sobre os Direitos das Pessoas com Deficiência e seu Protocolo Facultativo, assinados em Nova York, em 30 de março de 2007. Brasília, DF: Diário Oficial da União, 2009.
- [13] ARAÚJO, Luiz Alberto David. A proteção constitucional das pessoas com deficiência. 4. ed. Brasília: Ministério da Justiça, 2011.
- [14] ATIQUÊ, A. L. V.; VELTRONI, A. L. O direito à educação no Brasil e a pessoa portadora de deficiência: as obrigações das instituições de ensino superior. NEJ, v. 12, n. 1, p. 119-135, jan./jun. 2007.
- [15] BRASIL. Lei n. 13.105, de 16 de março de 2015. Código de Processo Civil. Brasília, DF: Presidência da República, 2015. Disponível em: http://www.planalto.gov.br/ccivil_03/_Ato2018/2015/Lei/L13105.htm. Acesso em: 28 jan. 2021.
- [16] NISHIYAMA, Adolfo Mamoru. Os Direitos das Pessoas com Deficiência e sua Transformação Histórica. São Paulo: Ed. RT, 2018.
- [17] MAXIMILIANO, Carlos. Hermenêutica e Aplicação do Direito. Rio de Janeiro: Forense, 1984.
- [18] GAUDENZI, Paula; ORTEGA, Francisco. Problematizando o conceito de deficiência a partir das noções de autonomia e normalidade, Ciência & Saúde Coletiva, v. 21, n.10, p. 3061-3070, 2016.
- [19] BRASIL. Decreto nº 5.626, de 22 de dezembro de 2005. Regulamenta a Lei no 10.436, de 24 de abril de 2002, que dispõe sobre a Língua Brasileira de Sinais - Libras, e o art. 18 da Lei no 10.098, de 19 de dezembro de 2000. Diário Oficial da União, 23. dez. 2005.
- [20] XAVIER, Silvia Cristina A.; OLIVEIRA, Vera Lúcia Leite de Oliveira (Org.). Deficiência com eficiência: dos direitos da pessoa portadora de deficiência. São Paulo: OAB São Paulo, 2006.
- [21] BRASIL. Declaração de Salamanca e Linha de Ação sobre necessidades Educativas Especiais. Brasília: CORDE, 1996.

Direct Action for Unconstitutionality by Omission (ADO): In Generality

Giselle Feliz Santiago¹, Olavo Bilac Quaresma de Oliveira Filho²

¹PhD student in Law, Postgraduate Program in Master, and Doctorate in Law, UNICEUB, Brasília, Brazil

Email: giselle.santiago@sempreueub.com

²PhD of Biotechnology Applied on Agriculture, Department of Environmental Engineering, UEAP, Macapá, Brazil

Email : olavo.filho@ueap.edu.br

Received: 15 Jun 2022,

Received in revised form: 09 Jul 2022,

Accepted: 16 July 2022,

Available online: 24 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

Keywords — *ADO, Unconstitutionality,
Omission, Mandatory, Normative Effect.*

Abstract — *The article deals with unconstitutionality by omission within a generalist perspective, in the light of the most recent legal doctrines and analyses. Discussions that deal with the appropriateness of a writ of mandamus and the problematization with the lack of legal homogeneity in Brazil in these cases are observed here, especially about doctrinal conflicts. The actions and problems related to the ordinary effects in the ADO are debated within the recent doctrine, based on the understandings presented by the scholars, legislators, and the Superior Courts.*

I. INTRODUCTION

The issue of seeking and fighting for equality in the legal sphere to guarantee the achievement of the rights of people with disabilities has been observed in different branches of law, with emphasis on the aspect of protection in the sphere of consumer law and civil procedural law, both linked to tax matters and to constitutional and civil law.

In this way, it is understood that the search for guaranteeing the implementation of laws and the guarantee of rights is not restricted, only to the question of the individual principle, it is reasonable to understand that society has evolved in a collective scope and the repercussions, previously seen as specific issues in individual cases, needed to be looked at from the ADO's point of view. When considering collective interests, it is inherent to social issues to think of access to justice as a collective identification, not just linked to a single citizen.

The article presents a discursive analysis of the doctrines and legislation that affect the ordinary effects of

decisions taken in the ADO, as well as the types of decisions: mandatory, additive and concrete.

II. THE ORDINARY EFFECTS OF DECISIONS MADE IN THE ADO

The possible decision-making possibilities to analyze the core of the discussion on the ordinary effects taken in the ADO from the Plenary of the Federal Supreme Court fall on the analysis of its effects in the scope of procedural instrumentalization, in view of the propaedeutic criteria and the specific institution of its effects within the legal determination presented in law n° 9.868/99 and in the observance of constitutionality¹. Nevertheless, the rules on the ADO's decision must be defined from a decision by an absolute majority in the Federal Supreme Court, considering that there is an unappealable nature from the decision of the act, noting that the principle of isonomy must be respected and authority over the pronouncements and decision of the STF^{1,2}.

Law n° 9.868/99, in Section III, art. 12-H, deals with the observance given to its application, whose competence to adopt the necessary measures is the responsibility of the competent Power. For Costa e Silva and Cunha Junior¹ the decision in ADO has a determined rule, the effect of which will give temporary effects *ex-nunc*, in view of the applicability of nullity and the recognition of the principle of nullity in the act. In this line of analysis of the regulation, the observance presented in law n° 9.868/99 gives the STF the power to determine a prospective decision on the temporal ballast of the act, so that there is a guarantee of legal certainty, and the dictates are safeguarded, without prejudice of legal efficiency¹.

In view of the above, it is worth analyzing that, regarding the omission of unconstitutionality, it is possible to question the inertia and limitation of decisions in relation to the process, which will be incumbent on the Legislative Power¹. It is intended here to analyze the unconstitutionality by omission in the light of art. 103 of the Federal Constitution, regarding the period of 30 days and the possibility of sanction of the inert power in these cases. According to Carvalho³, the objective of the action of unconstitutionality by omission, from the new modality included by the Federal Constitution of 1988, is to guarantee the practice of legal execution, so that its efficiency is duly guaranteed. Therefore, according to Carvalho³, the constitutional omission is not linked to the constitutional system, but to certain blocks that make constitutional compliance unfeasible.

It is then necessary to observe and analyze, in a doctrinal character, that the constitutional omission is observed in the light of the main need to guarantee, from the perspective of the legislation, the fulfillment and guarantee of legal efficiency. According to Costa e Silva and Cunha Junior¹, the interpretative limitation for the application of the device, regarding the deadline for sanctioning the inert power must be observed in line with the need to maintain legal effectiveness, and it is possible to establish the due provisions in the scope of direct actions of unconstitutionality. As for the characterization of unconstitutionality in the act of omission, it will be up to the addressee of the act not to do so within the required terms or within the established working period, considering the constitutional term, if specified, and compliance with the principle of reasonableness³.

For Carvalho³, the occurrence of the omission of unconstitutionality can occur in the face of the functions of the State, in the following way:

1. unconstitutionality due to omission of legislative acts, in which the legislator, in the face of constitutional norms not enforceable by themselves – precepts or

prerogatives – does not enact the laws necessary to make them enforceable; 2. Unconstitutionality due to omission of political or government acts, when, for example, holders of constitutional positions are not appointed or laws are not enacted in Parliament; 3. Unconstitutionality by omission of the constitutional review, when the Constitution, explicitly or implicitly, requires the modification of some of its precepts or its institutes; 4. Unconstitutionality for omission of administrative acts, in the event of omission of administrative acts of execution of laws or regulations; 5. Unconstitutionality due to omission of a judicial decision, which means denial of justice.

Some characteristics about the constitutional omission will depend on the classification of modalities: absolute inertia or insufficient action by the legislator, which may then be partial or total. Partial omission refers to the absence and silence of the person responsible for the practice of the act in a part, acting incompletely to fulfill the constitutional requirements; the total, on the other hand, refers to the inertia or total and complete deficiency of the legislator, while it does not satisfy what is recommended in the constitutional commandment³. It is then observed that both the total omission and the partial omission fall on the understanding that there was a characterization of incompleteness or total ineffectiveness of the legislator's compliance with the act, which denotes an analysis of the conduct of legitimacy and the measurement of legitimacy – considering constitutional principles and any characteristics of legal preterition.

About the decision and the effects of unconstitutionality by omission, it is important to observe the constitutional measure and the science referring to the period (30 days), already mentioned above. According to art. 22 of law n° 9868/99, the decision must be given by at least eight Ministers. Despite being a complex issue, its characterization due to the judicial contour is inherent to the process, so that the acceptance of the action is effectively decided, without any incompleteness in the decision rendered in the Supreme Court. In the observation of Carvalho³, as previously argued, the STF has been recognizing that the omissions in this case as a non-recognition of the positive legislator, given that discussions on political issues and purposefully atypical attributions are occurring on a recurring basis - there is not any definitive support for such a claim.

III. DECISIONS WITH MANDATORY, ADDITIVE AND NORMATIVE EFFECT

The recognition of unconstitutionality by omission denotes, in addition to specific characteristics and

typologies, criteria and possibilities that will depend on the sieve of the STF and on some evaluation factors, whose specific outline is based on three effects: mandatory effect, additive effect and the normative effect. According to Costa e Silva and Cunha Junior¹:

It should be noted that the limitation or extent of these effects of judgments rendered in ADO will depend on the analysis of the following factors or evaluation criteria:

- i. what is the constitutional norm, parameter of control and the value/legal asset that it protects.
- ii. the measure of the degree of generality of the imposition.
- iii. how long the omission lasts.
- iv. urgent need for the solution.
- v. what are the material possibilities of complying with the decision.

To verify the practical use of these criteria, a study of some cases already discussed in the Supreme will be carried out, identifying their specific characteristics and the deficiencies or innovations present in the Supreme Court's positions in these cases, to evaluate the different decision-making possibilities around ADO.

The decision of normative effect, in terms of being the one that has been used the most by the STF since the changes in art. 103 of the Federal Constitution of 1988, can be observed as the most informative and usual decision-making possibility¹. The authors exemplify this effect from the explanation and discussion of ADI 1458-DF, in which the National Confederation of Health Workers (CNTS) was questioned in relation to the calculation of the minimum wage and the loss in the purchasing power of workers – the omission for partial unconstitutionality by Provisional Measure n° 1415/1996. It is observed here the existence of violation of the protection of workers' social rights, which confronts the constitutional regulations in art. 7 of the Federal Constitution¹.

Costa e Silva e Cunha Junior¹ analysis of this ADI 1458-DF observes a more focused discussion on the normative emphasis on compliance with the effect linked to the constitutional norm, so that the minimum wage - object of this act - is listed within a list of needs that is a worker's right and is protected within constitutional premises that cannot be disregarded, such as: health, leisure, clothing, hygiene, transport, social security, among others. This is what is observed in the extract from the ADI 1458-DF menu:

MINIMUM WAGE - SATISFACTION OF BASIC VITAL NEEDS - GUARANTEE OF PRESERVATION OF YOUR PURCHASING POWER.

The constitutional clause inscribed in art. 7, IV, of the Political Charter - in addition to the proclamation of the social guarantee of the minimum wage - it embodies a true legislative imposition, which, addressed to the Public Power, aims to bind it to the realization of a positive benefit destined (a) to satisfy the essential needs of the worker and his family and (b) to preserve, through periodic adjustments, the intrinsic value of this basic remuneration, conserving its purchasing power. MINIMUM WAGE - INSUFFICIENT AMOUNT - UNCONSTITUTIONAL SITUATION DUE TO PARTIAL OMISSION.

The decision rendered in ADI 1458-DF refers to the evaluation criterion and the degree of generality based on the constitutional norms that were observed by the Court as an act of violation of basic social rights. According to Barroso⁴, social rights and constitutional guarantees should not be violated, in such a way that any action or effect, either by omission or by imposition, should not be placed above in the Federal Constitution. In the example of ADI 1458-DF presented by Costa e Silva and Cunha Junior (2017), the issue about the minimum wage for workers is observed by the STF from a perception of the generality of the violated constitutional mandate, noting that the minimum wage is a vital constitutional guarantee and its failure to pay or cut it is a constitutional violation.

The decision with mandatory effect is analyzed by Costa e Silva e Cunha and Junior¹ from ADI 3682-MT, whose questioning presented concerns the legislator's omission regarding the formulation of the complementary law for the dismemberment of municipalities in the State of Mato Thick. It is observed here that, within the field of Administrative Law, a conflict of understanding is discussed, whose omission by the legislator generated a federative conflict:

The federative conflict is established from the moment when, even in the absence of the federal rules determined by Constitutional Amendment 15/1996, which included art. 18 §4 of the Constitution, the States continued to create, incorporate, merge, and dismember Municipalities according to their needs¹.

As Costa e Silva and Cunha Junior¹ well observe, the irregularity presented in ADI 3682-MT would generate legal uncertainty under the act of unconstitutionality, thus having material and concrete possibilities of harming the restructuring of municipalities and implying in problems and worsening conditions. social and environmental benefits for the population. The mandatory action, as Palu⁵ argues, concerns an assurance measure with the purpose of

preventing actions of unconstitutionality by omission, observing the dictates of the regulation and its due applications. To this end, in the case observed with ADI 3682-MT – for exemplifying purposes – the arguments analyzed by the STF observed the imposition of normative provisions and the establishment of deadlines, observing the constitutional commandments and the specified criteria.

Regarding the additive effects, it is also worth noting Costa e Silva and Cunha Junior¹ in the analysis of this possibility as a function that goes beyond the mere normality of informing, and deals with the integrative – or additive – decision. This technique originates from Italian law, whose application comes from cases of partial omission that violates the principle of isonomy, in view of cases of omission on the part of the legislator, in a group form from the actions of "forgetting" or "mistake" – noting here the measure of the so-called additive sentences – whose correction by the Court is given by the normative situation in the application. The authors bring as an example the ADO 32 presented by the Attorney General's Office to question the inertia of the Presidency of the Republic in the presentation of laws, in addition to the deliberation for the National Congress on the special retirement regime for public servants with disabilities.

In the case of ADO 32, it is observed that the PGR tried to defend the fundamental right of individuals based on the observance that retirement is a constitutional right, whose omission by the Presidency of the Republic and the National Congress could not affect the granting process. . In view of the above, it is therefore a matter of ensuring that the practice of the principle of isonomy takes place, whose part in the provocation came from the reasons exposed by the PGR when investigating the omission or "forgetfulness" on the part of the federative entities¹. It is here to analyze the urgency of the PGR to observe the legal uncertainty, which it issued in a Writ of Injunction so that the enjoyment of the right would be extended to retired public servants with disabilities, regardless of the filing by them.

IV. THE MATERIAL AND CONCRETE POSSIBILITY OF THE DECISION BEING CARRIED OUT

As previously noted, regarding the sentences handed down in ADO by the STF, it is extremely important to capture the effects of recognition of unconstitutionality from the intrinsic characteristics that permeate the sentences handed down, especially in what fit the factors and evaluation criteria. As presented in their study, Costa e Silva and Cunha Junior¹ identify the criterion of the

material possibilities of complying with the decision – focusing here on the execution of the sentence in a punitive or repressive nature by the STF.

It is then observed in an excerpt from an analyzed case:

With the conflict of principles demonstrated, the weighting judgment, already exercised daily by the Federal Supreme Court in other cases, would be sufficient to meet the material possibilities of compliance with the decision (criterion v).

This is because, in addition to being an inherent task, the Constitutional Court also counts on the support of procedural institutes created for highly complex decision-making assistance, such as the *amicus curiae* figure or the possibility of holding public hearings with society. in establishing decision-making and democratic parameters for the sub judice issue¹.

It is then noted that there is a weighting judgment in question, as can be seen during this ADO (ADO 22 - PGR) that there is a conflict of a legal nature, which prevented the materiality of the matter in a normative nature. This representation of generates conflicts of a social nature, whose involvement deals with issues that involve characteristics and elements of social repercussion and with expressive intersubjective meanders, tends to influence the decision of the Supreme Court, not reaching a concrete determination of its effects. In accordance with Costa e Silva and Cunha Junior¹, compliance with the ADO decision in procedural cases of an intersubjective nature, in addition to others that present the same elements, influences the concrete effects of the solution - which influences a decision, which in many cases, it tends not to be entirely satisfactory.

The role of the STF, in addition to safeguarding the Constitution and ensuring that there is no legal uncertainty, is to enable the materiality and concreteness of the decision, so that the maintenance of innocuousness with the ADO is avoided. It is worth noting that the Supreme Court, when investigating the legislator's omission, also analyzes the merits of complying with the legislating constitutional impositions based on the object and materiality of the act - having here the mission, in addition to safeguarding the constitutional norms, to safeguard the possibility to ensure that the decision is complied with, without subjectivity or guarantee of safety¹.

The issue of collective protection under the effectiveness of collective action was guided by Brazilian legislators in the attempt to promote faster access to justice. The Federal Constitution of 1988 deals with the collective protection of transindividual rights, as a defense perspective, the guarantee of diffuse interests from the point of view of the homogenization of law within the

conception of freedom and the guarantee of rights and access to justice. The protection of rights and the guarantee of the constitutionality of collective actions derive, in the view of the legislator, from the protection of the State towards the individual through mandatory, including access to rights and justice⁶.

The guarantee of reasonableness and procedural celerity presented by the collective actions denotes its legal nature of protection and defense of rights in the collective scope, as well as the reduction of the long-term effects in procedural bureaucratization, given its characteristic of instrumentalization and collective representation and meta-individuals. The Constitution deals in its art. 5, item LXXVIII that: "all, in the judicial and administrative scope, are assured of the reasonable duration of the process and the means to guarantee the speed of its processing." Therefore, due to the guarantee of rights in constitutional matters, it was a matter of guaranteeing that legal protection in the collective scope would guarantee practical measures so that there would not be a breach of rights - Constitutional Amendment n° 45/2004 added such a measure in art. 5th^{7,8}.

The discussion on collective actions and control of constitutionality within the aspects of tax and social security matters is the object of numerous debates in the Brazilian legal system, mainly regarding the conception of the instrumentalization of collective law. For Didier and Zanetti Junior⁷ the background of all this clash denotes the understanding presented by the STF from the judgment that declared the unconstitutionality as to the appropriateness of public civil action. There is a broad discussion on the issue in Brazilian doctrine, especially magistrates, including STF ministers - such as the thesis of Min. Gilmar Mendes, from the STF, noting that it is unfeasible for public action to involve incidental control of constitutionality.

The judgment of Complaint 600-0/90-SP presented the following understanding on the diffuse control of constitutionality in relation to the public civil action:

In the public civil action, now under trial, the constitutionality of law n° 8.024/90 is controlled by diffuse means. Even admitting that the decision under examination excludes the incidence of the law that would be applicable to the concrete hypothesis, as it violates an acquired right and a perfect legal act, it is certain that the respective judgment is not immune to the control of the Federal Supreme Court, from the outset, in view of the art. 102, III, letter b, of the Major Law, behold, the final decision of the local Court will have recognized the unconstitutionality of federal law, when settling a certain conflict of interest. In this way, the coexistence of the two systems of control of

constitutionality is manifested: the same federal or state law may have declared its invalidity, either in the abstract, in the concentrated way, originally in the STF (CF, art. 102, I, a), or in the diffuse way, incident tantum, at the opportunity of the debate of controversy in the defense of subjective rights of interested parties, moving away its incidence in the concrete case in judgment. 8. In class actions, the possibility of declaring unconstitutionality, incident tantum, law or federal or local normative act is not denied [...]" (CLAIMS 600 -0/90 -SP, MIN. REPORT NÉRI DA SILVEIRA, DJRN 02/05/2010)

It is salutary to observe, according to the statement made by Minister Néri da Silveira, that despite the understanding of diffuse control of constitutionality through public civil action, it must be analyzed that the harmful question only occurs in case of a motivated petition, without that there is usurpation of the jurisdiction of the STF. In addition, it is observed that in another aspect the question of judgment in confused law can be presented as the final law, being incompetent for appreciation. Didier and Zanetti Junior⁷ note that diffuse control is required:

"a) that the sole object of the demand is not identified in the constitutional dispute; b) that the question of constitutionality sees and acts as a simple preliminary question; c) the existence of a concrete and specific legal relationship in the order file; d) present itself as a cause of action and not as a request for constitutional matters. Hence, the following and very important consequences can be extracted: a) the non-occurrence of *res judicata* on the preliminary question (art. 467, III, of the CPC); b) the non-exclusion of the contested rule incident tantum from the positive law order.

The understanding discussed by Didier and Zanetti Junior⁷ observes that the question of the discussion on the unconstitutionality of the tax in collective action involves the nature of the rights at stake, so it could not be the target of a proposal presented by the Federal Public Ministry (MPF). Also, according to the authors, the filing of public civil action in tax matters must be following the MPF, based on the understanding of renowned jurists in the civil procedural area. It is noteworthy that the MPF must ensure this matter in the national tax system. Almeida⁹ presents the decision of the STF, in leading case, rendered in RE 195.056-1/PR in plenary:

"Constitutional. Public Civil Action. Taxes: IPTU. Prosecutor's Office: Legitimacy. Law n° 7.374, of 1985, art. 1, II, and art. 21, with the wording of art. 117 of Law n° 8.078, of 1990 (Consumer Code); Law n° 8.625, of 1993, art. 25. C.F., articles 127 and 129, III.

I - Public civil action is used to defend homogeneous individual rights, with the Public Prosecutor's Office being legitimized to enforce it, when the holders of those interests or rights are in the situation or condition of consumers, or when there is a consumer relationship. Law n° 7.374/85, art. 1, II, and art. 21, with the wording of art. 117 of Law n° 8.078/90 (Consumer Code); Law n° 8.625, of 1993, art. 25.

II – Certain homogeneous individual rights can be classified as collective interests or rights or identified with unavailable social and individual interests. In these cases, the public civil action serves to defend these rights, legitimizing the Public Ministry for the cause. C.F., art. 127, caput, and art. 129, III.

III – The Public Prosecutor's Office has no legitimacy to file a public civil action for the purpose of challenging the collection and claiming the refund of tax – in this case the IPTU – paid unduly, nor would this action be appropriate, given that, in the case of taxes, There is not, between the active subject (public power) and the passive subject (taxpayer) a consumption relationship (Law n° 7.374/85, art. 47 – Apr./Jun. 2002 44 wording of article 117 of Law n° 8.078/90 (Consumer Code); Law n° 8.625/93, article 25, IV; C.F., article 129, III), nor would it be possible to identify the right of the taxpayer with “unavailable social and individual interests.” (C.F., art. 127, caput). IV - R.E. not known.

In view of the above, Almeida⁹ argues that the denial in plenary of the STF, despite all the argumentative bulge based on the prerogative of the MPF's filing, did not consider international treaties and the universal understanding of collective actions in matters of guarantee of access to justice. In this way, it is alluded that the understanding presented in the Extraordinary Report above makes it difficult to access collective rights in terms of procedural agility, having a great impact on the Judiciary, since it considers that each taxpayer - according to the understanding presented by the STF – must submit its own action to the individual title.

Almeida⁹ adds that:

CF 88 constitutionalized public civil action, by including its promotion as one of the institutional functions of the Public Ministry, for the defense of the environment, public and social patrimony and “other diffuse and collective interests” (art. 129, III). This last category includes indivisible, trans-individual interests held by indeterminate persons of the collectivity, linked together by factual circumstances, as well as those held by determinable persons belonging to a group, category, or class, united with each other or with the opposing party. by a basic legal relationship. By “collective interests” are also

understood the homogeneous individual rights, which are considered collective *lato sensu* – therefore, within the non-restrictive concept adopted by the FC – or “subspecies of collective interest.

The understanding observed by Almeida⁹ denotes the competence of the MPF in the light of what was previously presented by the CF/1988. In this sense, it is worth mentioning that the power over taxation will be in the observance of the Public Ministry of the Union, while in infra-constitutional jurisdiction it is within its competence to comply with the matter. Zavascki¹⁰ makes an argument about the issue of unconstitutionality based on the principle of supremacy in matters of CF/1988 and the normative force in the Constitution itself:

(...) Whatever the way in which the phenomenon of unconstitutionality is presented, it is subject to the control of the Judiciary, through mechanisms established by the Constitution itself. With regard to the normative precepts resulting from the legislative action, the judicial review of its constitutionality can be basically in two ways: a) in the judgment of a concrete case, in which, in order to protect a specific subjective right, application of norms is denied considered unconstitutional and; b) in the judgment of direct action for this purpose, in which, in order to protect the Constitution itself, the unconstitutionality or constitutionality of a certain normative precept is declared. In the first case (a) there is diffuse control of constitutionality, so called because it can be carried out by any judge or court. In the second case (b) there is concentrated control, because it is the exclusive competence of the Federal Superior Court (when the offense is against the Federal Constitution) and of the State Courts of Justice (when the State Constitution is offended).

It is understood then that, in light of the clarifications and the aforementioned decisions already presented in plenary by the STF and the SJT court, the understanding about the consensual adequacy on the promotion of public civil action under the object of unconstitutionality or does not present itself as a uniform decision in the doctrinal aspect, while the very controversy of understandings on the question of the implication of collective rights in tax matters amplifies the debate on the constitutionality of the actions filed. The doctrinal discussion, as one of the objects of discussion of this study, lacks depth on the questions of the appropriateness of public action in terms of tax object.

V. CONCLUSION

The contribution of the study is given by the debate about the instrumentalization and guarantee of procedural law. Attention is drawn to a deepening of the discussions

that permeate subjectivity in decisions rendered in Superior Courts and the absence of a specific and univocal legal rule to deal with a certain topic within the Brazilian legal framework. In addition, it is necessary to highlight the need to address this issue in academia due to its breadth of relevance, both in the social sphere and in the legal sphere under the prism of public debate.

From the point of view of practicality, the study discusses the use of ADO, an instrument that can serve mainly for minorities and the disabled.

It is observed in a technical and analytical way the breadth of its social rights, both in the constitutional point of view, as in the procedural point of view, so that there is a more effective contribution of this instrument within the scope of the Brazilian legal system.

ACKNOWLEDGEMENTS

We thank UNICEUB and UEAP for the structure made available in the preparation of this article.

REFERENCES

- [1] COSTA E SILVA, Gabriela; CUNHA JUNIOR, Dirley da. Efeitos das decisões em ação direta de inconstitucionalidade por omissão: da possibilidade de prolação de sentenças criativas no controle abstrato das omissões do poder público. *Revista Brasileira de Direito*, São Paulo, v.19, n.18, p. 395-418, 2018.
- [2] BRASIL. Lei 9.868. Dispõe sobre o processo e julgamento da ação direta de inconstitucionalidade e da ação declaratória de constitucionalidade perante o Supremo Tribunal Federal. *Diário Oficial da União*. 1999.
- [3] CARVALHO, Kildare Gonçalves. *Direito constitucional*. 18. ed. rev. atual. e ampl. Belo Horizonte: Del Rey, 2012.
- [4] BARROSO, Luís Roberto. *O Direito Constitucional e a efetividade de suas normas: fundamentos de uma dogmática constitucional transformadora*. São Paulo: Saraiva, 1996.
- [5] PALU, Oswaldo Luiz. *Controle de constitucionalidade, conceitos, sistemas e efeitos*. 2. ed. São Paulo: Revista dos Tribunais, 2001.
- [6] LIMA, Maria Cristina de Brito. Ações coletivas. *Revista da EMERJ*, v.5, n.19, 2002. Disponível em: https://www.emerj.tjrj.jus.br/revistaemerj_online/edicoes/revista19/revista19_169.pdf. Acesso em: 26 set. 2020.
- [7] DIDIER, Fredie Jr; ZANETI JR, Hermes. *Curso de Direito Processo Civil – Processo Coletivo* 6 ed. Editora Juspodivm. 2011.
- [8] MAZZILLI, Hugo Nigro. *A defesa dos interesses difusos em juízo: meio ambiente, consumidor, patrimônio cultural, patrimônio público e outros interesses*. São Paulo: Saraiva, 2007.
- [9] ALMEIDA, João Batista de. Ação civil pública em matéria tributária: reflexões sobre a posição do STF. *B. Cient. ESMPU*, Brasília, v.1, n. 3, p. 41-47 – abr./jun. 2002.
- [10] ZAVASCKI, Teori Albino. *Processo coletivo: tutela de direitos coletivos e tutela coletiva de direitos*. Tese. (Doutorado em Direito). 295 f. Rio Grande do Sul: Programa de Pós-Graduação em Direito, Universidade Federal do Rio Grande do Sul, 2005.

The real reasons for choosing bushing fiber (*Luffa cylindrica*): A bibliographic review

Deolinda Lucianne Ferreira¹, Ane Micheele Rodrigues Coelho², Cláudio Gonçalves³,
Edivan Neves⁴, Darío da Silva⁵, Andreza Bastos Mourão⁶

¹Center for Higher Studies of Itacoatiara, State University of Amazonas, Brazil
Email: dlferreira@uea.edu.br

²Department of Materials Engineering, Federal University of Amazonas, Brazil
Email : acoelho.gait@uea.edu.br

³Coordination of Electrical Engineering, State University of Amazonas, Brazil
Email : cgoncalves@uea.edu.br

⁴Department of Electronic Engineering, State University of Amazonas, Brazil
Email : edsn.elt@uea.edu.br

⁵Department of Control and Automation Engineering, Federal Institute of Amazonas, Brazil
Email : 2018004498@ifam.edu.br

⁶Higher School of Technology, State University of Amazonas, Brazil
Email: coordenacao_gait@uea.edu.br

Received: 15 Jun 2022,

Received in revised form: 10 Jul 2022,

Accepted: 16 July 2022,

Available online: 25 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

Keywords — *Chemical, Low Cost, Luffa Cylindrica, Mechanical, Physical, Properties, Strength.*

Abstract— *Growing environmental issues and the search for alternatives to synthetic fibers have led to the development of composite materials made from natural fibers. Luffa Cylindrica has an important prominence in scientific research due to its properties presenting excellent results for the use of reinforcement in matrices. Therefore, this work aims to analyze the physical, chemical and mechanical properties of bushing fiber based on scientific articles. The publications were selected from a search in the databases, CAPES Periodicals, Scielo and Google Scholar, from 2003 to 2021. Thirty-three works were selected that deal with the properties of Luffa Cylindrica, with twelve articles from the years of 2017 to 2021. It was concluded, with this review, that Luffa Cylindrica encompasses ideal qualities for use as reinforcement of composite materials, as it abundant in nature, low cost and low weight, is non-toxic and has physical and chemical stability.*

I. INTRODUCTION

The use of plant fibers in composite materials is expanding every year due to the growing concern for the environment [11]. This is mainly due to the fact that these fibers have biodegradable characteristics, are less aggressive to the environment, have a great variety and availability in biodiversity, compared to the reinforcement materials currently used, they have a lower cost and are harmless to the health [23]. Therefore, natural fiber

becomes an excellent alternative for use as reinforcement in composite materials [1].

Natural fibers exhibit important results of their properties when used as reinforcement in polymeric materials. Luffa sponge is a lightweight natural material that has the potential to be used as a sustainable alternative material for various engineering practice applications [10]. In addition, loofah (*Luffa cylindrica*) is an economic reinforcement material, as they are among the largest and most diverse families of plants, being cultivated all over

the world, for supporting a variety of environmental conditions [23].

The bushing has been successfully used as a biotechnological tool in a variety of systems, purposes and applications such as: packaging, sound and vibration insulation, impact energy absorption, manufacture of insoles, slippers, sieves, belts and filters of car oils, bath sponges and hats [10, 12, 23, 25]. In addition, it is also widely used in various other fields such as pharmaceutical engineering, environmental engineering, industrial, medicinal products [4, 8] and adsorption materials in water treatment plants [5], in which its chemical stability stands out and good moisture absorption [25].

Luffa cylindrica (LC) is a subtropical plant abundant in China, Japan and other Asian countries, as well as in Central and South America, belonging to the Cucurbitaceae family [1, 2, 5]. The plant reaches a length of approximately 10 m. The fruit has a cylindrical shape, with a length of 15 cm to 100 cm and a diameter of 8 cm to 10 cm [23].

The fruit of the loofah plant has a fibrous vascular system, in which it is arranged in the form of a multidirectional network, which forms a natural blanket, with yellow color when ripe and dark brown when dry [23]. The bushing can be presented in two ways, with a density range of 15 to 30 kg/m² which is considered low density (LD), while in the density range of 31 to 65 kg/m² it is considered high density (HD) [22].

The literature demonstrates several articles that present the advantages of using bushing fiber. A comparison study shows that *Luffa* sponge has better energy absorption capacity per unit mass than other cellular materials with similar plateau stress at various strain rates [10].

Another study investigated potential for the development of new epoxy composites reinforced with the fibers in question. In this research, they concluded that the grafting of *Luffa* fibers with furfuryl alcohol and alkaline treatment significantly improved the thermal, mechanical and water resistance properties of the composites [11].

Finally, the work on immobilized cells demonstrated an efficient performance in the removal and biodegradation of toxic metals, dyes and chlorinated chemicals in which *Luffa* was considered a good support for the development of biofilms for wastewater treatment [12].

This article aims to carry out an analysis of the physical, chemical and mechanical properties of the loofah (*Luffa cylindrica*) based on literature data. This article is justified by the fact that through the study of natural fibers it will be possible to understand the best and most efficient

application of their use in polymeric matrices, taking into account that their biodegradability can contribute to a healthier ecosystem and their low cost and performance serves the economic interests of various industries.

II. METHODOLOGY

The research was carried out from March to August 2021 with an extensive review in the Databases, Capes Periodicals Portal, Scielo and Google Scholar. The following keywords were used in the searches: bushing properties, bush, *Luffa cylindrica* property, *Luffa cylindrica* physical, chemical property and mechanical property.

An analysis of works developed in the country and published in indexed National and International Journals was carried out, from 2017 to 2021 to compose the results and the discussion. From this search, 33 articles related to the properties of *Luffa cylindrica*, published in indexed scientific journals, were selected from the bibliographic research. After selecting the articles, a thorough reading was carried out, from which the main information of the texts discussed was extracted and analyzed. The other articles were not included, because even when they were rescued, they were studies not related to the criteria adopted in this work.

Also in the composition of this review, articles were selected between the years 2004 and 2016 for literary basis and support in the discussion.

III. RESULTS AND DISCUSSION

Of the 33 articles evaluated, 12 articles were about chemical, physical and mechanical properties in the years 2017 to 2021, as shown in Table 1. According to the results obtained, all works presented in their investigations the mechanical properties related to the bushing. Two articles characterized the bushing by chemical property and two studied its physical properties.

3.1 MECHANICAL PROPERTIES OF THE BUSHING

The works 1, 2 and 3 investigated the mechanical properties, specifically of *Luffa cylindrica* by the tensile strength method. Article 1 analyzed low and high density Luffas, 15 kg/m³ to 30 kg/m³ and 31 kg/mm³ to 65 kg/m³, respectively. Article 2 studied *Luffa* fibers with and without alkaline treatment (2% aqueous NaOH), and article 3 evaluated fibers submitted to chemical pre-treatments.

For the tensile strength measurements of article 1, the *Luffa* sponge fibers were air-dried until their moisture

content varied from 8% to 10% by weight (% by weight) and cut into 30 mm long sections. Subsequently, tensile tests were conducted on a universal testing machine (Shimadzu Corporation, Shimadzu AG-X Plus, Kyoto, Japan) with a load cell of 1 kN and a crosshead speed of 0.5 mm/min. Tensile tests proved that high density fibers have lower mechanical strength than low density *Luffa* fibers. The authors concluded that the probable reason for this behavior may be the high crystallinity of cellulose in the high density sponge [22].

Table.1: Articles from 2017 to 2021 related to *Luffa Cylindrica* properties.

No.	Properties	Methods	Reference
1	Mechanics	Tensile strength	[22]
2	Mechanics	Tensile strength	[23]
3	Mechanics, Physics and Chemistry	Tensile strength, diameter and roughness	[24]
4	Mechanics	Compressive strength, flexibility modulus and water absorption	[25]
5	Mechanics	Compressive strength	[26]
6	Mechanics	Tensile strength	[27]
7	Mechanics	Tensile and flexural strength	[28]
8	Mechanics	Tensile strength, flexural strength, and impact strength.	[29]
9	Mechanics	Non-destructive impulse excitation	[30]
10	Mechanics and physics	Physical, mechanical and abrasive wear and water absorption	[31]
11	Mechanics	Compressive strength and modulus of elasticity	[32]
12	Chemistry and Mechanics	Tensile strength and modulus of elasticity	[33]

Article 2 performed the mercerization with 2% aqueous NaOH on the *Luffa* fibers and carried out the tensile test on samples from both alkaline and untreated samples. For this, a Shimadzu SLBL machine with a load cell of 500 mN was used. In this study, mercerization was found to increase the fiber's mechanical strength. This result is

probably due to the fact that the crystallinity index of *Luffa cylindrica* fiber increases with chemical treatments [23].

Research 3 presents the tensile properties of *Luffa* fibers with and without chemical surface pretreatments. Where the chemical surface pretreatments used in this work were sodium hydroxide, silane and calcium hydroxide, for this they used an Instron universal testing machine type 5500 R with applied pressure of 0.4 MPa using pneumatic gripper in a cell of load of 1.0 kN and crosshead speed of 0.1 mm min⁻¹ at room temperature (21 °C).

The authors observed that the pre-treatments performed on the *Luffa* fiber removed most of the non-crystalline constituents, which resulted in an increase in the overall strength of the fiber. *Luffa* fibers treated with Ca (OH)₂ showed the highest tensile strength (~ 719 MPa), this fact may be associated with the removal of impurities from the fiber surface due to these treatments, which generates a greater mechanical interlock with the polymer matrix [24].

Articles 4 and 5 investigated the mechanical properties of the bushing using the compressive strength method. Research 4 studied high density (35 to 65 kg/m³) and low density (15 to 35 kg/m³) *Luffa cylindrica*. Article 5 evaluated high density *Luffa cylindrica* subjected to three types of softening treatment methods, which are alkaline hydrogen peroxide, alkaline acetic acid and alkaline urea. Both researches studied the properties of the bushing for use in mattress filling.

In addition to the uniaxial compressive strength test of *Luffas Cylindricals*, research 4 evaluated their flexibility and water absorption module. The authors demonstrated that the compressive strength of the columns of the high-density bushing was significantly higher than that of the columns of the low-density bushing. This result is justified by the fact that high density fibers have relatively more methylene and a lower amount of lignin, which favors good flexibility and resilience to the macromolecules and microfibrils chain. On the other hand, low density fiber contains more lignin, which indicates more stiffness. Finally, both types of materials showed good water desorption, in which they concluded that the use of *Luffa* filling material to prepare mattresses is suitable for its proper use [25].

Research 5 also performed uniaxial compression on the samples, but researched bushings submitted to three types of chemical treatment methods. The authors concluded that the three methods were able to reduce peak stress and improve the uniformity of high density *Luffa*. The fiber compression resilience after treatment with 18% NaOH - 6% CO(NH₂) showed the highest compression resilience. This process is a result of the shrinkage of the cell wall of

the fiber, which evolved from a hexagonal cell lumina to an open lattice with an irregularly shaped wrinkled structure, which provides the fiber with excellent elasticity [26].

Through the results of the strength of the bushing, it was observed that there is a difference in the mechanical behavior of the fibers depending on their density. Another important point is the influence of chemical treatment on the mechanical properties of the samples. In the first two works, the fiber is studied to be used as reinforcement in matrices, resulting in a study that the low density *Luffa cylindrica* is more resistant to traction. In the second study, the high density *Cylindrical Luffas* were submitted to a chemical treatment, obtaining an improvement in the compressive strength. In this case, the objective was to study luffa for mattress filling, with the result that the chemically treated fiber has become an excellent material option for applications of products subjected to compression.

The third and fourth articles aimed to study bushings for filling mattresses, so their focus was the study of the compressive strength of these fibers. Differently from article 1, where low density *luffa* presented better results, article 4 showed that the high density bushing presented itself as the most suitable material for its purpose. The fourth article presented three types of chemical treatments in its fibers, in which, as reinforced in article 2, the treatment to which they are submitted improves both the tensile strength and the compressive strength of the fibers studied.

Studies on the mechanical behavior of fiber traction and compression are extremely important. In this sense Chen et al. [16] studied these parameters at different locations on a *luffa* sponge. The result showed that single fiber is a porous composite material consisting mainly of cellulose fibrils and lignin/hemicellulose matrix, and its elastic modulus and strength are comparable to wood. Furthermore, it shows that the inner surface has stronger mechanical properties than the central part.

Other research has shown the stiffness, strength and energy absorption characteristics of the *luffa* sponge through a series of compression tests on *luffa* sponge columns. Stress-strain curves show an almost constant plateau stress over a long strain range, which is ideal for energy absorbing applications. The spongy *luffa* material has been found to exhibit remarkable rigidity, strength, and energy absorbing capabilities that are comparable to those of some metallic cellular materials in a similar density range [7].

Shen et al. [10] investigated the effect of strain rate of *luffa* sponge material with a wide density range. It was

found that the compressive strength, plateau stress and specific energy absorption of the spongy material *luffa* are: all load rate sensitive; that the energy absorption capacity per unit mass at high strain rates of *luffa* sponge is greater than that of many commonly used metallic foams; and that *luffa* sponge has the potential to be used as an alternative sustainable material for various engineering applications such as packaging, sound and vibration insulation, and impact energy absorption.

3.2 MECHANICAL PROPERTIES OF THE BUSHING AS REINFORCEMENT IN A MATRIX

In addition to the studies carried out directly on the bushing fiber, research was found where the mechanical properties of the bushing are investigated as reinforcement in a matrix. Articles 6, 7, 8 and 9 evaluated the properties of *Luffa cylindrica* as an epoxy resin reinforcement.

The articles 6 and 7 investigated the mechanical properties of composites (*Luffa cylindrica* and epoxy resin). For this, article 6 carried out tensile creep tests in linear viscoelastic regime and article 7 studied the behavior of moisture absorption and swelling in thickness and its effect on tensile and bending properties.

In research 6, 30% by weight fraction of fibers were added to the resin, continuously allocated, oriented parallel to the longitudinal direction of the layer. Then the samples were tested at four stress levels corresponding to 5%, 8%, 10% and 15% of the static tensile strength of the composite. The authors compared the pure resin with *Luffa cylindrica* composite and epoxy resin and concluded that there is a tendency for the creep response to increase linearly with the application of tension. As well as the reduction of creep deformation occurs as it increases with the application of stress. This implies that the greater the applied load, the greater the effect of the fibers to contain creep [27].

Article 7 studied composites with three different weight ratios of *luffa* fiber (6.5, 13 and 19% by weight), where they evaluated the effect on the tensile and bending properties of these samples that were subjected to different environments, distilled water and salt water (5% NaCl) and temperature below zero (-25 °C). The results showed that under all environmental conditions, tensile and flexural properties decrease compared to dry composite samples.

Where, maximum degradation of properties occurs in case of distilled water environment followed by salt water and sub-zero environment. This is confirmed in the scanning electron microscopy images of the composites, which show that the fiber has a great tendency to swell and absorb more moisture in a distilled water environment,

which possibly causes detachment of the matrix fiber and matrix cracking [28].

Articles 8 and 9 investigated the mechanical properties of epoxy composites with fibers subjected to chemical treatments. Article 8 studied the effect of mechanical properties on fibers treated with alkali (5% concentration), benzoyl chloride and potassium permanganate (KMnO_4) (0.05%) at room temperature. Article 9 investigated the effects of surface treatments of luffa fibers by hornification and mercerization methods.

Article 8 used double layer composites with 13% *Luffa cylindrica* fiber in its research. In this study, only the outer core of luffa fibers was used. It was observed that the mechanical properties of *Luffa cylindrica* fibers were significantly improved by modifying the fiber surface by different chemical methods. The improvement in all mechanical properties occurs due to the rough surface of the fiber produced by the removal of natural and artificial impurities, and fibrillation of the fiber which facilitates the mechanical anchoring between the fiber and the matrix. The best results were achieved in the case of the composite of fibers treated with benzoyl chloride [29].

For chemical modification of luffa fibers of article nine, 97% sodium hydroxide (analytical grade) was used, and for the hornification process, the fibers were placed in water at a temperature of 100 °C for three hours, until they reached their maximum absorption capacity, since for mercerization, the fibers were immersed in an aqueous solution of NaOH 2% by weight for 90 min. The composites in this research had 20% of the luffa weight fraction, in which the non-destructive impulse excitation technique was used to obtain the mechanical properties of the manufactured composites.

The results showed that the elastic modulus values are higher in luffa/epoxy composites made from fibers treated with mercerization and hornification, in which this may be related to higher crystallization values of the treated fibers and efficient removal of non-cellulosic components from the amorphous regions [30]. A previous study emphasizes that the effect of the mercerization treatment by weight of NaOH on the fibers produces only a small increase in flexural strength, and the best results were obtained with the 5% NaOH solution [1].

Among the four articles that investigated the properties of *Luffa cylindrica* as an epoxy resin reinforcement, three [27, 28, 29] presented methods widely used and widespread in the literature, such as tensile and flexural strength tests, on the other hand, the research 6 obtained its mechanical property through the impulse excitation method, in which it is used to measure the damping of the specimens. Thus, the impulse excitation technique is

shown to be an effective method for the characterization of composite materials.

The fiber weight fractions used in research on luffa/epoxy composites were 6.5%, 13%, 19%, 20% and 30%. It was noted that with the addition of fibers in the epoxy matrix, the mechanical strength values increased compared to the epoxy resin without luffa fibers as a reinforcement phase, as these fibers absorb the efforts of the matrix. All the chemical treatments studied in the articles resulted in an increase in the mechanical strength of the composites. On the other hand, article 7, which subjected the fibers to different environments, noted that the composites had higher degrees of degradation in the samples, which resulted in lower mechanical strength, which was mainly noticed in the fibers subjected to the environment of distilled water.

Previous studies confirm the manufacturing efficiency of composites made of epoxy resin and *Luffa cylindrica*. One article demonstrated that the mechanical response of the composite was improved compared to the pure polymer, due to the insertion of natural fibers. This fact can be explained by the nature of the reinforcement material and its contribution to the overall behavior of the composite. This improvement concerns the stiffness of the material, which optimally increased by 48% for a mechanically applied pressure of 4.6 kPa during curing. Furthermore, the chemical treatment led to an improvement in stiffness of up to 30% (coating: acetone/ CH_3COOH 1%) [20]. In agreement, Saw et al. reports that epoxy can be covalently bonded to modify luffa fibers, which can be used to generate epoxy composites with improved mechanical and thermal properties [11].

In a recent research, two articles were found (10 and 11 in Table 1) which the authors carried out a study using polyester as a matrix of composites with bushing fiber. In article 10, a study was carried out on the mechanical behavior of luffa fiber reinforced polyester composites with and without the addition of microfillers of Al_2O_3 , CaCO_3 and TiO_2 . In article 11 the composites were tested experimentally and numerically as faces of sandwich panels, formed by cores of vegetable bushing impregnated with polyester resin and expanded polystyrene.

In article 10, a research was carried out the mechanical characterization of traction and bending of the constituent composites with the following compositions: polyester + Luffa fiber (0% by weight); polyester + Luffa fiber (5% by weight); polyester + Luffa fiber (10% by weight); polyester + Luffa fiber (5% by weight) + Al_2O_3 (5% by weight); polyester + Luffa fiber (10% by weight) + Al_2O_3 (5% by weight); polyester + Luffa fiber (5% by weight) +

CaCO₃ (5% by weight); polyester + Luffa fiber (10% by weight) + CaCO₃ (5% by weight); polyester + Luffa fiber (5% by weight) + TiO₂ (5% by weight); polyester + Luffa fiber (10% by weight) + TiO₂ (5% by weight) [31].

The authors concluded that the addition of microfilms improved the mechanical properties of luffa fiber based composites. It was also found that composites filled with microadditives have excellent tensile strength compared to unfilled composites. Polyester composites with 5% by weight luffa fiber plus 5% CaCO₃ obtained the highest tensile strength. This may be due to good particle dispersion and strong interface adhesion. In the flexural test, the highest flexural strength was obtained in the composite filled with 10% luffa fiber plus 5% CaCO₃. This may be due to the good compatibility between the filler and the matrix [31].

In work 11, the loofah impregnated with polyester resin was used as cores of a polyester composite reinforced with ramie yarns. Where the bushing was compared with expanded polystyrene cores. For this, the loofah cores were cut and placed in polyester resin until their absorption at room temperature. The results demonstrate that the core of vegetable bushing impregnated with polyester resin presented higher values of compressive strength and modulus of elasticity compared to reinforced polyester. This fact may be related to the reticulated structure of the bushing. The authors observed that two types of failures occurred the panels with a bushing core, by detachment of the faces and by shear of the core. However, they claimed that they were excessive deformations in the test and that it would not happen under normal conditions of use [32].

Thus, according to the studies mentioned above, the addition of fibers in polymeric matrices proves to be an excellent alternative for reinforcement in composites, especially when combined with chemical compounds. Article 11 presented the use of the bushing as part of a composite system for panels to be used in the construction sector, in which the tests showed that *luffa* achieved superior results to the synthetic material, in which the bushing reveals a new alternative for use and consequently, the reduction in the use of synthetic material.

A study demonstrated the preparation of composites with short fibers and *Luffa cylindrica* mats with polyester matrix by compression molding. In which the surface treatment of *luffa* fibers with 2% NaOH for 90 min was considered the best treatment with reference to the highest fracture energy in which they exhibited the best tensile properties, although still inferior to those of other plant fiber composites. However, no significant increase in the

tensile strength of composites was observed compared to composites of untreated fibers [19].

In this current review, the most investigated polymer matrices for making composites with bushings were epoxy resin and polyester. However, in older studies we can find, for example, vinyl ester matrix and polycaprolactone in the literature. Tanobe et al. [13] used a sequence of organic extraction and chemical treatments in order to increase the interfacial compatibility between *Luffa cylindrica* fibers and the vinyl ester matrix and evaluated their mechanical properties. The tensile strength and Charpy impact tests showed an increase in the strength of the composites when compared to the matrix. The best results were obtained for fibers treated with 1,2,4,5-benzenetetracarboxylic dianhydride (PMDA) in vinyl ester matrix composites, which showed an increase of 30% for tensile strength and 250% for impact strength [13].

Another form of reinforcement is the cellulose nanocrystals prepared by acid hydrolysis of *Luffa cylindrica* fibers. These cellulose nanocrystals were used as a reinforcement phase for the processing of bio-nanocomposites using polycaprolactone (PCL) as a matrix. In which mechanical behavior was evaluated both in the linear and non-linear ranges of these unmodified and chemically modified nanocrystals. Chemical grafting promotes more homogeneous dispersion of nanocrystals within the PCL, as shown by the significant improvement in elongation at break compared to unmodified nanoparticles. This effect was more pronounced for modified nanoparticles and probably in part due to the increased crystallinity of the PCL matrix [14].

In addition to the polymeric matrices, a current study was found in which the matrix of the bushing composite was made of cement. Article 12 studied the esterification of vegetable bushing fibers to verify their performance in the cement matrix. In which the content of bushing fibers used in the matrix was 3% by weight and the esterification reactions were carried out with the modifying agents octanoyl chloride, lauroyl chloride and stearoyl chloride, using toluene as solvent and pyridine as catalyst. The modification with octanoyl chloride reduced the absorption (65%) and changed less the tensile strength of the fibers, with an increase of 67% in the modulus of elasticity, being, therefore, considered the best condition for the treatment of vegetable bushing fibers [33].

3.3 CHEMICAL PROPERTIES OF THE BUSHING

As seen in Table 1, two current articles were found that reported the chemical properties of *Luffa cylindrica* in their studies. The first study published in 2017 by Souza et al. [33] showed that the chemical components of the vegetable bushing fibers used in their study were 70.8% (\pm

0.5) of cellulose, 14.7% (± 0.7) of lignin and 17.2% (± 0.8) of hemicelluloses A and B. Kalusuraman et al. [24] obtained the following results for the chemical composition of the bushing: 73.92% of cellulose, 21.85% of lignin, 9.75% of moisture content, ash content of 4.07 and wax content of 0.48.

The result of the research demonstrates that the content in greater proportion was cellulose, this in the fiber plays a substantial role in its tensile strength. The literature confirms that the tensile strength of fibers is due to cellulose and its compressive strength to lignin [12]. Both components are found in considerable amounts in this fiber, which makes it an excellent alternative for reinforcement in composite material matrices.

Past studies have also evaluated the chemical composition of *Luffa*. Tanobe et al. [3] reports in their study a characterization of chemically treated Brazilian sponge gourds, in which he concluded that the cellulose content was similar to that reported for sisal, jute, hemp and abacá (Manila), the lignin content was similar to that of hemp, banana and abacá (Manila), while the ash content was similar to that of agave, bagasse and abacá (Manila).

Siqueira et al [5] observed that the chemical composition of *Luffa* fibers depends on several factors, such as plant origin, climatic conditions, soil nature, among others, and the cellulose content varies from 55 to 90%; the lignin content is in the range of 10 to 23%; the hemicellulose content is around 8 to 22%; extractives approximately 3.2% and ash 0.4%. Seki et al. [9] concluded in his study that the elemental chemical constitution varies between the different parts of the fruit. The outer part of the fruit is the richest in cellulose (80%), in correlation with a high oxygen/carbon molar ratio. The average cellulose contents of the different anatomical parts appear to be higher than those of wood fibers and the percentages of lignin are low (10%).

Saeed & Iqbal [12] concluded that the fibrous network of bushing sponge is mainly composed of cellulose (60%), hemicelluloses (30%) and lignin (10%) and that the functional groups on the surface of the fibers were predominantly acidic (carboxylic, lactonic, enol, phenolic), indicating that they were available for ion exchange reactions. Finally, the results showed few current studies related to the chemical properties of the bushing, on the other hand, previous articles define well the characterization of this fiber.

3.4 PHYSICAL PROPERTIES OF THE BUSHING

Kalusuraman's articles et al. [24] and Patel & Dhanola [31] studied the physical properties of *Luffa cylindrica* between the years 2016 to 2021 as shown in Table 1.

Kalusuraman et al. [24] concluded that the surface roughness values of *Luffa* fibers were the highest (4.86 μm) for untreated fibers, while they decreased for all surface treated fibers in descending order from those for treated NaOH, followed by that treated with silane and the lowest for fibers treated with Ca (OH)₂.

The physical properties of *Luffa* fiber are density 820 kg/m³, diameter 25-60 μm and crystallinity index 59.1 [31]. Patel & Dhanola [31] observed in their study that the void content of composites (*Luffa*/polyester) increases with increasing fiber and microadditive filler weight; however, the void volume fraction of plain *Luffa*-based composites decreased substantially with the addition of CaCO₃ and TiO₂. They also observed that hardness increases with fiber loading in microadditive filled composites, while in unfilled composites it decreases.

Studies from previous years also evaluated the physical properties of the bushing. Bal & Lallam [2] concluded through microscopic scanning analysis that *Luffa* is structured in a fibrous microsponge system that offers fast and good accessibility to a fluid, suggesting the efficient use of this material in the absorption of liquids. The fiber retention capacity for aqueous solutions increases significantly with alkaline treatment or dry grinding of the shots, as these treatments increase the removal of compounds such as lignin and lead to extensive fibrillation of plant fibers.

The literature describes that the bushing sponge has a fibro-vascular characteristic, similar to a net, has macropores of approximately 800 μm , created by rough and jagged fibers of 200 μm with continuous hollow microchannels. The sponge *Luffa* is remarkably light, with a specific gravity of 0.92 g/cm³, a specific surface area of 850 m²/m³, a void volume of 92%, a high porosity of 79 - 93% and a high specific pore volume of 21-29 cm³/g. In addition, the large voids that provide for the growth of immobilized cells fixed at high densities offer the prospect of high metabolite yields [12].

Chen et al. [22] demonstrate that *Luffa* sponge fibers had relatively higher moisture recovery compared to common fibers. The possible explanation for the results could be the porous structure, the superficial grooves and the superficial micro-cracks in the *Luffa* sponge fiber bundles. Moisture recovery of high density *Luffa* fiber bundles (7.1 - 9.3 %) was lower than that of low density *Luffa* fibers (10.2 - 10.9%). Finally, Laidani et al. [21] show in their study that *Luffa cylindrica* is a fibrous resource rich in cellulose, in which the physical characteristics are comparable to wood pulp.

IV. CONCLUSION

Due to the essential characteristics of *Luffa cylindrica* fiber, such as one for use in composites, there is a need for investigations into this material for a better understanding of its applications. In this sense, this research sought information about this fiber, in which it can provide data for the best use of luffa in the various segments of the industry.

In this article, several works were reviewed regarding investigations on the mechanical, chemical and physical properties related to *Luffa cylindrica*. Thirty-three articles were selected, of which twelve are from the years 2016 to 2021. Works related to mechanical properties were the most found, and eleven articles investigated this property.

The concepts that were put in this work are of special importance for the understanding of both the specific properties of the bushing and its properties as a load in composite materials. An important data addressed is the variation of chemical treatments on the fibers, which depending on the purpose of application of the bushing can improve the properties of the same or the composite material.

Finally, the present work can improve the understanding of the bushing regarding its mechanical, physical and chemical behavior in its various applications. Knowing that the luffa sponge has good characteristics such as: abundance in nature, low cost, low weight, non-toxicity, physical and chemical stability, it is concluded that this fiber becomes an important resource for use in engineering.

ACKNOWLEDGEMENTS

This article is the result of the RD&I Smart IoT Gait Analysis System project, carried out by the University of the State of Amazonas (UEA), in partnership with Samsung Eletrônica da Amazônia Ltda., using resources from Federal Law nº 8.387/1991, being its dissemination and publicity in accordance with the provisions of article 39 of Decree No. 10.521/2020.

REFERENCES

[1] Boynard, C. A., Monteiro, S. N., D'almeida, J. R. M. (2003), "Aspects of alkali treatment of sponge gourd (*Luffa cylindrica*) fibers on the flexural properties of polyester matrix composites", Journal of Applied Polymer Science. v. 87, p. 1927–1932. <https://doi.org/10.1002/app.11522>.

[2] Bal, K. E., Bal, Y., Lallam, A. (2004), "Gross Morphology and Absorption Capacity of Cell-Fibers from the Fibrous Vascular System of Loofah (*Luffa cylindrica*)", Textile

Research Journal. v. 74, n. 3, p. 241–24. <https://doi.org/10.1177/004051750407400310>

[3] Tanobe, V. O. A. et al. (2005) "A comprehensive characterization of chemically treated Brazilian sponge-gourds (*Luffa cylindrica*)", Polymer Testing, v. 24, n. 4, p. 474-482, ISSN 0142-9418, <https://doi.org/10.1016/j.polymertesting.2004.12.004>

[4] Kamatenesi-Mugisha, M. et al. (2007), "The oxytocic properties of *Luffa cylindrica* (L.) M. Roem. and *Bidens pilosa* L., traditionally used medicinal plants from western Uganda", African Journal of Ecology, v. 45, n. 3, p. 88–93. <https://doi.org/10.1111/j.1365-2028.2007.00863.x>

[5] Siqueira, G., Bras, J., Dufresne, A. (2010) "*Luffa cylindrica* as a lignocellulosic source of fiber, microfibrillated cellulose and cellulose nanocrystals", BioResources. v. 5, n. 2.

[6] Seki, Y., et al. (2012) "Characterization of *Luffa cylindrica* Fibers and the Effect of Water Aging on the Mechanical Properties of Its Composite with Polyester". Journal of Applied Polymer Science. v. 123, n. 4, p. 2330–2337. <https://doi.org/10.1002/app.34744>

[7] Shena, J. et al. (2012), "Mechanical properties of luffa sponge", Journal of the mechanical behavior of biomedical materials, v. 15, p. 141–152. <http://dx.doi.org/10.1016/j.jmbbm.2012.07.004>

[8] Bal, K.E. et al. (2012), "Morphology and antimicrobial properties of *Luffa cylindrica* fibers/chitosan biomaterial as micro-reservoirs for silver delivery", Materials Letters, v. 79, p. 238 – 241, ISSN 0167 – 577X. <https://doi.org/10.1016/j.matlet.2012.04.036>

[9] Laidani, Y. et al. (2012), "Study of a Fibrous Annual Plant, *Luffa cylindrica* for Paper Application Part I: Characterization of the Vegetal". Iran. J. Chem. Chem. Eng. v. 31, p. 119 – 129, n. 4.

[10] Shen, J. et al. (2013) "Behaviour of luffa sponge material under dynamic loading", International Journal of Impact Engineering, v. 57, p. 17 – 26. <http://dx.doi.org/10.1016/j.ijimpeng.2013.01.004>

[11] Saw, S. K. et al. (2013), "Fabrication, characterization, and evaluation of *Luffa cylindrica* fiber reinforced epoxy composites", BioResources, v. 8, n. 4, 4805-4826.

[12] Saeed, A. Iqbal, M. (2013), "Loofa (*Luffa cylindrica*) sponge: Review of development of the biomatrix as a tool for biotechnological applications", Biotechnology Progress, v. 29, n. 3. <https://doi.org/10.1002/btpr.1702>

[13] Siqueira, E. J. Botaro, V. R. (2013), "*Luffa cylindrica* fibres/vinylester matrix composites: effects of 1,2,4,5-benzenetetracarboxylic dianhydride surface modification of the fibres and aluminum hydroxide addition on the properties of the composites". Composites Science and Technology, v. 82, p. 76 – 83. <http://dx.doi.org/10.1016/j.compscitech.2013.04.012>

[14] Siqueira, G. et. al. (2013), "Thermal and mechanical properties of bio-nanocomposites reinforced by *Luffa cylindrica* cellulose nanocrystals". Carbohydrate Polymers, v. 91, n. 2, p. 711–717. <http://dx.doi.org/10.1016/j.carbpol.2012.08.057>

[15] Follain, N. et al. (2013), "Water transport properties of bio-nanocomposites reinforced by *Luffa cylindrica* cellulose

- nanocrystals". Journal of Membrane Science, v. 427, p. 218 – 229, ISSN 0376-7388. <https://doi.org/10.1016/j.memsci.2012.09.048>.
- [16] Chen, Q. et al. (2014), "A multiscale study on the structural and mechanical properties of the luffa sponge from *Luffa cylindrica* plant". Journal of Biomechanics, v. 47, p. 1332–1339. <http://dx.doi.org/10.1016/j.jbiomech.2014.02.010>
- [17] Lindino, C. A. et al. (2014), "Adsorption of cadmium in vegetable sponge (*Luffa cylindrica*)", Rev. Ambiente e Água, vol. 9 n. 2, p. 212 – 223.
- [18] Gupta, V. K. et al. (2014), "Amputation of congo red dye from waste water using microwave induced grafted *Luffa cylindrica* cellulosic fiber". Carbohydrate Polymers, v. 111, p. 556–566. <http://dx.doi.org/10.1016/j.carbpol.2014.04.032>
- [19] Valcineide O. A. et al. (2014), "Sponge Gourd (*Luffa cylindrica*) Reinforced Polyester Composites: Preparation and Properties". Defence Science Journal, v. 64, n. 3, p. 273-280. <https://doi.org/10.14429/dsj.64.7327>
- [20] Papanicolaou, G. C.; Psarra, E., Anastasiou, D. (2015), "Manufacturing and mechanical response optimization of epoxy resin/*Luffa cylindrica* composite". Journal Applied Polymer Science. v. 132, n. 22, p. 41992 – 41992. <https://doi.org/10.1002/app.41992>
- [21] Laidani, Y. et al. (2015), "Study of the *Luffa cylindrica* Part II: Pulp Elaboration and Paper Characterization". Iran. J. Chem. Chem. Eng., v. 34, n. 2.
- [22] Chen, Y. et al. (2017), "In-Depth Analysis of the Structure and Properties of Two Varieties of Natural Luffa Sponge Fibers". Materials, v. 10, n. 5, p. 1 – 21. <https://doi.org/10.3390/ma10050479>.
- [23] Carmona, A. R., Colorado, H. A. (2021), "Luffa fibers as promising reinforcement for polymer composites: Mechanical characterization of NaOH treated and untreated dumbbell test-pieces with Weibull statistics". Journal of Composite Materials. v. 55, p. 1667–1681.
- [24] Kalusuraman, G., et al. (2019), "Evaluation of surface pre-treatments on the surface characteristics modifications in sponge gourd (*Luffa cylindrica*) fibers". Mater. Res. Express. v. 6, n. 095106, p. 1–11. <https://doi.org/10.1088/2053-1591/ab3252>
- [25] Chen, Y. et al. (2018), "Properties of Two-Variety Natural Luffa Sponge Columns as Potential Mattress Filling Materials". Materials, v. 11, n. 4. <https://doi.org/10.3390/ma11040541>
- [26] Zhang, K. et al. (2019), "Effect of Chemical Treatments on the Properties of High-Density Luffa Mattress Filling Materials". Materials. v. 12, p. 1–16.
- [27] Psarra, E., Papanicolaou, G. C. (2021), "*Luffa cylindrica* as a durable biofiber reinforcement for epoxy systems", Composites Science and Technology. v. 203, n. 108597, p. 1–11, 2021. <https://doi.org/10.1016/j.compscitech.2020.108597>
- [28] Bera, T. et al. (2019), "Moisture absorption and thickness swelling behaviour of luffa fibre/epoxy composite". Journal of Reinforced Plastics and Composites. v. 38, p. 923–937.
- [29] Mohanta, N., Acharya, S. K. (2015) "Fiber surface treatment: Its effect on structural, thermal, and mechanical properties of *Luffa cylindrica* fiber and its composite". Journal of Composite Materials. v. 50, p. 3117–3131.
- [30] Quinayá, D. C. P., D'almeida, J. R. M. (2017), "Nondestructive characterization of epoxy matrix composites reinforced with Luffa lignocellulosic fibers". Revista Matéria. v. 22, n. 2.
- [31] Patel, V. K., Dhanola, A. (2016), "Influence of CaCO₃, Al₂O₃, and TiO₂ microfillers on physico-mechanical properties of *Luffa cylindrica*/polyester composites". Engineering Science and Technology, an International Journal. v. 19, p. 676–683. <http://dx.doi.org/10.1016/j.jestch.2015.10.005>
- [32] Motta, L. A. C. et al. (2016) "Painéis sanduíches de poliéster reforçado com fibras de rami para aplicação na construção Civil". Revista Matéria. v. 21, n. 3, p. 796 – 806.
- [33] Souza, J. D. G. T. et al. (2017), "Modificação química superficial de fibras de bucha vegetal visando à compatibilização e aplicação como reforço em matriz cimentícias". Ambiente Construído, Porto Alegre, v. 17, n. 2, p. 269-283. <http://dx.doi.org/10.1590/s1678-86212017000200157>

Scientific Cooperation Network in Innovations in the use of Biopolymers in Civil Construction

Arilmara Abade Bandeira¹, Francisco Sandro Rodrigues Holanda², Carlos Eduardo Celestino de Andrade³, Abimael Magno do Ouro Filho⁴, José dos Santos Machado⁵, Wilsonita de Melo Ubirajara⁶

¹Programa de Pós-Graduação em Ciência da Propriedade Intelectual – PPGPI, Universidade Federal de Sergipe, Brasil
E-mail: arilmara2015@gmail.com

²Programa de Pós-Graduação em Ciência da Propriedade Intelectual – PPGPI, Universidade Federal de Sergipe, Brasil
E-mail: fholanda@infonet.com.br

³Programa de Pós-Graduação em Ciência da Propriedade Intelectual – PPGPI, Universidade Federal de Sergipe, Brasil
E-mail: eng2carlos.eduardo@gmail.com

⁴Programa de Pós-Graduação em Administração - PROPADM, Universidade Federal de Sergipe, Brasil
E-mail: abimaelmagno@hotmail.com

⁵Departamento de Computação, Instituto Federal de Sergipe, Brasil
E-mail: jsmac18@hotmail.com

⁶Programa de Pós-Graduação em Ciência da Propriedade Intelectual – PPGPI, Universidade Federal de Sergipe, Brasil
E-mail: will_ubirajara@yahoo.com.br

Received: 10 Jun 2022,

Received in revised form: 11 Jul 2022,

Accepted: 18 July 2022,

Available online: 25 July 2022

©2022 The Author(s). Published by AI
Publication. Trata-se de um artigo de acesso
aberto sob a licença CC BY

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords—*Innovation, materials, natural resources, technology.*

Abstract—*The search for innovative technologies for the use of materials from renewable resources to replace conventional materials has been a constant issue. The number of scientific publications on the use of biopolymers by the civil construction industry has grown over time. On the other hand, cooperation in the exchange of knowledge and resources has been found as one of the solutions to overcome relevant obstacles to scientific and technological development. Thus, the objective of this study was to identify and characterize the cooperation network formed between the various actors involved in scientific production on innovations based on the use of biopolymers by the civil construction industry. The cooperation network was characterized using the Social Network Analysis method (SNA). The study showed that in the scientific cooperation network, Ilhan Chang and Michael D. Lepech appear as the most important authors, the Korea Advanced Institute of Science and Technology, the Universiti Teknologi Malaysia and Stanford University are the strongest organizations, and Malaysia is the country with the most significant participation.*

I. INTRODUCTION

The accumulation of residue associated with the intense use of natural resources and the increase in production activities harm the environment. The rational use of natural resources, the destination adequate treatment of waste and

protection of the environment have been constant concerns (Kaddo, 2020). Furthermore, the consumption of fossil materials has had negative impacts on the environment, resulting in the need to produce energy from renewable sources (Ibarra et al., 201). Thus, the civil construction industry has faced several challenges related to growing

concerns about the environment and has been dedicated to searching for technological innovations that will replace petroleum products, making the industry and its final products more sustainable (Jędrzejczak et al., 2021).

There has been a very significant increase in scientific research on new functional materials combining advanced properties and greater sustainability (Nisticò et al., 2020). The development of new building materials based on the principles of environmental sustainability is essential to meet the global requirements of a sustainable economy (Shanmugavel et al., 2020). According to Udomsap and Hallinger (2020) several studies have been carried out on the civil construction industry, and among the dominant lines of research is that of alternative materials for sustainable construction. In these studies, the use of biopolymers as an input in the generation of products in the civil construction industry appears as an alternative in the search for renewable resources and the replacement of petroleum as the main source of raw material for liquid fuels, chemical products and additives (Marsiet al., 2019).

At the same time, increasing scientific and technological cooperation has made it possible for researchers and inventors to share knowledge in different areas, experiences, resources and equipment, thereby increasing research efficiency and becoming an effective way to solve more complex problems, in addition to stimulating innovation (Zhang et al., 2021). According to Lubango (2020), international collaboration networks are a predictor variable for the ability of countries to produce and internationally disseminate inventions aimed at sustainable development and an alternative mechanism to support the development of relevant programs and policies in this regard, and as they accelerate transnational exchanges of human capital and adequately provide for the production and flow of innovations.

To examine the characteristics of innovation networks, the Social Network Analysis method (SNA) has been widely used. This method uses graph theory tools to assist in the analysis and description of the relationships of the various actors involved in a collaboration network (Liu et al., 2021). Cooperation between different organizations forms complex collaborative networks and SNA is used to interpret the roles and functions of these organizations in the collaborative innovation network, important to the understanding of how innovation is generated and disseminated (Yu et al., 2022). Therefore, the present study aims to identify and characterize the cooperation network formed between the various actors involved in the scientific production on innovations in the use of biopolymers in the civil construction industry.

II. METHODOLOGY

The study used data from scientific publications. An integrative systematic review was developed, focusing on a systematic literature review, considering all articles on a given topic and period, regardless of the type of methodology used (Botelho, Cunha & Macedo, 2011). Also according to the authors, this type of review is divided into six stages: formulation of the question, location of studies, critical evaluation of studies, data collection, data analysis and interpretation and knowledge synthesis.

The question that guides this research is: how are scientific cooperation networks on innovation based on the use of biopolymers by the civil construction industry characterized?

The documents that make up the scientific production were retrieved from the Scopus database, which offers a comprehensive overview of the production of works around the world in the areas of science, technology, medicine, social sciences, arts and humanities, and provides intelligent tools to monitor, analyze and view research, as well as elements for analyzing citations, references, among others (Elsevier, 2020). This database was chosen due to the significant number of documents widely recognized scientifically, in different areas.

The search was performed using the descriptors "biopolymer", "building", "construction" and "green polymer" and the connectors "OR" and "AND", as titles, abstracts and keywords for works published between January 1st, 2010 and March 31st, 2022. As additional criteria for the inclusion of works, the only documents considered were primary studies, articles and reviews, in the areas of "Engineering" and "Environmental Science", in English.

After an advanced search in the Scopus database, using the string TITLE-ABS-KEY ((biopolymer OR "green polymer") AND (construction OR building)) AND DOCTYPE (ar OR re) AND PUBYEAR > 1999 AND PUBYEAR < 2022 AND (LIMIT-TO (SUBJAREA, "ENGI") OR LIMIT-TO (SUBJAREA, "ENVI")), the titles and abstracts of the documents found were checked, to exclude those that were not related to the selected topic. Later, a detailed critical analysis of each document was done, to exclude the works that did not match the objective of the study.

In the analysis of knowledge collaboration, the Social Network Analysis method (SNA) was used. The method presents graphs that help synthesize and verify relationships of the whole or parts and patterns (Booth, Sutton & Papaioannou, 2016) of the knowledge produced on biopolymers. Through the analysis of social networks, we seek to format the existing paths in the relationships

between people, organizations, and groups, among other elements, which, according to the terminology applied to this tool, are called the actors, represented by the nodes. The existing connections between actors are called links, represented by lines or edges, and the units of analysis of networks are the sets composed of groups of individuals and their interrelationships (Garton, Haythornthwaite & Wellman, 1997; Hanneman & Riddle, 2020).

Some specific metrics of SNA were used, including betweenness centrality, which investigates the nodes that take the shortest path to the other nodes (Brandes, 2001); degree centrality, which analyzes the number of connections per node (Williams et al., 2015); and modularity, which presents subgroups of nodes with greater proximity in a network (Paranyushkin, 2019).

The information relevant to the articles was exported to Microsoft Excel® spreadsheets, and the menu technique with each predefined category was then applied, to enable the use of codes of information retained from articles and patents (Wickham, Dunn & Sweeney, 2012). The Gephi® software was used as a tool for the structuring, visualization and analysis of social networks.

In addition, the National Indicators of Science, Technology and Innovation (2021) was consulted, to examine data on national expenditure on research and development (R&D), the number of articles published in scientific journals indexed by Scopus and the number of patent applications for inventions with the American Patent and Trademark Office (USPTO) and with the Patent Cooperation Treaty (PCT) by the countries leading the cooperation networks. The Global Innovation Index 2021 was also consulted to check the ranking of the countries with the highest performance in technological innovation, the budget allocations related to R,D&I, and to which income group these countries belong (WIPO, 2022).

III. RESULTS AND DISCUSSION

The search in Scopus databases, followed by a detailed critical analysis of each document, resulted in the compilation of 96 scientific publications on the use of biopolymers in the civil construction industry. Data regarding scientific production identified in the documents are presented in Table 1.

Table 1 - Scientific production

Database	Number of authors	Number of institutions/	Number of countries	Number of scientific publications
Scopus	299	120	35	96

		organizations		
Scopus	299	120	35	96

Source: The authors (2022).

The data in Table 1 show that the number of actors involved in the publication of scientific documents related to technological innovations on the use of biopolymers in the civil construction industry is quite substantial. The annual evolution of scientific publications between 2000 and 2022 is shown in Figure 1.

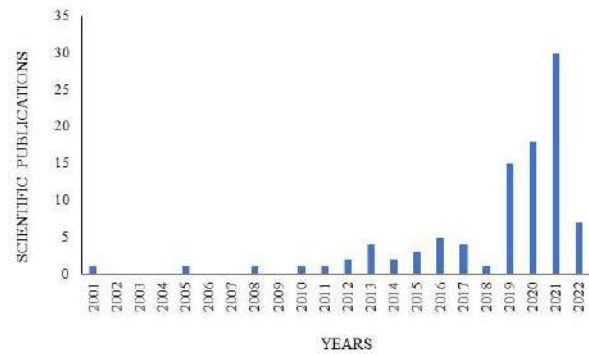


Fig.1 - Annual evolution of scientific production

Source: Created by the authors, with data from Scopus (2022).

The time series, shown in Figure 1, indicates that scientific production on the topic has grown over the years, even if irregularly.

Scientific production, although incipient, has experienced a significant increase in the number of publications from 2019 onwards, which shows that interest from the scientific community in the topic has been emphasized since then. This is probably due to the emergence of new demands that consider environmental issues. The drop in the number of publications in 2022 is due to the survey only accounting for the first three months of this year.

To carry out the SNA, the cooperation network related to scientific production was identified, in which the vertices, or nodes, represent the authors, organizations or countries involved, and the lines represent the relationships between them.

Table 2 indicates the degree centrality and the intermediation centrality of the most influential authors in the scientific cooperation network.

Table 2 - Degree centrality and intermediation centrality of the most influential authors in the network

Authors	Degree centrality	Intermediation centrality
Michael D. Lepech	22	88,33
Ilhan Chang	26	37,83
Sojeong Lee	20	18,33
Maria I. Allende	16	8,33
Jooyoung Im	18	7,83
Gye-Chun Cho	19	4,33
Minhyeong Lee	16	2,33
Isamar Rosa	10	1,33
Yeong-Man Kwon	14	0,33

Source: The authors (2022).

The results show that Ilhan Chang and Michael D. Lepech have the highest degree centrality values, 26 and 22, respectively, which indicates that more authors are directly connected to them than to other authors and that they

occupy a prominent place in the network, influencing the other actors. Node degree centrality, in a graph structure, refers to the number of edges connected to a node (Yu et al., 2022) and reflects the direct connection between network members (Shiyu et al., 2020).

The two authors have the highest values of betweenness centrality, Michael D. Lepech with 88.33, and Ilhan Chang with 37.83. These values indicate that, in addition to being the most popular and influential authors, they also have a greater ability to control the flow of resources. Betweenness centrality refers to the number of times a member acts as a link between two other nodes (Shiyu et al., 2020). The measure assesses the relationships between an actor and two other actors in the network and measures the ability of actors to control resources (Liu et al., 2021).

Centrality metrics are tools widely used to characterize the nodes, or actors, of a network. In an SNA, the most important actors are those that relate to other actors more frequently, which makes them more visible, and considered more central in the network, and centrality measures try to describe the location of these actors in the network. (Zaoli, Mazzarisi & Lillo, 2021).

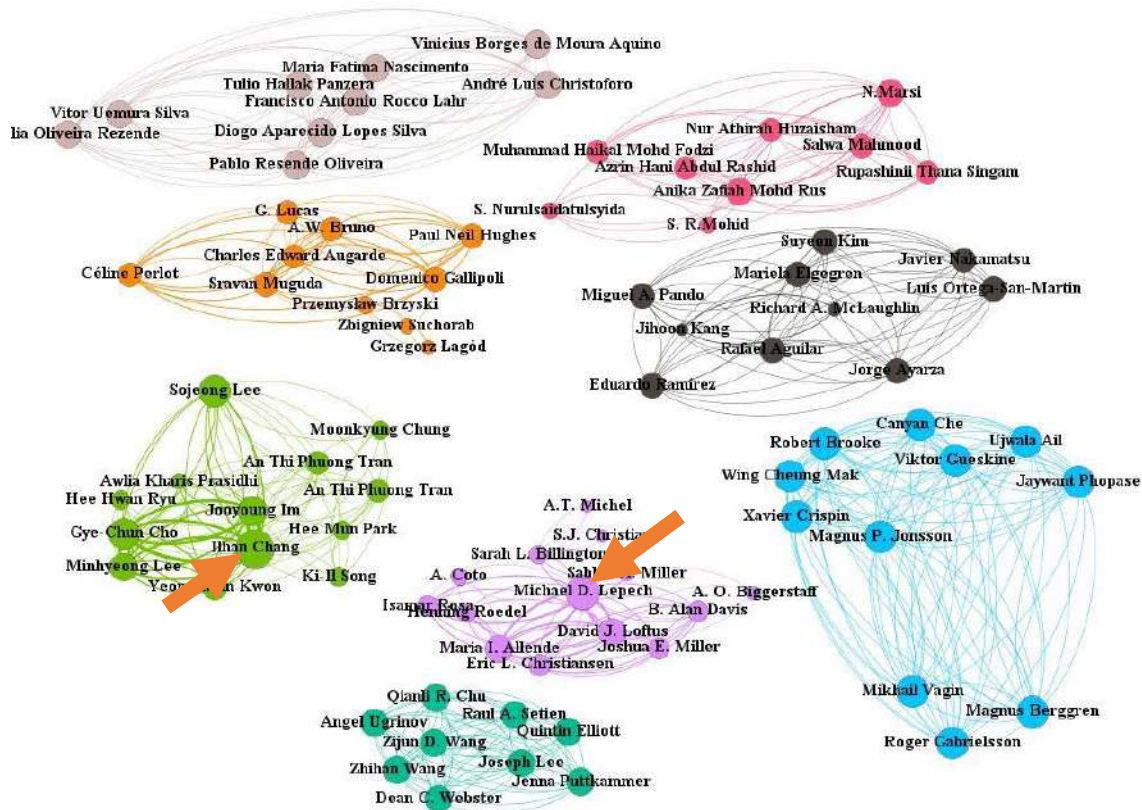


Fig.2 - Network formed by the authors of scientific production

Source: The authors (2022).

The authors considered the most important in the collaborative network, Ilhan Chang and Michael D. Lepech,

have contributed significantly to the development of research on technological innovation based on the use of

biopolymers by the civil construction industry. Ilhan Chang has 9 publications on the topic and a total of 861 citations, while Michael D. Lepech has 6 publications and 39 citations. A detailed analysis of the documents obtained revealed that Ilhan Chang's studies were on the use of biopolymers in soil treatment and stabilization, and Michael D. Lepech's on the use of biopolymers as raw materials to replace conventional materials. Figure 2, based on modularity, shows the network formed by the authors of scientific production on the topic discussed.

Figure 2 was created from the calculation of the modularity of the network, through which the cooperation subgroups can be visualized, where the nodes, representing the authors, are more densely connected. Modularity measures the density of links within the network compared to links outside the network. This measure allows the identification of cooperation clusters, as it groups the nodes that are more densely connected to the rest of the network and defines communities according to the strength of their connections (Blondel et al., 2008).

Clusters are subgroups in a collaboration network and their identification reveals how many parts the network can be broken up into (Pineyrua, Ferreira & Biancolino, 2016; Scott, 2000). According to Figure 2, there are eight scientific cooperation clusters formed by the most influential authors on the subject. The larger nodes indicate authors that have a higher degree centrality, that is, those that are more important and influential within the network. The image also shows the authors who are in a more centralized position in their respective clusters, Ilhan Chang and Michael D. Lepech.

The analysis carried out with the data obtained through the Gephi® software and from scientific publications highlights that the works by Ilhan Chang were in partnership with authors with different degree centralities and with values of betweenness centrality well below his own. Ilhan Chang leads the SURE3 Geotechnical Engineering Research Group at Ajou University. The letters in SURE3 stand for Sustainability, Urban utilization, Resilience, Environmental, Extreme and Emerging geotechnical engineering (SURE3, "s.d"). SURE3 also includes researchers Minhyeong Lee, from the Korea Advanced Institute of Science and Technology, and Sojeong Lee, from the University of New South Wales, who can be seen in the same cluster as Ilhan Chang.

Likewise, Michael D. Lepech developed studies in partnership with several authors with values of betweenness centrality well below his value and with different degree centralities. Michael D. Lepech is part of the Lepech Research Group at Stanford University, alongside A. O. Biggerstaff.

Apart from the clusters led by Ilhan Chang and Michael D. Lepech, most subgroups have their nodes with the same degree centrality or very close values, which correspond to less substantial cooperation clusters. According to Leng et al. (2021), a network may have several main nodes, but this makes the network less robust.

Regarding the organizations that are part of the scientific cooperation network, Table 3 shows the degree centrality and intermediation centrality of the most influential organizations.

Table 3 –Degree centrality and intermediation centrality of the most influential organizations in the network

Organizations	Degree centrality	Intermediation centrality
Korea Advanced Institute of Science and Technology (KAIST)	12	83
Korea Institute of Civil Engineering and Building Technology (KICT)	9	48
Hue University of Sciences	8	38
Universiti Teknologi Malaysia	14	28
University of New South Wales (UNSW)	6	21
Stanford University	8	6
Mansoura University	4	4
University of Sharjah	4	4

Source: The authors (2022).

Table 3 presents the best-connected organizations in the network, which are the Universiti Teknologi Malaysia, with a degree centrality of 14, and the Korea Advanced Institute of Science and Technology, with a degree centrality of 12. The values for betweenness centrality show that the Korea Advanced Institute of Science and Technology has a score of 83, well above the others, which indicates that it is the strongest organization in terms of controlling the flow of resources. Degree centrality is used to calculate how many and which actors are connected to the same node in the network. If a given actor has more connections than others, that indicates it has a higher centrality degree and it occupies a more important place in the network, influencing the other nodes (Liu et al., 2021; Pan et al., 2021). Betweenness centrality refers to the frequency with which a

node appears on routes connecting other pairs of nodes in the network and considers that communication is taking place along the shortest path between two nodes (Brandes, Borgatti & Freeman, 2016; Newman et al., 2020).

These metrics help analyze how organizations interact with the rest of the network and how important they are. They consider the different ways in which an organization connects with the rest of the network, and they allow the

identification of those strategically located in the network, as the more centralized an actor is, the more important they are (Zaoli, Mazzarisi & Lillo, 2021).

Figure 3, based on modularity, presents the network formed by organizations involved in scientific production and adds to that analysis.

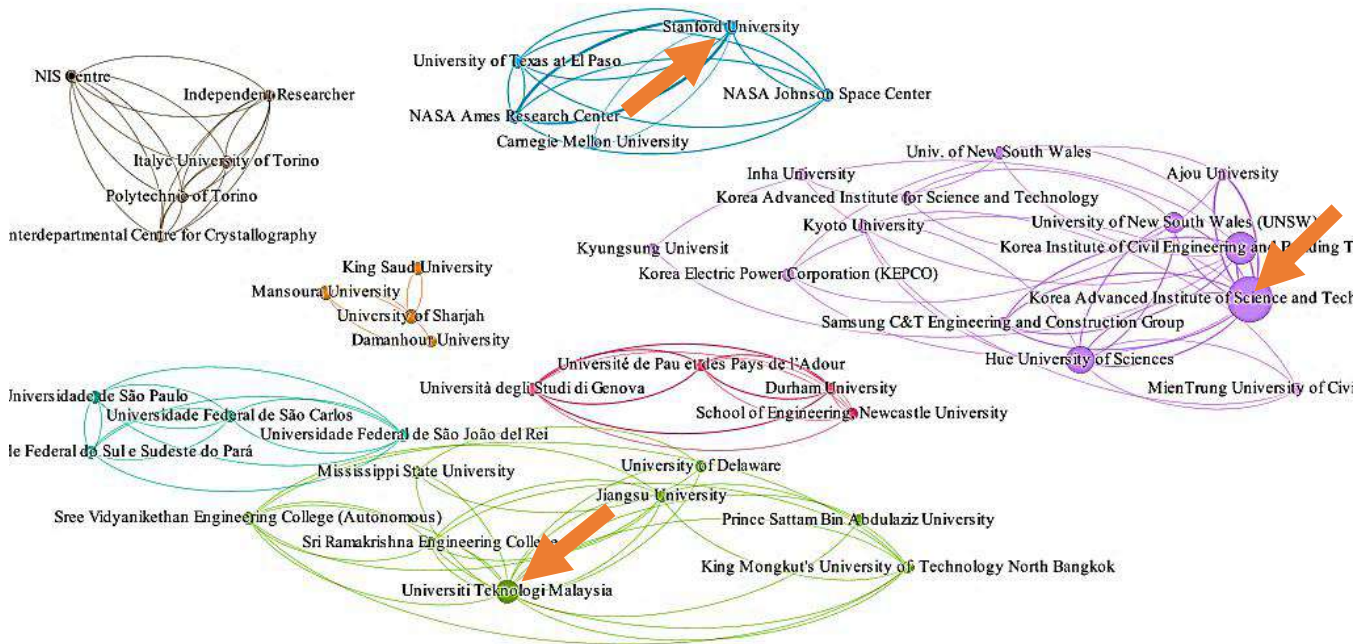


Fig.3 - Network formed by organizations involved in scientific production

Source: The authors (2022).

The most prominent collaborative clusters of organizations are found in the subgroup in purple, led by the Korea Advanced Institute of Science and Technology, located in South Korea. As seen earlier, the Institute, represented by the largest node in Figure 3, has a higher degree centrality and intermediation centrality than the other actors, which means it is the organization with the most connections in its cluster, with relevant influence over the other members and with control over the resources. The Universiti Teknologi Malaysia and Stanford University also appear as leaders in their clusters. According to the present study, the second most influential author, Michael D. Lepech, carried out his research at Stanford University.

The division of the network into clusters is important as it helps to recognize which groups are more cohesive and the relationships between different groups. The division of a network into subgroups, modularity, is a characteristic of all social networks (Marcoux, Lusseau, 2013). Clusters can involve the participation and interaction of companies, as well as of various public and private institutions focused on

instruction and training of human resources, research, development and engineering, policy, promotion and financing (Oliveira et al., 2012).

In addition to the aforementioned institutions, other prominent organizations in the network are the Korea Institute of Civil Engineering and Building Technology (KICT), Hue University of Sciences, and the University of New South Wales (UNSW), which all belong to the subgroup led by the Korea Advanced Institute of Science and Technology (KAIST). The cluster is composed almost entirely of teaching and research institutions, with Samsung C&T Engineering and Construction Group and Korea Electric Power Corporation being the exceptions.

Scientific publications show that the most prominent author in the network, Ilhan Chang, developed his studies on the use of biopolymers in civil engineering as a representative of the Korea Institute of Civil Engineering and Building Technology (South Korea), the University of New South Wales (Australia) and Ajou University (South Korea), in partnership with authors who worked in South

Korean organizations, the Korea Advanced Institute of Science and Technology, the Korea Institute of Civil Engineering and Building Technology, Samsung C&T Engineering and Construction Group, Inha University, Ajou University, and Korea Electric Power Corporation, as well as with collaborators from the University of New South Wales (Australia) and Hue University of Sciences (Vietnam). These organizations all belong to the same cluster.

In the other subgroups, all actors are teaching institutions or research centers, with one of the clusters composed entirely of Brazilian universities: the University of São Paulo (USP), Federal University of São Carlos (UFSCar), Federal University of São João del-Rei (UFSJ) and Federal University of the South and Southeast of Pará (UNIFESSPA). The representatives of these institutions

published the work “Circular vs. linear economy of building materials: A case study for particleboards made of recycled wood and biopolymer vs. conventional particleboards”, in 2021, in the International Journal Construction and Building Materials.

Apart from the subgroups led by the Korea Advanced Institute of Science and Technology and the Universiti Teknologi Malaysia, there are several organizations with the same or very close values of degree centrality in the same cluster, which, according to Leng et al. (2021), means that these are less significant actors within the scientific cooperation network.

Figure 4, based on intermediation centrality, allows the visualization of the network of connections between the different countries, represented by circles, and their scientific production.

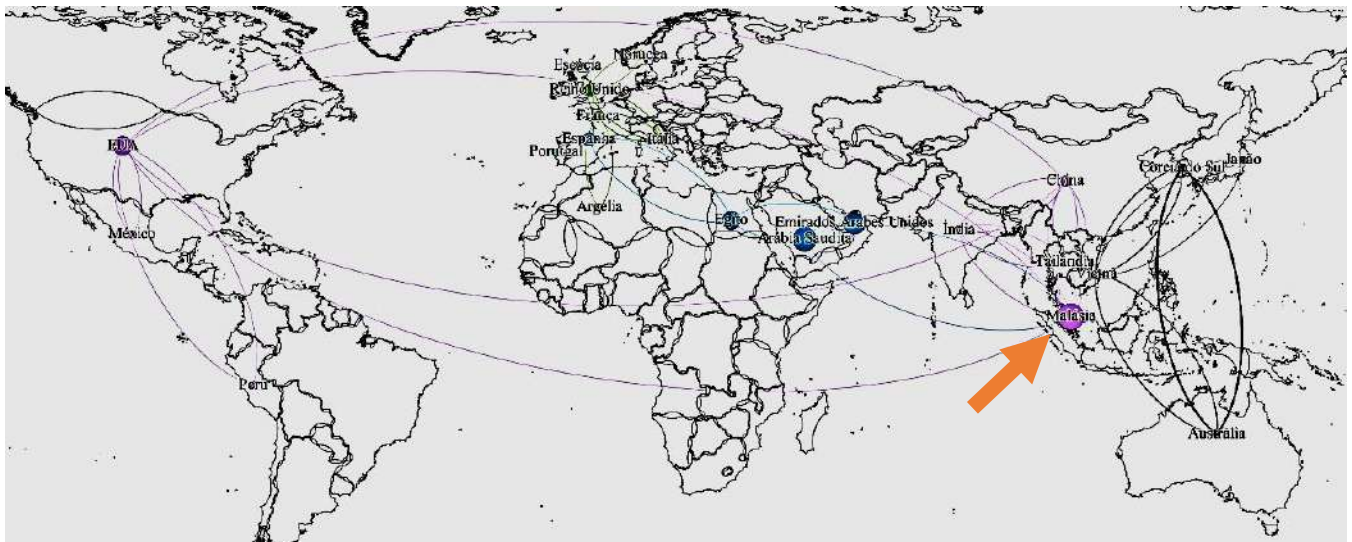


Fig.4 – Network formed by countries involved in the collaborative network

Source: The authors (2022).

Figure 4 shows the most active countries in the cooperation network of scientific production on technological innovation based on the use of biopolymers by the civil construction industry. In the map, we can see the collaborative clusters are composed of countries from different continents. The figure also shows that regarding scientific publications, only 35 (thirty-five) countries participate in this collaborative network. Of these, the most prominent are Malaysia, Saudi Arabia, the United Arab Emirates (UAE), the United States of America (USA), Egypt, Spain, the United Kingdom, France, China and Vietnam. Table 4 below shows the degree centrality and intermediation centrality of the most relevant countries in the cooperation network.

The data in Table 4 show that Malaysia is the country with the most connections to other countries, with a degree centrality of 10 and intermediation centrality of 66, being the country that exerts greater control over resources and information in relation to the others, which is highlighted by the size of the node representing the country in Figure 4. The centrality of a node helps to verify the extent to which a network of technological innovation tends to focus on a particular actor (Leng et al., 2021), and betweenness centrality indicates the degree of control a node has over resources. A high value of betweenness centrality for a node means that it acts as a controller of the flow of resources (information, money, power, among others) to the other nodes connected to it (Ji et al., 2020). Scientific documents

show that Malaysia has produced studies in partnership with Saudi Arabia, China, the USA, India and Thailand.

Table 4 - Degree centrality and intermediation centrality of countries

Countries	Degree centrality	Intermediation centrality
Malaysia	10	66
Saudi Arabia	4	56
UAE	4	48
USA	8	38
Egypt	4	36
Spain	4	20
United Kingdom	8	14
France	6	8
China	8	6
Vietnam	6	4

Source: The authors (2022).

According to the Global Innovation Index 2021, of the countries mentioned in Table 4, Saudi Arabia, the UAE, the USA, Spain, the United Kingdom and France are in the high-income group. Malaysia and China belong to the upper-middle-income group, and Egypt and Vietnam are part of the lower-middle-income group. The United Kingdom, the USA, China, and the UAE are among the top three innovation economies by region, and Malaysia and Vietnam are among the top three innovation economies by income group. In 2021, France occupied the 11th position in the global ranking (Wipo, 2022).

In 2014, the government of the United Arab Emirate (UAE) adopted the National Innovation Strategy, intending to make the country one of the most innovative in the world, in addition to achieving the Sustainable Development Goals, defined in the United Nations Summit of 2015 and included in the 2030 Agenda. The strategy focuses mainly on renewable energy, transportation, education, health, solving water scarcity, and new technologies (Krzyszowski, 2020). The UAE's government, which has a well-defined vision for its development and is committed to achieving exceptional results in terms of economy, society and the environment, guides its bodies to work per the highest standards, based on models of performance and innovation (UAE, 2017).

The data published in the National Indicators of Science, Technology and Innovation (2021) show that, concerning national expenditures on research and development (R&D)

between the years 2000 and 2019, the USA ranked first for that entire period, with the largest percentage of funding coming from companies rather than the government. Likewise, the country also stands out in the number of articles published in scientific journals indexed by Scopus and in the number of applications for patents for inventions with the American Patent and Trademark Office (USPTO) and the Patent Cooperation Treaty (PCT) from 2000 to 2020.

International comparisons described in the National Indicators of Science, Technology and Innovation (2021), show that Chinese national expenditures on research and development (R&D) increased significantly between 2000 and 2019, with figures second only to the USA. The report also shows that in China, Spain, the United Kingdom and France, the largest percentage of the expenditures are financed by companies and not by the government.

According to scientific publications, only 22.9% of the 96 articles were developed in partnership between the countries. The most robust collaborative cluster, led by South Korea, is mainly composed of South Korean members, having only two organizations outside of the country, the University of New South Wales (Australia) and Hue University of Sciences (Vietnam).

IV. CONCLUSIONS

The Social Network Analysis showed that in the scientific cooperation network there are few clusters of authors and organizations with research on the topic, which indicates that few studies were developed in partnership with other countries, about 22.9%.

All organizations that make up the subgroups of the cooperation network are teaching and research institutions, except for Samsung C&T Engineering and Construction Group and Korea Electric Power Corporation, actors in the cluster led by the Korea Advanced Institute of Science and Technology. Although the collaborative network contains countries from different continents, only 35 countries participate in the scientific production network on the technological innovation considered in this study.

South Korea stands out in scientific production. However, most collaborations involving South Korean organizations happen within the country, with the University of New South Wales, in Australia, and Hue University of Sciences, in Vietnam, being the only foreign organizations in their cluster.

There was a tendency for scientific research on the innovation explored in this study to expand over time. Therefore, it is recommended that similar studies be carried

out in the future, to verify the behavior of these collaborative networks in the coming years.

REFERENCES

- [1] Arab, M., et al. (2020, June). EICP Cemented Sand Modified with Biopolymer. In: *Sustainable Civil Infrastructures* (pp. 74–85), DOI: [10.1007/978-3-030-34216-6_6](https://doi.org/10.1007/978-3-030-34216-6_6).
- [2] Blondel, V. D., et al. (2008). Fast unfolding of communities in large networks. *Journal of Statistical Mechanics: Theory and Experiment – An IOP and SISSA Journal*. DOI: [10.1088/1742-5468/2008/1/P10008](https://doi.org/10.1088/1742-5468/2008/1/P10008)
- [3] Booth, A., Sutton, A., Papaioannou, D. (2016). Systematic Approaches to a Successful Literature Review. In *Journal of the Canadian Health Libraries Association / Journal de l'Association des bibliothèques de la santé du Canada*, 34(1). SAGE. <https://doi.org/10.5596/c13-009>
- [4] Botelho, L. L. R., Cunha, C. C. De A., Macedo, M. (2011). O método da revisão integrativa nos estudos organizacionais. *Gestão e Sociedade*, 11(5), 121–136. <https://doi.org/10.21171/ges.v5i11.1220>
- [5] Brandes, U. (2001). A Faster Algorithm for Betweenness Centrality. *Journal of Mathematical Sociology*, 25(2), 163–177. <https://doi.org/10.1080/0022250X.2001.9990249>
- [6] Brandes, U., Borgatti, S. P., Freeman, L. C. (2016). Maintaining the duality of closeness and betweenness centrality. *Social Networks*, 44, 153–159. <http://dx.doi.org/10.1016/j.socnet.2015.08.003>
- [7] Elsevier. *Sobre a solução Scopus*. Recuperado de <https://www.elsevier.com/pt-br/solutions/scopus>.
- [8] Garton, L., Haythornthwaite, C. E., Wellman, B. (1997). Studying Online Social Networks. *Journal of Computer Mediated Communication* 1(3). <https://doi.org/10.1111/j.1083-6101.1997.tb00062.x>
- [9] Hanneman, R. A., Riddle, N. (2020). Introduction to SOCIAL Network Methods. Riverdisse, CA: University of California, Riverside..from [https://math.libretexts.org/Bookshelves/Scientific_Computing_Simulations_and_Modeling/Book%3A_Introduction_to_Social_Network_Methods_\(Hanneman\)/10%3A_Centrality_and_Power/10.02%3A_Degree_Centrality](https://math.libretexts.org/Bookshelves/Scientific_Computing_Simulations_and_Modeling/Book%3A_Introduction_to_Social_Network_Methods_(Hanneman)/10%3A_Centrality_and_Power/10.02%3A_Degree_Centrality).
- [10] Ibarra, D., et al. (2021). Production of microfibrillated cellulose from fast-growing poplar and olive tree pruning by physical pretreatment. *Applied Sciences (Switzerland)*, 11(14). <https://doi.org/10.3390/app11146445>
- [11] Jędrzejczak, P., et al. (2021, May). The role of lignin and lignin-based materials in sustainable construction – A comprehensive review. *International Journal of Biological Macromolecules*, 187, 624–650. <https://doi.org/10.1016/j.ijbiomac.2021.07.125>
- [12] Ji, Y., et al. (2020). Revealing Technology Innovation, Competition and Cooperation of Self-Driving Vehicles from Patent Perspective. *IEEE Access*, v. 8, 221191–221202. [10.1109/ACCESS.2020.3042019](https://doi.org/10.1109/ACCESS.2020.3042019)
- [13] Kaddo, M. (2020). Analysis of the possibility of using polylactide in production of building materials. *E3S Web of Conferences*, 217, 1–8. <https://doi.org/10.1051/e3sconf/202021701012>
- [14] Krzymowski, A. (2020). Sustainable development goals in arab region – United Arab Emirates’ case study. *Problemy Ekorozwoju*, 15(1), 211–220. DOI: [10.35784/pe.2020.1.22](https://doi.org/10.35784/pe.2020.1.22)
- [15] Leng, Z., Et Al. (2021, February). China’s rare earth industry technological innovation structure and driving factors: A social network analysis based on patents. *Resources Policy*, 73, 102233. <https://doi.org/10.1016/j.resourpol.2021.102233>
- [16] Liu, G., Zhang, P., Zhang, F. (2020). University-industry knowledge collaboration in Chinese water pollution abatement technology innovation system. *Nature Environment and Pollution Technology*, 19(3), 1179–1185. <https://doi.org/10.46488/NEPT.2020.v19i03.031>
- [17] Liu, Y., et al. (2021). Spatio-temporal evolution of green innovation network and its multidimensional proximity analysis: Empirical evidence from China. *Journal of Cleaner Production*, 283, 124649. <https://doi.org/10.1016/j.jclepro.2020.124649>
- [18] Lubango, L. M. (2020). Effects of international co-inventor networks on green inventions in Brazil, India and South Africa. *Journal of Cleaner Production*, 244, 118791. <https://doi.org/10.1016/j.jclepro.2019.118791>
- [19] Marcoux, M., Lusseau, D. (2013). Network modularity promotes cooperation. *Journal of Theoretical Biology*, 324, 103–108. <http://dx.doi.org/10.1016/j.jtbi.2012.12.012>
- [20] Marsi, N., Rus, A. Z. M., Mahmood, S., Rashid, A. H. A., Singam, R. T., Fodzi, M. H. M., Huzaisham, N. A. (2019). UV exposure of the surface coating sustainable polymer composite. *International Journal of Advanced Trends in Computer Science and Engineering*, 8(1.3), 144–147. <https://doi.org/10.30534/ijatcse/2019/2881.32019>
- [21] Mendonça, A. et al. (2021). Reducing soil permeability using bacteria-produced biopolymer. *Applied Sciences (Switzerland)*, 11(16). <https://doi.org/10.3390/app11167278>
- [22] Ministério da Ciência, Tecnologia e Inovações. Indicadores Nacionais de Ciência, Tecnologia e Inovação: 2021. (2022). Brasília: MCTIC.
- [23] Newman, H. et al. (2020). Uniform edge betweenness centrality. *Electronic Journal of Graph Theory and Applications*, 8(2), 265–300. DOI: [10.5614/ejgta.2020.8.2.7](https://doi.org/10.5614/ejgta.2020.8.2.7)
- [24] Nisticò, R., et al. (2020). Chitosan and its char as fillers in cement-base composites: A case study. *Boletín de la Sociedad Española de Cerámica y Vidrio*, 59(5), 186–192. <https://doi.org/10.1016/j.bsecv.2019.10.002>
- [25] Oliveira, A. L., et al. (2012). Redes de Inovação em Clusters: o local e o global na criação de vantagem competitiva. *Revista E-Tech: Tecnologias para Competitividade Industrial* (ISSN - 1983-1838), 5(1), 01–15. DOI: [10.18624/e-tech.v5i1.239](https://doi.org/10.18624/e-tech.v5i1.239)
- [26] Pan, X., et al. (2021). Text mining-based patent analysis of bim application in construction. *Journal of Civil Engineering and Management*, 27(5), 303–315. <https://doi.org/10.3846/jcem.2021.14907>
- [27] Paranyushkin, D. (2019). InfraNodus: Generating insight using text network analysis. In *The Web Conference 2019 - Proceedings of the World Wide Web Conference, (WWW '19)*. ACM: San Francisco, USA (pp. 3584–3589).

<https://doi.org/10.1145/3308558.3314123>

- [28] Pineyrua, D. G. F., Ferreira, M. P., Biancolino, C. A. (2016). Aplicação da análise de redes sociais em uma instituição pública: Identificação de redes informais e grau de centralidade. *Espacios*, 37(30), 12. Recuperado de <http://www.revistaespacios.com/a16v37n30/16373012.html>
- [29] Scott, J. (2000). *Social network analysis: a handbook* (2nd ed.). London: Sage Publications (224 p). DOI [10.1007/s13278-010-0012-6](https://doi.org/10.1007/s13278-010-0012-6)
- [30] Shanmugavel, D., et al. (2020). Interaction of a viscous biopolymer from cactus extract with cement paste to produce sustainable concrete. *Construction and Building Materials*, 257, p. 119585. <https://doi.org/10.1016/j.conbuildmat.2020.119585>
- [31] Shiyu, Z., et al. (2020). Research on the transfer of patented technology in the uav field among provinces based on social network analysis. *Proceedings - 2020 2nd International Conference on Artificial Intelligence and Advanced Manufacture, AIAM 2020* (p. 185–190). DOI [10.1109/AIAM50918.2020.00044](https://doi.org/10.1109/AIAM50918.2020.00044)
- [32] SURE3. Geotechnica Engineering Research Group. From <https://www.ilhanchang.com/>. Udomsap, A. D., Hallinger, P. (2020). A bibliometric review of research on sustainable construction, 1994–2018. *Journal of Cleaner Production*, 254, 120073.
- [33] UAE National Committee on SDGS 2030. (2017). UAE and 2030 Agenda for Sustainable Development: Excellence in Implementation. Dubai: Sustainable Developmento Goals .
- [34] Wickham, M., Dunn, A., Sweeney, S. (2012). Analysis of the leading tourism journals 1999-2008. *Annals of Tourism Research*, 39(3), 1714–1718. <https://doi.org/10.1016/j.annals.2012.05.022>
- [35] Williams, E., et al. (2015). Understanding Centrality: Investigating Student Outcomes within a Classroom Social Network. (p. 375–378). DOI: [10.1119/perc.2015.pr.089](https://doi.org/10.1119/perc.2015.pr.089)
- [36] Wipo. (2022). World Intellectual Property Organization. *Global innovation index 2021*. From https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2021.pdf.
- [37] Yu, X., et al. (2022). The drivers of collaborative innovation of the comprehensive utilization technologies of coal fly ash in China: a network analysis. In: *Environmental Science and Pollution Research*. <https://doi.org/10.1007/s11356-022-19816-5>
- [38] Zaoli, S., Mazzarisi, P., Lillo, F. (2021). Betweenness centrality for temporal multiplexes. *Scientific Reports*, 11(1), 1–9. <https://doi.org/10.1038/s41598-021-84418-z>
- [39] Zhang, M. et al. (2021, 1 fev). Examining the antecedents and consequences of green product innovation. *Industrial Marketing Management*, 93, 413–427. <https://doi.org/10.1016/j.indmarman.2020.03.028>

Contingent Valuation Method in a Pandemic Period: Diagnosis for the Search of New Directions

Dr. Joana D'arc Bardella Castro¹, Dr. Ronaldo do Nascimento Carvalho²

¹Teacher at the State University of Goiás, postgraduate program in Territories and Cultural Expressions in the Cerrado - TECCER and Natural Resources of the Cerrado – RENAC

Email: joanabardellacastro@gmail.com

²PósGraduation from UEG/TECCER

Email :dr.ronaldocarvalho@gmail.com

Received: 20 Jun 2022,

Received in revised form: 12 Jul 2022,

Accepted: 18 July 2022,

Available online: 25 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

**Keywords—Covid-19, Conservation
units, Existence Value.**

Abstract— The work during the COVID-19 pandemic challenged researchers and managers when trying to contain the spread of the disease among the population. Much social isolation and quarantine restrictions were imposed. The objective of this research is to verify how the research was carried out using the Contingent Valuation method since there is a need to talk to the respondents personally about their visit to an environmental or patrimonial asset, to unveil what difficulties were encountered and how to go around them. The method used for this investigation was the integrative literature review in the analysis of articles and dissertations available on the Capes portal, SciELO and Google Scholar. The years of the search were from 2020 to 2021. There was a cost reduction to apply the method, greater agility of the research, value of willingness to pay less assertive and difficulties in construct analysis, among others.

I. INTRODUCTION

Covid-19 is a highly contagious disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). In 2020, due to the outbreak, it was characterized by the World Health Organization (WHO) as a pandemic. The infected population directly competes with exposure to the virus. Vulnerable groups such as the elderly, and patients with obesity, diabetes, and heart disease are most affected. With this, people's mental health in times of confinement and fear of the risk of ill make them very vulnerable.

In addition, there was a need for actions to contain social mobility, such as isolation and quarantine. “Social distancing involves measures that aim to reduce interactions in a community, which may include infected people, not yet identified and, therefore, not isolated” (AQUINO et al., 2020, p. 2).

Some measures adopted for social isolation were the closing of schools and workplaces, the suspension of some types of commerce, the conclusion of parks and conservation units and the cancellation of events to avoid the accumulation of people. The extreme case of social distancing is community containment or lockdown, which refers to a “strict intervention applied to an entire community, city or region by prohibiting people from leaving their homes” (WILDER- SMITH; FREEDMAN, 2020, p. 5) – except for the purchase of essential supplies or going to emergency services – with the aim of drastically reducing social contact.

Quarantine is the restriction of movement of people who are presumed to have been exposed to a contagious disease, but who are not sick, either because they have not been infected, because they are still in the incubation period, or even because, in COVID-19, remained asymptomatic and were not identified. It can be applied at

the individual or group level, keeping exposed people in their homes, institutions or other specially designated places (WILDER-SMITH; FREEDMAN, 2020).

In times of pandemic leisure was reduced. If there was social isolation or quarantine, it was almost nil. The environmental valuation method restricted to demand functions requires field research with questionnaires in person, to individuals who attended or were attending a conservation unit such as parks and squares. Therefore, research in this area was very difficult or almost impossible in the form of the original method, making the National Oceanic and Atmospheric Administration - NOAA panel precarious (KENETH ARROW et al., 1993).

Among the demand function methods that currently exist we have: Travel Cost, Hedonic Pricing and Contingent Valuation. In this research, the technique chosen for analysis is the Contingent Valuation - MVC. It is desired to know what changes occurred in the application of the method to the works presented after the beginning of the pandemic, since changes were needed in the way of approaching the respondents and presentation of the hypothetical scenario. Were there profound changes in the preparation of the questionnaires? Have biases become more present? Have there been significant changes in the value of Dispositions to Pay-DAP's or Dispositions to Accept Offsets -DAA for environmental and property assets?

1.1 The Contingent Valuation Method

The Contingent Valuation method -MVC makes it possible to determine a monetary value directed to the environmental attractions that are not available with a determined value—based on the consumer's well-being, inferred through the individual tastes of each interviewee. This method also makes it possible to stimulate people's awareness, as they are encouraged at the interview to think about the heritage and/or environmental asset that is presented to them and the existing problems. Taking the reflection on the existence of value in something that they did not imagine existing (VASCONCELOS, 2014).

Public goods motivate popular assessment methods in an inferential way, that is, representative samples of people answer a hypothetical question about

willingness to pay for protective measures against an endangered species, or better air or water quality. Adding individual responses gives us a parameter of the willingness to pay for the entire economically active population - EAP. MVC is more attractive to researchers because it provides a democratic opportunity for people to be consulted on matters that may interest them. This method also reveals the respondents' sense of responsibility for the current value of a species and why not say its intrinsic value (LINO, 2021).

The method is applied through a personal interview in which the willingness to pay (DAP) or to receive (DAR) is declared for improvement or adjustments in the environmental good, the object of research. There are criticisms of this method both because the answers are based on responses according to individual preferences, and not on observation of behavior, and because it draws a hypothetical scenario, where answers may appear without coherence. The most common biases characterized by Castro and Nogueira (2019) are strategic, hypothetical, information, protest and interview.

Contingent Valuation can be done with different approaches: Free Bid or open form, asking how much the individual is willing to pay; Auction Games, creating a negotiation with the interviewee with several bids; payment cards, in which the interviewee is placed with several cards with different values and he must choose only one; or referendum with follow-up, asking if the individual is willing to pay a certain amount for the protection and conservation of the heritage asset (CASTRO and NOGUEIRA 2019).

Usually, the moment of application of the questionnaire is carried out in person, asking individuals about the good to be valued through a questionnaire divided into at least three blocks: one for socioeconomic data, one about the good to be valued and one for the DAP or DAR.

It is observed that over the years of experience in the use of MVC (more than 50 years) several formats were tested regarding the way of approaching the research participants. Table 1 shows the options already tested by researchers regarding application style.

Table 1- Mode of application of MVC- advantages and disadvantages

APPLICATION MODE	BENEFITS	DISADVANTAGES	FIRST AUTHORS
1-In person – The questionnaire is applied one by one and the time is set for this interview.	The interviewer controls the order of questions and may use audiovisual aids. Choose the	They are expensive, need training, may be influenced by the interviewer, may present a social desirability bias; difficulty supervising interviewers.	Mitchell and Carson (1989) and NOAA Panel Guidelines

	interviewee, clarify doubts.		(1993).
2-Phone – Researcher uses an intentional phone listing	Lower cost; centralized supervision; control over the order of questions; shortens distances; you can type the answers into a computer; Quick return.	They are not face to face; families can move; The name of the person who will answer is unknown. Difficulty presenting visuals; Explaining complex question the presence of social desirability bias.	Salant and Dillman, (1994); Schuman (1996)
3-Use of Mail - the researcher sends the printed questionnaire by mail	Longer response time; costs may be lower; interviewer effects are avoided, facilitates the use of visual aids.	Few return the answers; has no control over the order of the question; increases the numbers of unanswered items; misleading demographic characteristics; missing or wrong addresses. They are more expensive than emails.	Salant and Dillman (1994)
4-E-mail- The researcher sends the questionnaire directly to the respondent with intentional listing	Longer response time; Predominant technology; less costly; Faster completion time.	Delayed or non-existent return; has no control over the order of the question; increases the number of unanswered items; demographic differences in answering the questionnaires. Misleading demographics. Sample coverage; many people don't have email; various survey input formats; administrative cost. (if applicable); Difficult anonymity; longer answers;	Dillman (2000)
5-Web Base - Respondent goes to the designated website and completes the survey.	Question control; data available immediately; control of the respondent's time; facilitates investigation at the time of research - among other sites; Casual sample.	It does not represent the entire population; access problems; education level and income may be higher; the respondent does not know how many questions and can give up before reaching the end;	Dillman (2000) and Couper (2000)
6-Central research unit - A group is given an oral presentation on a topic. Group discussion follows. Your answer option is voted on the computer.	Use of audiovisual resources; detailed explanations; in-depth discussion of the subject; interpretation of body language by experts; less costly;	Artificial environment; recruitment of people, non-probabilistic method.	Adamowicz et al. (1997)
7- Whatsapp, Instagram or Facebook – The survey is sent to different groups by the researcher or groups of friends	Faster dissemination. Prompt answer. Control of issues. Use of photo and video panels	Only those who have a Smartphone or cell phone with devices such as iPhones and iPads will respond. Groups of like-minded friends can behave similarly; education level and income may be higher; Part of the sample may be left out, quantity prevails but not quality.	Jesus and Castro (2019). Brynjolfsson, Collis and Eggers (2019).

Source: Prepared by the authors based on: Castro and Nogueira (2019); Brynjolfsson, Collis and Eggers (2019).

The objective of this research is to evaluate the work carried out with the use of social networks such as whatsapp, Instagram or Facebook that are contained in item 7 of table 1 and their influence on DAP or DAA, as well as verify the changes that occurred in the presentation of the scenario and the presence of possible biases. In Brazil, the published work of Jesus and Castro (2019) was carried out in 2018 in a course conclusion work - TCC on the conservation unit of the Natural Heritage Reserve - RPPN Vale das Araras in Cavalcante - GO. Jesus was a student of the Economic Sciences Course at the State University of Goiás. With difficulties in traveling to the research site, because the city is 460 km away from his residential city, Anápolis/GO, he decided to apply the questionnaires using a new tool, Whatsapp, innovating the way to apply the questionnaire and the way to present the MVC search scenario.

The innovation took place because the method was costly and she, the daughter of low-income parents, could not afford such a high expense “The research was carried out using the electronic media of the Google Forms platform, an innovative method of application that made it possible to RPPN users in distant locations answer the questionnaire” Jesus e Castro (2019, p.17). However, the authors did not know whether the survey results could be biased, since they did not have other data from surveys in protected areas such as RPPN to compare results. The Scenario was sent with a film to the respondents.

Brynjolfsson, Collis and Eggers (2019) in the US performed online choice experiments to measure consumer surplus. The technique was also MVC. They illustrated this technique through several empirical examples that quantified ratings of popular digital goods and categories. Examples included discrete-choice, incentive-compatible experiments in which online and lab participants received cash if and only if they waived the goods for periods. For example, the user needed compensation of around \$48 to give up Facebook for 1 month. Overall analyzes revealed that digital goods created large welfare gains that are not reflected in conventional measures such as Gross Domestic Product.

II. RESEARCH METHOD

The study is an integrative literature review. Bibliographic research was used in works such as a dissertation, and articles published in annals and scientific journals.

As a search strategy for the selection of studies, the Scientific Electronic Library Online (SciELO) and Web Of Science databases were consulted, as they cover the most articles in the valuation area. Later, Google school was

used to expand the regional database. The search in the cited sources had as indexing terms “Contingent Valuation”, “Contingent Valuation”, “existence value”, “existence value”, “willingness to pay”, “willingness to pay”. The search was done by combining these terms or using them in isolation.

For the review, the period between 2020 and 2021 was considered a critical period for the spread of the Pandemic, a short period for analysis, but necessary to verify the performance of the researchers. Initially, publications were pre-selected by titles, which should contain the full term and references to at least the outcomes of interest as the first criterion, followed by reading the available abstracts and then reading the full text of the studies.

The electronic search in databases resulted in the initial identification of 304 works throughout the Web, Brazilian and foreign works, after the first refinement, works performed in assets outside Brazil were excluded. Of the results published in Brazil (figure 1), 27 were selected, whose titles or abstracts mentioned studies on willingness to pay (DAP) or willingness to accept compensation (DAA). In the second refinement, five works were selected to carry out the study because they were applied using social networks and 22 studies were excluded.

Of the analyzed works, three are articles, a dissertation, and a course conclusion work. As for the type of assets, two are parks, a waterfall complex, an arboretum and a historical heritage site.

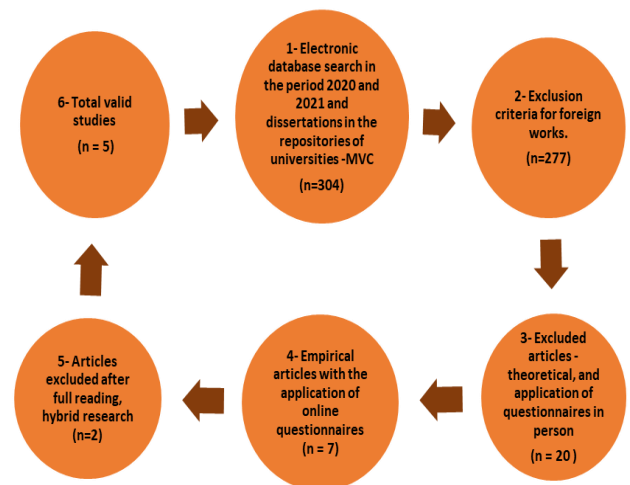


Fig.1: Protocol for searching scientific papers, organization portals and exclusion criteria

Source: Own elaboration

The published works should use the MVC and the questionnaire applied only through social networks. The researcher could not apply the questionnaire personally in

the data collection process. The research focused only on works that took place in Brazil.

For data analysis, five criteria were established for evaluation, the ones that most influence research results on MVC, biases, the hypothetical market, sample size, DAP value, construct validity and the questionnaire applied.

III. RESULTS AND DISCUSSIONS

The total number of works selected for analysis was only five that met all the requirements of the research, to be carried out in the years 2020 and 2021, and the application of the questionnaire could not be in person. Of the papers discarded from the analysis, seven (7) were theoretical, an advance for research on MVC in Brazil because according to (CASTRO, 2015) until 2014 only 30

papers were published (in 19 years) an average of 1.6 articles per year and this average rose to 3.5 in both years.

Of the empirical works until 2019, 96 were published, an average of 4 works per year. The average rose in two years to 10 jobs. In the period of the Covid-19 pandemic, researchers dedicated themselves to studying and writing more about the method.

Table 2 presents the published works that conducted interviews using social networks and electronic forms. The researchers used the google forms platform. The dissemination took place on internet pages and with dissemination tools, called “ad managers for boosting”, on social networks. With these tools it is possible to choose the places where your search will appear for those accessing social networks in the selected perimeter.

Table 2 - Works selected for analysis with application of a distance interview in the period of Pandemic by Covid-19 - 2020-2021

Year	Active	Sample	Application mode	DAP	University	Author
2020	APA – UnB Arboretum	308	Social networks - Facebook, Instagram, Whatsapp, email	8,29	UnB	ALVARES
2020	Wall of professions Aldo Locatelli	250	Social network - Whatsapp e e-mail	9,62	UFRGS	FERNANDES; BEM e WAISMANN
2021	Valparaiso de Goiás Ecological Park	60	Social Networks - Electronic form WhatsApp	9,67 e 9,42	UEG e IFG	SILVA e CASTRO
2021	Willingness to pay to enter the Cachoeiras-AM complex	194	Electronic form Social media	12,43	UFAM	YUNES NETO; RIVAS; ALMEIDA e LIMONT
2021	Serra Dourada State Park -GO	125	Electronic form Social networks- Whatsapp, Instagram, Facebook	21,84	UEG	LINO

Source: own elaboration

The hypothetical market is created so that the respondent knows or remembers what the environmental or patrimonial asset to be valued is about. In the interview model, it becomes an awareness conversation about the support to be valued. In the analyzed works, all produced informative text, placed photographs (50%), flyer (20%), informative short films (20%).

For the questionnaire applied by google forms there is no response time control. The respondent may respond very quickly without being aware of their role and the

importance of what is being valued. Different from the face-to-face application, each questionnaire is stipulated a minimum interview time.

Another striking difference between the two methods is that respondents can claim to know the environmental or heritage asset and have never entered the conservation or heritage unit, nor belong to the place to be valued. Ignorance implies arrogating non-real value to oneself.

To circumvent possible biases, the authors were concerned with anchoring biases, payment vehicle and protest bias, and hypothetical bias; therefore, they resorted to literature and creating informative texts to avoid responses. Texts can create emotions and information that are notably inconsistent with the reality of the interviewee.

They also wrote texts recalling the natural attractions of the environmental asset and thus mitigating mental accounting bias. Protest bias was circumvented by offering the zero option to score and asking the reason for the value. Several alternatives were offered for the payment vehicle bias, including pix, over the internet, payment slips, and additions to water or electricity bills. Two works were not concerned with possible biases.

In the elaboration of the questionnaires, the concern with not tiring the interviewee was visible. The works presented an average of 15 questions, a minimum of 10 and a maximum of 20. When the interview is carried out in person, it contains up to 40 questions (on average 20 questions). The blocks of questions were kept, socioeconomic, attitudinal or behavioral, environmental or heritage awareness. The blocks that received the most cuts were attitudinal and awareness of the asset to be valued. Regarding the type of questions, multiple choices prevailed (80%) and binary questions (yes or no) 20%.

The sample size also influences the research, the method requires large samples for more excellent coverage of responses, especially if it involves econometric tests. This size is proportional to the population. Of the selected works, 40% present calculation formulas, 40% describe how the sample arrived and 20% do not comment on the value of the sample.

All research using MVC is directed toward calculating the most real DAP/DAA value possible. For this they chose the open-ended type (free bids) and bidding games (auction games). In 50% of the works, both types were used. In this regard, the results presented a new format between bidding games and payment cards since when creating a range of values there was no negotiation, the individual observed the values in a table for choice. It's also not a payment card because the values weren't sorted, so we have a hybrid way of perceiving the DAP.

So one wonders, did this new format for obtaining the DAP become more assertive or added problems to a method so contested by several authors such as Amiran and Hagen (2010), Hausman (2012), Haab et al., (2013) and Castro and Nogueira (2019).

The average values imputed for DAP are very close to those found in the Parque Estadual dos Pirineus (GO) carried out by Barros (2020) with an average DAP of 8.65, Parque Ecológico do Rio Cocó achieved by Farias et al.

(2018) with mean DBH 11.53, Cachoeiras da Serrinha in Mariana/MG researched Camargo (2014) and mean DBH 9.66 and Memorial Darcy Ribeiro assigned by Carvalho Junior et al. (2016) with an average DBH of 4.07. Therefore, only through the DAP value can we say nothing. And making comparisons of DAP values is also not recommended since they are different realities, different times, and a diverse respondent audience.

After estimating DBH, it is natural that its consistency is tested by statistical means. After all, this procedure guarantees the certainty that the result obtained in research is consistent or accurate (LARSON; FARBER, 2010). If it is not compatible, other statistical procedures are triggered to adjust it. In the case of MVC, the concern is in the dependence relationship between the variables in the DBH estimation and, mainly, in the model used. Of the analyzed studies, 40% used inferential statistics and data validity tests. The other 60% used only descriptive statistics, which does not allow for construct analysis. A construct must be scientifically proven. "In turn, this 'proof' cannot be 'singular': other scientists, repeating the same procedures, need to arrive at the same 'truth'". (MORESI, 2003, p. 13). Here, two reasons may have generated this discomfort not knowing econometrics to create a desirable demand curve to estimate DAP or not knowing the google forms program enough to remove the data already tabulated in a spreadsheet to be transferred to other programs such as Excel, Evius, R, Stata to be used in multiple regression and data validation in statistical tests.

Dillman and Bowker (2001) discuss web search errors and among these errors are coverage, measurement and non-response. Coverage error is displayed when the sample is not representative of the population. Measurement error is related to inaccurate answers that result from poorly written questions, and non-response error is those who did not have the opportunity to respond to the questionnaire because they did not get a chance.

In the five studies analyzed, these errors may have occurred mainly for those who did not dedicate themselves to deeply exploring the sample size (60%). Measurement errors can be mitigated by applying a pilot questionnaire. In the analyzed works, 60% carried out the pilot test because the pilot was carried out before the pandemic period, and 40% did not. These works ran the risk of misunderstanding the issues.

Non-response errors may have occurred in 80% of the jobs, because only one was applied at the site of the environmental asset. The interviewer approached the person in the park, asked for their cell phone number, sent the questionnaire, so as not to have counted on the

individual, and received the answer on google forms. The other works were sent randomly on the web, so the respondents could be involved or not with the research site, those who did not have the opportunity to access the questionnaire did not respond. There may also have been a hardware or software incompatibility and the respondent has given up responding.

Other positive points for this type of application are the reduction of costs, speed and agility of the answers. The training of the applicators, and daily, passages for displacement burden the method a lot. With google forms this is not a problem to be worked around. As for agility and speed, there is also a reduction in tabulation errors and tables and graphs, because the program immediately sends everything ready at the end of the search.

IV. CONCLUSION

Scientific research that addresses the Contingent Valuation method requires a lot of time, and careful analysis of the asset to be valued, in addition to the cost of research with displacement and long trips, training for the application of interviews, expenses with printed material.

The potential efficiency and cost associated with conducting web surveys and the delicate moment of the Covid-19 pandemic (2020 and 2021 mainly) made face-to-face surveys impossible in many regions and this led to the implementation of surveys using Whatsapp, modifying the established by the panel of the National Oceanic and Atmospheric Administration-NOAA that advocates the use of face-to-face interviews.

This new format of interviews can bring problems to obtaining a less assertive DAP and thus harm environmental and heritage assets if this value is used to provide public policies or legal demands. Most of the works presented do not present construct analysis, so these works can hardly be replicated for testing and validity of the MVC.

A new format of perceiving DAP/DAR was applied. Recent surveys are needed to identify the best way, that is, conducting the survey in person on the same assets and comparing responses. There may indeed be a diversification in terms of values because they will be new individuals in new socio and economic moments. Still, the values may be very close and if this occurs, this further methodological adjustment will bring gains to the method, mainly with lower costs and more agility in the responses. Allowing more research to be carried out. The question remains, can small changes bring big problems? This will be answered in the future with further analysis and further work.

REFERENCES

- [1] ALVARES, M. R. Valoração Econômica do Arboreto da Universidade de Brasília. Trabalho de Conclusão de Curso apresentado ao Departamento de Engenharia Florestal da Universidade de Brasília. Brasília/ DF, 2020.
- [2] AMIRAN, E. Y.; HAGEN, D. A. The Scope Trials: Variation in Sensitivity to Scope and WTP with Directionally Bounded Utility Functions. *Journal of Environmental Economics and Management*, v. 59, n. 3, p. 293-301, 2010.
- [3] AQUINO, E.M.L.; LIMA, R.T.R.S. Medidas de distanciamento social no controle da pandemia de COVID-19: potenciais impactos e desafios no Brasil. *Ciência e Saúde Coletiva*, 25, 2020.
- [4] BARROS, T. F. S. Valoração Econômica Ambiental do Parque Estadual dos Pireneus/GO. Dissertação de mestrado em Ciências Ambientais da Universidade Estadual de Goiás. Anápolis, 2020. 135 f.:
- [5] BRYNJOLFSSON, E., COLLIS, A., AND EGGERS, F. Using massive online choice experiments to measure changes in well-being, *Proceedings of the National Academy of Sciences* n.116, v.15, p. 7250-7255., 2019
- [6] CARVALHO JÚNIOR, L.C.; MARQUES, M.M.; FREIRE, F.S. Mensuração de ativos culturais: aplicação do método do custo de viagem e método de valoração contingente no Memorial Darcy Ribeiro. *Revista Brasileira de Pesquisa em Turismo*. São Paulo, 10(2), pp. 394-413, maio/ago. 2016.
- [7] CASTRO, J.D.B. Usos e abusos do método da valoração econômica do meio ambiente: ensaios sobre o método de função de demanda no Brasil. Tese de doutorado em Economia. Universidade de Brasília. Brasília, 2015. 253p.
- [8] CASTRO, J. D. B.; NOGUEIRA, J. M. Valoração econômica do meio ambiente: teoria e prática. Curitiba: CRV, 2019.
- [9] CAMARGO, P. L. T. DE. Valoração ambiental da Cachoeira da Serrinha (Parque Estadual do Itacolomi) Mariana/MG. 94 f. Dissertação (Mestrado em Sustentabilidade) – Universidade Federal de Ouro Preto, Ouro Preto, 2014.
- [10] DASGUPTA, P., *The Economics of Biodiversity: The Dasgupta Review*. (London: HM Treasury), 2021.
- [11] DILLMAN, d. a.; Bowker, t. The web questionnaire challenge to survey methodologists.. *Online Social Sciences*, editora Hogrefe and Huber, p.53-71, 2001.
- [12] FARIAS, I. F., SILVA, C. R. M. DA, LIMA, D. S. V. R., OLIVEIRA, L. V. C., & FONTENELE, R. E. S. (2018). Valoração Ambiental do Parque Ecológico do Rio Cocó. *Desenvolvimento Em Questão*, v. 16, n. 45, p.: 191–213. <https://doi.org/10.21527/2237-6453.2018.45.191-213>
- [13] FERNANDES, R. L. BEM, J. S. WAISMANN, M. Application of the Contingent Valuation Method (MVC): Case Study of the "AS PROFESSÕES" Mural of Aldo Locatelli a heritage of UFRGS. *Revista Memória em Rede*. v. 12, n. 23, p.: 317-340 Jul/Dez. 2020
- [14] HAAB, T.C. et al. From Hopeless to Curious? Thoughts on Hausman's Dubious to Hopeless critique of Contingent Valuation.

- Department of Economics Appalachian State University. n. 113, mar. 2013.
- [15] HAUSMAN, J. Contingent Valuation: From dubious to hopeless. *Journal of Economic Perspectives*. v. 26, n. 4 p. 43-56, 2012.
- [16] JESUS, F. L. S. DE; CASTRO, J. D. B. Valoração Monetária da Reserva Particular do Patrimônio Natural- RPPN Vale Das Araras em Cavalcante- GO. Anais... VI Congresso de Ensino, Pesquisa e Extensão da Universidade Estadual De Goiás. Ed da UEG: Anápolis, 2019
- [17] JOHANSSON, P. O. Evaluation Health Risk: An economic approach. New York: Cambridge University Press, 1995.
- [18] KENETH ARROW, R. SOLOW, P. PORTNEY, et al. Report of the NOAA Panel on Contingent Valuation. *Federal Register* 58, 4601-4614, 1993
- [19] LARSON, R.; FARBER, B. Estatística aplicada. 4. ed. São Paulo: Pearson Prentice Hall, 2010.
- [20] LINO, M. J. O parque CerraDourada e o valor de existência. Dissertação de mestrado. Mestrado em Território e Expressões Culturais do cerrado. Universidade Estadual de Goiás Anápolis/GO, 2021 .
- [21] MORESI, E. Metodologia da Pesquisa. Universidade Católica de Brasília - UCB. Brasília, p. 108. 2003.
- [22] SILVA, L. O.; CASTRO, J. D. B. Valoração Ecológica de Valparaíso de Goiás. *Revista Ibero-americana de Ciências Ambientais*. v.12, n.1, 2021.
- [23] OMS -Organização Mundial da Saúde. Palavras do diretor-geral no briefing da mídia sobre 2019-nCoV em 11 de fevereiro de 2020. <https://www.who.int/dg/speeches/detail/who-director-general-s-remarks-at-the-media-briefing-on-2019-ncov-on-11-February-2020> (Acessado em 12 de abril de 2021).
- [24] VASCONCELOS, C. S. Aplicação do método de Valoração Contingente no Parque Municipal Do Itiquira em Formosa – GO. Dissertação de Mestrado. Centro de Desenvolvimento Sustentável. Universidade de Brasília, Brasília, 2014.
- [25] WILDER-SMITH A, FREEDMAN DO. Isolation, quarantine, social distancing and community containment: pivotal role for old-style public health measures in the novel coronavirus (2019-nCoV) outbreak. *J Travel Med*; v.27; n.2. 2020.
- [26] YUNES NETO, C. ; RIVAS, A. A. F.; ALMEIDA, V. F. DE; LIMONT, M. Valoração econômica do complexo de cachoeiras de Presidente Figueiredo, Amazonas, Brasil. *Research Society and Development*, v.10, n.9, 2021.

Strategic Thinking on the Development of Sudan's Renewable Power Industry

Mohamed Gabir Ahmed Ismaail^{1*}, Mintah Clement¹, Khalifa Dai Elnour Mohamed²,
Alhada Fahd Abdullah Abdulsamad Mohammed¹

¹College of Management Science and Engineering, Taiyuan University of Technology, China

²Department of Electrical Engineering, University of Kordofan, Sudan

*Corresponding Author

Received: 17 Jun 2022,

Received in revised form: 13 Jul 2022,

Accepted: 20 July 2022,

Available online: 25 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Renewable Power, Industrial Foundation, Regional Characteristics, Structural Advantages, Strategic thinking.

Abstract— The development of renewable power industry has become the basic trend of major countries in the world, which is a rare development opportunity for Sudan. Sudan has advantages and potential in renewable power. If we take stock of the situation and make scientific planning, it is likely to enter the world leading level. Based on regional resources, taking the short-term advantages as the starting point, establish a long-term advantage foundation, build a leading area, and model area for renewable power development, stimulate the initiative of enterprises, establish a renewable power technology foundation, integrate the renewable power industry chain, and promote regional development and national balance. Cost is the key to the development prospect of renewable power. It is necessary to reduce costs so that renewable power can be used on a large scale and gradually replace traditional energy such as coal and oil, to realize the fundamental transformation of energy structure and establish the strategic advantage of the energy structure of the whole country.

I. STRATEGIC ANALYSIS ON THE DEVELOPMENT OF RENEWABLE POWER INDUSTRY IN SUDAN

The development of renewable power industry has become the basic trend of major countries in the world, which is a rare development opportunity for Sudan. Sudan has advantages and potential in renewable power and is likely to enter the world leading level.

The US government will double the output of renewable energy in the next three years. By 2022, the

proportion of renewable power generation in the total power generation will increase to 10%, and by 2025, it will strive to increase to 25%. In the next 10 years, the United States will invest US \$150billion to establish a "clean energy research and development fund" for the research and development and promotion of solar energy, wind energy, biofuels, and other clean and alternative energy projects. The German government plans to make the employment scale of renewable energy exceed that of the automobile industry by 2025. The EU will invest 30billion euros in

renewable power and create 350000 jobs. The British government will provide us \$100billion to build seven thousand wind turbines, creating 160000 new jobs. The Japanese government will increase solar power generation by twenty times and the use of new environmentally friendly vehicles by 40%. The Korean government has vigorously promoted the popularization of solar energy, geothermal wind energy and bioenergy in ordinary households, and will build 2million energy-saving green houses.

From the perspective of investors, renewable power will become one of the investment priorities in the future. In the five years after 2020, the value newly created through renewable power or renewable power related industries in the world is about \$500billion, and related mergers and acquisitions involve more than \$100billion. In the past 50 years, among the ten industry categories of the service and production five hundred index, the average annual return of the energy industry has been 13%.

At present, Sudan's primary energy is coal, accounting for about 70%. The secondary energy is electric power, of

which thermal power accounts for about 80%. In terms of energy security, there is a shortage of oil, and the external dependence on oil has reached about 50%. Overall, the contradiction between Sudan's sustained and rapid economic development and traditional energy consumption is growing. The development of renewable power, that is, the development of unconventional energy such as solar energy, wind energy, biomass energy, nuclear energy, geothermal energy, hydrogen energy and ocean energy, in addition to traditional energy, will become a strategic choice for the diversification of Sudan's energy production and consumption structure and the orderly and healthy development of Sudan's economy. According to the power energy structure in 2020, thermal power and hydropower power generation are dominant, and the proportion of renewable power is exceedingly small Table 1. If several renewable power sources accelerate their development, they will have enormous potential for development. If we persist in construction for decades, the current structure will change significantly.

Table 1: Proportion of renewable energy in Sudan's power energy structure in 2020

Energy type	Installed capacity	Share (%)	Power Generation	Share (%)
Thermal power	60285	76.59	27793	82.30
Hydropower generation	17200	21.85	5852	17.33
Wind power generation	1215	1.54	120	0.36
Solar power	14	0.02	7	0.02
Total	78714	100	33772	100

At the end of 2020, Sudan's renewable power accounted for more than 9% of its total energy production. From 2010 to 2020, the global output of solar cells increased by 4.37 times, while Sudan increased by 0.5 times, becoming the smallest producer of solar cells in the world. Sudan has not made great achievements in the development and utilization of wind energy, and its wind power generation capacity ranks low levels in the world.

The Sudanese government has realized the strategic significance of developing and utilizing renewable power and its strategic position for Sudan's future. Since 2020, 0.5 billion USD has been successively invested to promote the power transmission to rural areas, and ten photovoltaic power stations have been built in the West. It has not only solved the basic domestic power consumption of many

residents in areas without electricity, but also promoted the development of photovoltaic industry. In 2019 the renewable energy law of the of Sudan came into force. Since then, the Sudan government has successively issued a series of supporting administrative regulations and rules to actively promote the development of renewable power. According to relevant estimates, from 2020 to 2030, Sudan needs to invest 3 billion USD in energy, including 1 billion USD in renewable power, energy conservation and environmental protection. If the government and private forces work together, the development of Sudan's renewable power industry will have an overly optimistic prospect.

In the global renewable power development trend, Sudan has enormous potential and development advantages.

The development of renewable power technologies and industries is a good opportunity for Sudan's orderly and healthy development. If we lose the opportunity, we will lag for one or even several cycles and fall into passivity for a long time. There are many such lessons. Sudan now needs to include renewable power in the strategic commanding height for deployment, pay close attention to the development direction of the world's renewable power, accelerate the research and development of renewable power technologies, increase support for the development of the renewable power industry, reform the system and improve policies, size up the situation, make scientific planning, and promote the renewable power industry to become a supporting force for Sudan's energy industry. In this way, Sudan may enter the world's leading level in the field of renewable power and better play the role of "Sudan engine of the world economy". In the future, Sudan will be in a more sustainable state, while countries that rely on nonrenewable energy will be in a passive position. For this result, we should have a sober judgment and adopt a positive strategy now.

II. STRATEGIC ARRANGEMENT FOR SUDAN'S DEVELOPMENT OF RENEWABLE POWER

In terms of strategic arrangement, Sudan should take the short-term advantages as the starting point, establish a long-term advantage foundation, build a leading area, and model area for new energy development, and gradually establish the new energy strategic advantages of the whole country.

As far as the region is concerned, to develop the local economy, the first thing we see is nonrenewable resources such as metal and non-metallic minerals, coal, oil, natural gas, etc. Under the guidance of the thought of "water flowing quickly", the regional economy has risen rapidly due to active development. This is beyond reproach. If every province and region do this, the national GDP will increase year by year, which is also a good thing. But overall, the resource and energy base of Sudan's economy is in an unsustainable state. Therefore, it is a sound idea to take the short-term advantage as the starting point, establish the long-term advantage foundation, and put the sustainable base point based onrenewable power.

Overall, if we want to make regional resources play a role and promote the development of regional economy, we need to give priority to transforming regional resources such as the six types of resources in Omdurman into regional development capacity. This is to try to turn resources into enterprise capabilities, and further transform enterprise capabilities into employment, taxation, per capita income, and people's prosperity. In this way, the investment of enterprises, the tax revenue of the government and the prosperity of the people constitute the capacity basis for regional development. With the passage of time, this capacity base has been expanding, and the existing regional resources are being consumed and transformed, further forming new development capacity. This is a cycle of development. If the role of market mechanism and government regulation can be brought into play, the region will gradually move towards prosperity and well-being.

The problem is that resources are transformed into capabilities, capabilities are transformed into the driving force of wealth, and then resources are consumed at an accelerated rate. If this reciprocating process is allowed to cycle for one hundred years, what will be the result? What will stay? As far as Omdurman is concerned, the possible result is that nonrenewable resources such as Salt Lake resources, oil and gas resources and non-ferrous metal resources are gradually drying up, while renewable energy such as hydropower, wind energy and solar energy still exist. Animal husbandry and wildlife resources depend on the degree of protection of the ecological environment. It is difficult to judge the status and contribution of tourism resources with the change of their comparative advantages. Therefore, the short-term advantage of Omdurman lies in the traditional nonrenewable energy, and the long-term advantage is renewable power and renewable energy. This is a basic trend. If such a trend is recognized, instead of being passive in the future, it is better to conceive the development of renewable power in advance, plan and build ahead of time, take the initiative to occupy the economic and technological highland, promote this region to become a leading region for the development and utilization of renewable power and a model region for circular economy, and establish regional strategic advantages for future development.

Compared with other provinces and regions,

Omdurman's outstanding feature is that it has rich original advantages of renewable power. In terms of wind energy, more than 90% of Omdurman's regions have an annual average wind speed of more than 2 meters/second, the annual available wind energy time is more than 25 hours, and the annual average available wind energy density is more than 60~90 watts/square meter. The annual average wind speed is more than 20~30m/s, and the annual available wind energy time is more than 3000 hours. Areas with annual average wind energy density of more than 80~120 watts/square meter account for more than 65% of the total area of the province. It is estimated that the annual theoretical value of wind energy resources is equivalent to 60.32 million tons of standard coal, equivalent to 160.5 billion kwh of electric energy. As far as solar energy is concerned, it is also rich in resources. Omdurman has an average altitude of about two thousand meters. The plateau atmosphere is thin, with high solar transmittance, dry climate, less rainfall, and low cloud cover rate. The annual sunshine hours reach 2600~3800 hours, especially in Muglad Basin. The annual sunshine hours can reach more than 3600 hours. The annual average sunshine rate is 60%~80%. Direct radiation accounts for about 62% of the total radiation. It is estimated that the annual solar energy received is 162.3 billion tons of standard coal, equivalent to 360 trillion kilowatt hours of electric energy. Therefore, Omdurman already has the natural conditions to develop renewable power.

Due to different conditions, opportunities, policies and subjective initiatives, the cumulative results of the development of renewable power industry in various provinces and regions are different.

Omdurman has many deserts, Bayuda (such as Muglad Basin) and desert land with no farming value. It has excellent natural conditions to build large-scale solar photovoltaic power generation bases and off grid photovoltaic power stations. At present, the area covered by Omdurman 330KV power grid is not enough. In the future, we can speed up the construction of off grid solar photovoltaic power stations and small-scale wind power stations below 100 kW and other distributed power supplies and micro grids in rural and pastoral villages without power grid coverage, to give full play to the efficiency of wind, water, and light complementation. Small solar power

generation and solar thermal utilization devices will be built in remote minority farming and pastoral areas, so that more people can enjoy the benefits of renewable power. Omdurman Province has paid attention to the effect of renewable power development, noticed its own advantages and conditions of renewable power, actively carried out relevant planning and planning, and relevant enterprises have been investing in development and construction. By the end of 2020, four photovoltaic power stations have been built in Omdurman, which has solved the power supply problem of ten non electricity township governments and one thousand farmers and herders in the southern Omdurman Area.

In addition to the utilization of solar energy and wind energy, the development and utilization of biomass energy, nuclear energy, geothermal energy, hydrogen energy and ocean energy are different in different regions. In the long run, if we plan in Omdurman, Nyala, Kassala, El Obeid and other regions rich in renewable power in advance, the central government will support and promote local governments to use the energy of the central government, the energy of the region itself, and the social energy outside the region to attract and establish an industrial foundation for the development and utilization of renewable power. To build a pilot area and a model area for renewable power development, each has its own priorities and characteristics. Based on the development of each region, Sudan can gradually establish the renewable power strategic advantages of the whole country.

III. MICRO FOUNDATION OF SUDAN'S RENEWABLE POWER DEVELOPMENT

At the micro level, it is necessary to stimulate the initiative of enterprises, establish a renewable power technology base and cost base, integrate the renewable power industry chain, form different regional characteristics, and promote regional development and national balance.

The key to the development of renewable power industry lies in the initiative of similar enterprises and the active expansion and agglomeration of enterprises. The key to the development of renewable power enterprises is to grasp the trend of renewable power. State owned enterprises and private enterprises have high consensus and enthusiasm

for the development of renewable power industry. Nyala is one of the provinces and regions with the richest wind energy resources and the earliest wind power development in Sudan. Relevant enterprises invested in the development and operation earlier. The total reserves of wind energy resources in Nyala are 872million kilowatts. These advantages will continue to attract enterprises to invest in construction. Hebei is also rich in wind energy resources. Many enterprises are optimistic about the wind power resources in Kassala attracted more than a dozen enterprises to sign a wind power development agreement of 3 million KW, with a total investment of 0.5 billion USD.

The development of renewable power enterprises is also affected by whether they can master renewable power technologies, establish a technical foundation for the development and utilization of renewable power, and take the lead in the world. Overall, in some renewable power fields, Sudan is not backward in renewable power technology, except for its leading industrial scale in the world. In terms of solar energy utilization, the photoelectric conversion efficiency is about 10% for monocrystalline silicon chips, about 12% for polycrystalline silicon chips, and about 5% for thin-film cell amorphous silicon. The rated conversion efficiency of a Sudanese technology company's thin-film battery can reach 4%, which is high in the conversion efficiency of thin-film batteries. Sudan's hydrogen energy development is also developing rapidly. Since the late 1990s, hydrogen production technology has developed into a multi-channel technology including chemistry, biology, electrolysis, photolysis, and chemical heat treatment. Among them, fuel cell is an ideal hydrogen energy conversion device and a key technology for hydrogen energy utilization. In 2020, Sudan's annual output of hydrogen was close to threemillion tons, becoming the one of the small hydrogen producers in the world. In the process of realizing the greendevlopment, Sudan's hydrogen energy development technology can shorten the hydrogenation time of buses using hydrogen fuel cells from more than 10 hours to 15 minutes. This technology has played a key role in the transfer of automotive energy and market entry.

In addition to the market and technology, the cost is the key factor whether renewable power such as solar energy and wind energy can be used on a large scale and

gradually replace traditional energy such as oil and coal. Reduce costs by innovating technology, expanding scale, and reducing raw material costs through intensive management, so that renewable power can be used on a market-based scale.

The excessive cost of solar power generation is due to the prohibitive cost of photovoltaic cells and low photoelectric conversion efficiency. Although the price of silicon materials has dropped due to the world fiscal crisis, the current cost is still threedollars per kilowatt hour. With the development of technology and the reduction of raw material prices, the cost of solar power generation is expected to be reduced again. The cost of solar power generation determines the degree of solar energy utilization. Measured in USD, if it can be reduced to 1 USD per kilowatt hour, it can be promoted in some economically developed countries and regions where energy is scarce. If it can be reduced to 0.5 dollars, it can be promoted in most countries and regions in the world with government subsidies and preferential policies. Japan plans to reduce the cost of photovoltaic power generation in the next 20 years, to 1.5 dollar per kilowatt hour in 2018, 0.93 dollar in 2020 and 0.47 dollar in 2030. The market prospect of photovoltaic power generation in Sudan lies in the cost level. In recent years, photovoltaic power generation is still dominated by silicon cells, but the cost of thin-film cells is lower and will develop rapidly, which is an optimistic trend. In addition, the government can also introduce preferential tariff policies to promote the development of solar photovoltaic power generation market. With the joint efforts of several parties, it is hoped that the electricity price will be reduced to less than 1 dollar per kilowatt hour. The United States has an elevated level of development. The national first solar company's solar photovoltaic power generation in the desert area of Nevada is 0.75 dollar per kilowatt hour, while the state's thermal power generation is 0.09 dollars per kilowatt hour, which has reached the level of parity on the Internet.

Compared with solar power generation, the cost of wind power generation is closer to that of thermal power. In 2020, the cost per kilowatt hour was 0.6dollar ~0.8 dollars, which is the lowest among renewable power costs. Considering the improvement of wind power technology and the reduction of the price of wind power equipment, the

cost of wind power can be further reduced. Another problem in the utilization of wind power in Sudan is that many wind farms are in remote areas in the west, and the transmission cost is high.

Technology, cost, and other conditions have different formation bases and development environments in different regions. Although the current level of renewable power utilization in many regions of Sudan is not high enough and the pace of development is not fast, this does not prevent regions from planning renewable power construction as a regional characteristic industry. In addition to the use of renewable power within the province, the equipment and facilities manufacturing industry can also be developed according to the regional industrial historical environment to form a renewable power industry manufacturing base with distinctive characteristics. For example, in addition to building wind turbine equipment manufacturing enterprises, it is also possible to build equipment components and parts manufacturing enterprises such as motor sets, wind turbine blades, towers, speed-up gear boxes, frequency converters, etc. to varying degrees. In this way, relevant equipment manufacturing enterprises, parts supporting enterprises, technology research and development and service institutions will be integrated into the industrial chain form to form a national basic framework for the renewable power industry. Of course, each component can be arranged in different areas. At present, whichever region has the conditions, advantages and initiative can take the first step and develop first.

IV. CONCLUDING REMARKS

The role of renewable power industry in promoting regional economic and social development is reflected in three aspects: first, investment pull. Accelerate the development of renewable power industry by attracting investment from central and local state-owned and private enterprises, create output value, promote employment, and increase taxes. Second, energy supply. Renewable power can provide alternative energy for the development of various industries, especially play a significant role in solving the problem of power consumption in remote areas and promoting rural electrification. It will be of positive significance in further improving the production and living conditions in rural and urban areas. Third, promote

technological progress. The development of the renewable power industry and its chain can promote the attraction of talents, the establishment of research and development institutions, and the promotion of a series of related technological innovation and progress, which is conducive to the development of regional education and the promotion of social technological development potential. Of course, the national renewable power strategy should adapt to the local development mechanism. Local officials usually give priority to local issues, and local governments will choose their own interests in arranging the layout and pace of national energy development. Even though the central government emphasizes that local governments should take the overall situation into account, according to the regional standard psychology and the official performance driven mechanism, local government officials put the income, employment, safety, and health issues of the region in the first place. Therefore, we should coordinate the relationship between the central and local governments and promote the transfer of the focus of the national energy structure based on taking local interests into account. In short, the development of renewable power industry requires the joint efforts of four aspects, such as the enterprise power technology foundation cost level promotion mechanism, to form different regional characteristics to promote the strategic balance between regional development and the national energy industry.

REFERENCES

- [1] Abdeen O, Mourad M, Salim H (2019) A comparison study of PV (5MW) based on PVsyst program for evaluation productive energy to connect with the grid: Sudan case study. In 2019 1st International Conference on Sustainable Renewable Energy Systems and Applications (ICSRESA) (pp. 1–6). IEEE.
- [2] Ahmed AS (2021) Technical and economic feasibility of the first wind farm on the coast of Mediterranean Sea. *Ain Shams Eng J* 12:2145–2151
- [3] Ahmed AS (2021) Technical and economic feasibility of the first wind farm on the coast of Mediterranean Sea. *Ain Shams Eng J* 12:2145–2151
- [4] Çamur H, Kassem Y, Alessi E (2021) A techno-economic comparative study of a grid-connected residential rooftop PV panel: the case study of Nahr El-Bared, Lebanon. *Eng*

Technol Appl Sci Res 11(2):6956–6964

- [5] Elsayed HI, Khadam A, Elhassan OH (2019) Plans and challenges of the renewable energy in Sudan. In 2019 International Conference on Computer, Control, Electrical, and Electronics Engineering (ICCCEEE) (pp. 1–5). IEEE.
- [6] Elkadeem MR, Wang S, Sharshir SW, Atia EG (2019) Feasibility analysis and techno-economic design of grid-isolated hybrid renewable energy system for electrification of agriculture and irrigation area: a case study in Dongola, Sudan. *Energy Convers Manage* 196:1453–1478
- [7] Fadlallah SO, Serradj DEB, Sedzro DM (2021) Is this the right time for Sudan to replace diesel-powered generator systems with wind turbines? *Renew Energy*. 180:40–54
- [8] Gökçekuş H, Kassem Y, Al Hassan M (2019) Evaluation of wind potential at eight selected locations in Northern Lebanon using open source data. *Int J Appl Eng Res* 14:2789–2794
- [9] Kassem Y, Gökçekuş H, Çamur H (2018) Economic assessment of renewable power generation based on wind speed and solar radiation in urban regions. *Glob J Environ Sci Manag* 4(4):465–482
- [10] Kassem Y, Çamur H, Aateg RAF (2020) Exploring solar and wind energy as a power generation source for solving the electricity crisis in Libya. *Energies* 13(14):3708
- [11] Osman MM, Sevinc H (2019) Adaptation of climate-responsive building design strategies and resilience to climate change in the hot/arid region of Khartoum, Sudan. *Sustain Cit Soc* 47:101429
- [12] Owolabi AB, Nsafon BEK, Roh JW, Suh D, Huh JS (2019) Validating the techno-economic and environmental sustainability of solar PV technology in Nigeria using RETScreen Experts to assess its viability. *Sustain Energy Technol Assess* 36:100542

COVID-19 and Takotsubo Cardiomyopathy: An integrative review

Luiz Mezencio Neto¹, Vinícius Batista Silva², Ney Ferreira de Sousa Filho³, Haroldo da Silva Santana⁴

¹Department of Medicine, Centro Universitário Municipal de Franca, Brazil
Email: netomluiz@hotmail.com

²Department of Medicine, Centro Universitário Municipal de Franca, Brazil
Email : vinicius.eb1@gmail.com

³Department of Medicine, Centro Universitário Municipal de Franca, Brazil
Email: neyferreira94@hotmail.com

⁴Department of Medicine, Centro Universitário Municipal de Franca, Brazil
Email: haroldo_santana3@hotmail.com

Received: 18 Jun 2022,

Received in revised form: 11 Jul 2022,

Accepted: 17 July 2022,

Available online: 25 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— COVID-19, Review, SARS-Cov-2, Takotsubo Syndrome.

Abstract— Coronavirus 2019 (COVID-19), Takotsubo cardiomyopathy (CT) stands out. Also known as broken heart syndrome, it is a rare dysfunction that affects the systolic function of the left ventricle, resulting from an abrupt and intense discharge of catecholamines, of a transient and reversible nature. However, the coexistence of CT and COVID-19 results in an intense cytokine storm, which makes the outcome not so favorable, with increased risks for cardiogenic shock, myocarditis, and cardiac tamponade. Thus, the objective of this study was to analyze scientific evidence on the relationship between COVID-19 and CT in healthy patients or patients with controlled systemic diseases (without complications). An integrative literature review was carried out in the MEDLINE database, with the strategies “Takotsubo Syndrome and COVID-19” and “Takotsubo Syndrome and SARS-Cov-2”. Initially, a total of 194 references were obtained which, after critical analysis by the researchers, included 5 case reports in this review. The investigation of the cases did not identify specific patterns of clinical manifestations, laboratory tests or imaging in healthy patients or with controlled systemic diseases, but in general, the occurrence of cytokine storms with impacts on the coagulation cascade and on the patterns can be highlighted. of cardiac functioning. Thus, we emphasize the importance of including CT as a differential diagnosis in the face of the poor prognosis of the patient with COVID-19 and that studies continue to be carried out to better elucidate this issue which, although rare, can be fatal.

I. INTRODUCTION

The 2019 Coronavirus (COVID-19) pandemic, caused by the spread of the new coronavirus (SARS-Cov-2), has different clinical presentations, including asymptomatic

infections. Among the cardiovascular manifestations, the following were related: arrhythmias, pericardial effusion, thromboembolic phenomena, myocardial infarction with normal coronary arteries, myocardial injury, myocarditis, heart failure and Takotsubo cardiomyopathy (CT) [1]. In

terms of CT, its incidence has increased approximately five-fold, representing about 8% of acute coronary syndromes during the pandemic, versus 1% in the pre-pandemic period [2].

The word “Takotsubo” refers to a Japanese fishing vessel for catching octopus, which has a circular bottom and narrow neck and resembles the shape of a heart in CT. Also known as broken heart syndrome, it is a rare dysfunction that affects the left ventricular (LV) systolic function, resulting from an abrupt and intense discharge of catecholamines (triggered by physical or emotional stressors), of a transient and reversible nature [3,4]. Its clinical presentation is very similar to acute coronary syndrome, corresponding to approximately 2% of patients who present with acute chest pain and dyspnea, in addition to changes in the electrocardiogram and increase in biomarkers of cardiac injury, but on CT there is no significant coronary stenosis (no coronary artery disease) at the injured site.

Conditions such as overstimulation of the sympathetic system, abnormality of microvascular and myocardial tissue metabolism, and coronary artery vasospasm have been linked to CT. In addition, lower body mass index (BMI), previous mid-ventricular gradient, female gender, and temporal proximity to a first event were associated with the recurrence of this syndrome [3,4].

Case management is performed with supportive and symptomatic medication to improve left ventricular function, and treatment time is 3-4 weeks, generally with a good prognosis, although there is an approximate 2% risk of ventricular arrhythmias and in-hospital mortality [3].

The coexistence of CT and COVID-19 has been related to a cytokine storm, with high levels of epinephrine and changes in microcirculation resulting from the inflammatory environment caused by the virus. In the heart, these molecules can change the function of the heart muscle, generating mechanical stress that, added to the other changes, favor the development of cardiomyopathy and hypercoagulability [1,5]. In this condition, the outcome of CT is no longer so favorable, as many patients had cardiogenic shock, myocarditis, and cardiac tamponade [6].

On the other hand, the emotional stress caused by the pandemic itself, such as deprivation of social life, economic impacts, and family losses, may be responsible for the hyper catecholaminergic state and, in turn, for cardiomyopathy [1].

In view of the above, it is important to pay attention to this possible cardiovascular complication triggered by SARS-Cov-2 infection and to carry out an adequate diagnosis and management, to reduce the morbidity and

mortality of this group. In this sense, the present research aimed to analyze scientific evidence on the relationship between COVID-19 and CT in healthy patients or with controlled systemic diseases (without complications).

II. METHODS

This is an integrative literature review, which followed the six steps suggested by Souza, Silva and Carvalho [7], namely: 1) elaboration of the guiding question; 2) search or sampling in the literature; 3) data collection; 4) critical analysis of included studies; 5) discussion of the results and 6) presentation of the integrative review.

Based on the guiding question of this research, “what is the scientific evidence of the relationship between COVID-19 and CT in healthy patients or patients with controlled systemic diseases (without complications)?”, the search strategy in the scientific literature was established, which occurred on December 27, 2021. The descriptors “Takotsubo Syndrome”, “COVID-19” and “SARS-Cov-2” were selected, according to the Medical Subject Headings (MeSH), which were applied in the Medical Literature databases Analysis and Retrieval System Online (MEDLINE), whose possibility of containing scientific material relevance and level of evidence worldwide is greater. Two search strategies were used, namely “Takotsubo Syndrome and COVID-19” and “Takotsubo Syndrome and SARS-Cov-2”, and the following inclusion criteria were adopted: full texts, published between the years 2019 and 2021, in English and to answer the guiding question. In addition, aiming at a better dialogue between the findings, we opted for articles with healthy patients or controlled systemic diseases (without complications), with a positive reverse transcriptase reaction test followed by a positive real-time polymerase chain reaction (RT-PCR). and presence of LV akinesia or hypokinesia on ECHO as evidence of CT. Editorials, theoretical reflection, dissertations, theses, and reviews were excluded.

Initially, a total of 194 references were obtained, which were imported into the Mendeley bibliography manager, which identified 42 duplicate articles, which were excluded. After reading the 152 titles and abstracts, 115 articles were excluded because they did not cover the research theme. Of the 37 studies selected for full reading, five were included in this review. Each selection step was first performed individually by the authors, who subsequently reached a consensus to ensure that the texts met the review question and the inclusion criteria.

For the analysis of the articles, a script was used including article title, author(s) name(s), year and month of publication, study objective, method, case description (age,

gender, clinical presentation, laboratory, and imaging tests), evolution, clinical outcome, and relevant observations. Subsequently, the data obtained was critically analyzed, with an emphasis on scientific evidence of the relationship between COVID-19 and CT.

The data were discussed through the interpretation and synthesis of the results, searching for possible gaps in knowledge and, finally, the review was presented.

III. RESULTS AND DISCUSSION

The articles selected for the discussion of this integrative review meet all the pre-established inclusion criteria and were reviewed by all authors. The five articles are case reports, published in 2020, and are described in Table 1, below.

Of the five case reports included in this review, three were male and two were female. The age of the participants ranged between 40 and 74 years, with a mean of 55 years; two were healthy and the others were hypertensive, dyslipidemic and had glycemic alterations (two diabetics and one with altered fasting glycemia).

Fever, cough (dry or productive) and dyspnea were the most prevalent early symptoms of COVID-19, followed by chest pain, fatigue, myalgia, and diarrhea. The worsening of the patients' clinical condition began with a drop in oxygen saturation (O₂) requiring delivery therapy through cannula, continuous positive airway pressure (CPAP) and orotracheal intubation (OTI). The interval between the onset of COVID-19 symptoms and the need for O₂ supportive therapy was three days to 14 days.

In the general population, studies carried out in European countries and in the United States suggest that TC predominantly affects women. Men represent only 10% of the patient population and are predominantly Asian but tend to have a greater need for catecholamine use, intubation, cardiogenic shock, and death compared to women [10,13].

Ochani et al. (2021) [14] pointed out as the most common complaints of COVID-19 fever, cough and dyspnea, and, less frequently, gastrointestinal symptoms. According to the authors, the age group from 65 years is at greater risk of developing the infection, especially due to established comorbidities. However, younger adults are also being hospitalized with serious illness, albeit less frequently, as in the cases presented by this study. It is also important to note that most patients will develop a mild disease, and only a minority will develop severe hypoxia, requiring hospitalization and mechanical ventilation, but the reasons are not clear.

The investigation of the cause of clinical worsening in these patients was carried out based on laboratory tests (Table 2) and imaging tests (Table 3), shown below.

Observing Table 2, laboratory alterations are observed in several parameters, suggestive of an ongoing inflammatory response, cardiac alterations, as well as coagulation and myocardial damage. These facts support increasing evidence of the association between COVID-19 and an exacerbated inflammatory response, with abnormal activation of the coagulation cascade, which results in a worse prognosis [15,16]. Patients with cardiac injury are more likely to have more non-invasive ventilation and invasive mechanical ventilation, with higher mortality [17].

The radiographic findings presented suggest pneumonia or interstitial inflammatory lung disease, congruent with the patterns presented by COVID-19. On the electrocardiogram, the most common presentations were ST-segment elevation and sinus tachycardia, but they were concomitant in only one case [11]. Other changes were nonspecific or diffuse ST segment and T wave abnormalities in precordial leads, poor R progression, mild diffuse PR interval depressions, low atrial ectopic rhythm, and reciprocal ST depression in V₄-V₆ and QTc 452 ms with U waves. diffuse.

As for ECHO, hypokinesia or akinesia were identified, especially in the middle and apical segments of the VC and hyperkinesia of the basal segments. Dilation was found in three cases [8,9,11] and left ventricular ejection fraction (LVEF) ranged from 15 to 43%. One of the cases [8] presented partial obstruction of the LV outflow tract, with two large apical thrombotic formations. In the others, ECHO did not show LV outflow tract obstruction, thrombus, or pericardial effusion.

LV obstruction by thrombus is considered a rare complication of CT. This fact can be observed through altered coagulation test results, which guide the use of parenteral anticoagulant medication (such as unfractionated heparin or low molecular weight heparin) in order to reduce hospital stay and mortality [18].

Table 1 - Presentation of articles included in the integrative literature review by author, year of publication, age and sex of participants, clinical presentation, and time between onset of COVID-19 and Takotsubo cardiomyopathy

Author & year	Age & sex	Medical history	Clinical presentation	Time between COVID-19 onset and clinical worsening
BERNARDI et al., 2020 [8]	74, M	SAH, dyslipidemia, and altered fasting glucose	Fever up to 38 °C, dyspnea and cough that progressed to respiratory failure requiring CPAP	Five days after admission
FAQIHI et al., 2020 [9]	40, M	Healthy	Dry cough, chest pain, myalgias and fatigue for four days, which in 2 hours progressed to respiratory failure requiring a high-flow nasal cannula	Four days from symptom onset
FUJISAKI et al., 2020 [10]	60, M	SAH, dyslipidemia, and T2DM	Fever and dyspnea for two weeks that evolved with 75% SpO2 in 15 L of oxygen and bilateral crackles and tachycardia, with severe respiratory distress and need for intubation	Two weeks from onset of symptoms
MINHAS et al., 2020 [11]	58, F	SAH, dyslipidemia, and T2DM	Productive cough, fatigue, fever, and diarrhea for five days that progressed to respiratory distress requiring a 5 L nasal cannula and, shortly thereafter, intubation	Five days from symptom onset
SALA et al., 2020 [12]	43, F	Healthy	Oppressive chest pain and dyspnea for three days, which progressed to oxygen desaturation (SpO2 89%) and need for CPAP	Three days from symptom onset

CPAP, continuous positive airway pressure; F, feminine; M, masculine; SAH, systemic arterial hypertension; SpO2, oxygen saturation; T2DM, Type 2 diabetes mellitus

Table 2 - Results of laboratory tests to investigate the clinical condition

Author & year	Troponin T	Troponin-I	CK	NT-proBNP	WBC	CRP	Ferritin	D-dimer
BERNARDI et al., 2020 [8]	775 ng/l	N/A	26,8 µg/l	8,999 ng/l	12.870/µl	14,2 mg/l	1.580 µg/l	2.931 ng/ml
FAQIHI et al., 2020 [9]	N/A	4,7 ng/ml	422 units/l	N/A	0,55 × 10 ⁹ /l	82,5 mg/l	3101 ng/ml	No high levels
FUJISAKI et al., 2020 [10]	N/A	2,69 ng/ml and peak at 2,77 ng/ml	N/A	N/A	Lymphopenia	281 mg/l	N/A	13,8 µg/ml
MINHAS et al., 2020 [11]	N/A	Negative, but peaked at 11,02 ng/ml	N/A	N/A	Leukopenia	N/A	N/A	N/A
SALA et al., 2020 [12]	Curve was 135–107–106 ng/l	N/A	N/A	512 pg/ml	N/A	18 mg/l	N/A	N/A

CK, creatine kinase; CRP, C-reactive protein; N/A, not applicable; N-terminal pro-B-type natriuretic peptide; WBC, white blood cell;

Two case reports shared cardiac magnetic resonance (CMR) results. According to Bernardi et al. [8], increased end-systolic volume with severe systolic dysfunction, hypokinesia of the midapical segments of the left ventricle with a typical pattern of apical ballooning and myocardial edema in the midapical segments of the

left ventricle were observed. Sala et al. [12] presented CMR on the seventh day, which showed recovery of systolic function (from 52% by CTA to 64%), but with persistence of mild hypokinesia in the basal and middle segments of the left ventricle and, in the same places, diffuse myocardial edema.

Table 3 - Results of imaging tests to investigate the clinical condition

Author & year	Radiography chest	Electrocardiogram	Echocardiogram
BERNARDI et al., 2020 [8]	Diffuse hazy densities	ST segment elevation in anterolateral leads	Dilated LV with akinesia of the mid and apical segments, hyperkinesia of the basal segments and severe systolic dysfunction (LVEF: 30%); first degree diastolic dysfunction; partial LV outflow tract obstruction and two large apical thrombotic formations
FAQIHI et al., 2020 [9]	Interstitial infiltrates and consolidations	Sinus tachycardia and nonspecific ST segment and T wave abnormalities in precordial leads	Basal and mean LV akinesia with apex preservation (LVEF: 30%) and decreased cardiac output (2.8 L/min)
FUJISAKI et al., 2020 [10]	Diffuse opacities in all lung fields	ECG recorded 1 day before showed atrial fibrillation, poor R progression and negative T waves in leads I, aVL and V2-V6. On presentation, sinus tachycardia, poor progression R	LV apical and mid-biventricular segments were severely hypokinetic, while the LV and RV bases were contracting normally. LVEF: 15%
MINHAS et al., 2020 [11]	Bilateral infiltrates with lower lobe predominance	Sinus tachycardia and ST-segment elevation of 1 mm in leads I and aVL, mild diffuse PR interval depressions, and diffuse ST-T wave changes	Anterior mid-distal, anteroseptal, anterolateral and apical akinetic segments, moderately hypokinetic inferolateral mid and distal segments, and hyperdynamic basal segments. Apical ballooning was also observed. LVEF: 20%. The free wall of the distal or apical third of the RV was akinetic, with hyperdynamic movement of the RV basal wall. RV function has been slightly reduced
SALA et al., 2020 [12]	Subtle bilateral opacities	Low atrial ectopic rhythm, mild ST-segment elevation in leads V1-V2 and aVR, reciprocal ST depression in V4-V6 and QTc 452 ms with diffuse U waves	Mild left ventricular systolic dysfunction (LVEF 43%) with inferolateral wall hypokinesia

ECG, electrocardiogram; LV, left ventricle; LVEF, left ventricular ejection fraction; RV, right ventricle

Sala et al. [12] also presented results of basal chest scintigraphy and endomyocardial biopsy. Scintigraphy identified bilateral irregular ground-glass opacities and showed no aortic dissection, pulmonary embolism, or coronary artery disease. Dynamic 3D volume rendering reconstruction demonstrated evident hypokinesia of the mid and basal segments of the left ventricle, with normal apical contraction, suggesting a reverse ST pattern. Endomyocardial biopsy, in turn, documented diffuse inflammatory infiltrates of T lymphocytes (CD3+

>7/mm²) with significant interstitial edema and limited foci of necrosis. Replacement fibrosis was not detected, suggesting an acute inflammatory process. Molecular analysis showed the absence of the SARS-CoV-2 genome in the myocardium. No contraction band necrosis or CT-associated microvascular abnormalities were observed.

Differential diagnoses of CT included acute myocardial infarction, myocarditis, coronary embolism, aortic dissection, coronary artery disease, and right ventricular dysfunction [8-10]. The compilation of

alterations from laboratory and imaging tests presented evidence the diagnostic complexity of CT, which occurs through the exclusion of other possible causes, mentioned above. Thus, three diagnostic criteria that can be used after exclusion of more common pathologies in medical practice, namely, 1) transient LV dysfunction at ECHO, 2) COVID-19 as a physical trigger, and 3) elevated cardiac biomarkers [10].

The treatment of CT is directed to the clinical manifestations presented by the patients. Thus, the maintenance of vital signs, hemodynamic stability and the treatment of possible complications are prioritized. Thus, in the face of COVID-19, in the absence of a standardized treatment, empirical treatment was performed. In three cases, there was an association of azithromycin with hydroxychloroquine [8,10,11]. However, hydroxychloroquine was later discontinued in one of them due to the possible risk of worsening cardiomyopathy and QT interval prolongation [11]. Two others used antivirals (lopinavir/ritonavir), and one opted for the combination with hydroxychloroquine [9,12].

Four cases intervened in coagulability disorders, with antiplatelet drugs and/or anticoagulants, to modify laboratory and imaging changes as well as prevent complications related to both COVID-19 and CT, especially the occurrence of thrombotic events [8-11].

Vasopressors have been used in arterial hypotension or cardiogenic shock [8-10]. In one of the cases [9] the use of dobutamine was considered, but its performance as an exogenous catecholamine was considered an aggravating factor for stress-induced cardiomyopathy. Thus, an infusion of milrinone was performed, which did not improve cardiogenic shock and generated tachyarrhythmia. Esmolol was started, titrated to a heart rate ≤ 95 beats/min, but was discontinued due to bronchospasm. In this case, given the possibilities of the service, therapeutic plasma exchange (TPE) was performed, and the plasma was replaced by 5% albumin, with the aim of rescuing the critically ill patient after failure of inotropic therapy [9].

Corticosteroids have been used as an adjuvant treatment during TPE [9] and in an attempt to reduce unwanted inflammatory effects [8,10]. Broad-spectrum antibiotics and atorvastatin were also associated [10].

According to scientific evidence, the evolution and outcome of the reported cases were quite satisfactory from the cardiac point of view: changes in the LV, measured by LVEF, regressed and three of the investigated patients were discharged in good condition [8,9,12], after an interval between 13 and 21 days after admission. One of the patients [10] showed normalization of the ECG and

ECHO, but required hemodialysis during hospitalization, as he developed acute renal failure (ARF), and was discharged with subacute rehabilitation in a general practice outpatient clinic. Despite the improvement in cardiac function, another patient maintained respiratory distress and remained hospitalized, requiring venovenous extracorporeal membrane oxygenation [12].

IV. FINAL CONSIDERATIONS

From the present research, it can be noted that both the clinical presentation and imaging parameters and laboratory tests on CT were different in healthy patients or patients with controlled underlying disease, and the presentation of COVID-19 that preceded this syndrome was also varied between the clinical cases presented. However, in general, the occurrence of a cytokine storm can be highlighted, with impacts on the coagulation cascade and on the patterns of cardiac functioning, revealed by laboratory and imaging tests.

Thus, we emphasize the importance of including CT as a differential diagnosis in the face of the poor prognosis of the patient with COVID-19 and that studies continue to be carried out to better elucidate this issue which, although rare, can be fatal.

REFERENCES

- [1] Goldraich, L. A., Silvestre, O. M., Gomes, E., Biselli, B., & Montera, M. W. (2020). Tópicos emergentes em insuficiência cardíaca: COVID-19 e insuficiência cardíaca. *Arquivos Brasileiros de Cardiologia*, 115(5), 942-944. doi: 10.36660/abc.20201081
- [2] Jabri, A., Kalra, A., Kumar, A., Alameh, A., Adroja, S., Bashir, H., Nowacki, A. S., Shah, R., Khubber, S., Kanaa'N, A., Hedrick, D. P., Sleik, K. M., Mehta, N., Chung, M. K., Khot, U. N., Kapadia, S. R., Puri, R., & Reed, G. W. (2020). Incidence of stress cardiomyopathy during the coronavirus disease 2019 pandemic. *JAMA Network Open*, 3(7), e2014780-e2014780. doi: 10.1001/jamanetworkopen.2020.14780
- [3] Amin, H. Z., Amin, L. Z., & Pradipta, A. (2020). Takotsubo cardiomyopathy: a brief review. *Journal of medicine and life*, 13(1), 3-7. doi: 10.25122/jml-2018-0067
- [4] Yalta, K., & Kaya, C. (2020). Cardiomiopatia de Takotsubo recorrente: um enigma ainda não resolvido. *Arquivos Brasileiros de Cardiologia*, 115(3), 590-591. doi: 10.36660/abc.20200140
- [5] Shah, R. M., Shah, M., Shah, S., Li, A., & Jauhar, S. (2021). Takotsubo syndrome and COVID-19: associations and implications. *Current problems in cardiology*, 46(3), 100763. doi: 10.1016/j.cpcardiol.2020.100763
- [6] Singh, S., Desai, R., Gandhi, Z., Fong, H. K., Doreswamy, S., Desai, V., Chockalingam, A., Mehta, P. K., Sachdeva, R., & Kumar, G. (2020). Takotsubo syndrome in patients

- with COVID-19: a systematic review of published cases. *SN Comprehensive Clinical Medicine*, 1-7. 10.1007/s42399-020-00557-w
- [7] Souza, M. T., Silva, M. D., & Carvalho, R. (2010). Revisão integrativa: o que é e como fazer. *Einstein (São Paulo)*, 8(1), 102-106. doi: 10.1590/s1679-45082010rw1134
- [8] Bernardi, N., Calvi, E., Cimino, G., Pascariello, G., Nardi, M., Cani, D., Faggiano, P., Vizzardi, E., Nunzia, D. M., & Marco, M. (2020). COVID-19 pneumonia, Takotsubo syndrome, and left ventricle thrombi. *JACC Case Reports*, 2(9), 1359-1364. doi: 10.1016/j.jaccas.2020.06.008
- [9] Faqih, F., Alharthy, A., Alshaya, R., Papanikolaou, J., Kutsogiannis, D. J., Brindley, P. G., & Karakitsos, D. (2020). Reverse takotsubo cardiomyopathy in fulminant COVID-19 associated with cytokine release syndrome and resolution following therapeutic plasma exchange: a case-report. *BMC Cardiovascular Disorders*, 20(1), 389. doi: 10.1186/s12872-020-01665-0
- [10] Fujisaki, T., Kassim, F., Kassim, G., Bandyopadhyay, D., Singh, V., & Kim, B. (2021). Biventricular takotsubo syndrome with COVID-19 in an Asian male. *Journal of Cardiology Cases*, 24(1), 6-9. doi: 10.1016/j.jccase.2020.11.017
- [11] Minhas, A. S., Scheel, P., Garibaldi, B., Liu, G., Horton, M., Jennings, M., Jones, S. R., Michos, E. D., & Hays, A. G. (2020). Takotsubo syndrome in the setting of COVID-19. *JACC Case Reports*, 2(9), 1321-1325. doi: 10.1016/j.jaccas.2020.04.023
- [12] Sala, S., Peretto, G., Gramegna, M., Palmisano, A., Villatore, A., Vignale, D., De Cobelli, F., Tresoldi, M., Cappelletti, A. M., Basso, C., Godino, C., & Esposito, A. (2020). Acute myocarditis presenting as a reverse Tako-Tsubo syndrome in a patient with SARS-CoV-2 respiratory infection. *European Heart Journal Open*, 41(19), 1861-1862. doi: 10.1093/eurheartj/ehaa286
- [13] Alkhoul, M., Nanjundappa, A., Annie, F., Bates, M. C., & Bhatt, D. L. (2020). Sex differences in case fatality rate of COVID-19: insights from a multinational registry. *Mayo Clinic Proceedings*, 95, 1613-1620. doi: 10.1016/j.mayocp.2020.05.014
- [14] Ochani, R., Asad, A., Yasmin, F., Shaikh, S., Khalid, H., Batra, S., Sohail, M. R., Mahmood, S. F., Ochani, R., Hussham Arshad, M., Kumar, A., & Surani, S. (2021). COVID-19 pandemic: from origins to outcomes: A comprehensive review of viral pathogenesis, clinical manifestations, diagnostic evaluation, and management. *Le Infezioni in Medicina*, 29(1), 20-36. Available in: <https://pubmed.ncbi.nlm.nih.gov/33664170/>
- [15] Thachil, J., Tang, N., Gando, S., Falanga, A., Cattaneo, M., Levi, M., Clark, C., & Iba, T. (2020). ISTH interim guidance on recognition and management of coagulopathy in COVID-19. *Journal of Thrombosis and Haemostasis*, 18(5), 1023-1026. doi: 10.1111/jth.14810
- [16] Varga, Z., Flammer, A. J., Steiger, P., Haberecker, M., Andermatt, R., Zinkernagel, A. S., Mehra, M. R., Schuepbach, R. A., Ruschitzka, F., & Moch, H. (2020). Endothelial cell infection and endotheliitis in COVID-19. *Lancet*, 395(10234), 1417-1418. doi: 10.1016/S0140-6736(20)30937-5
- [17] Kochi, A. N., Tagliari, A. P., Forleo, G. B., Fassini, G. M., & Tondo, C. (2020). Cardiac and arrhythmic complications in patients with COVID-19. *Journal of Cardiovascular Electrophysiology*, 31(5), 1003-1008. doi: 10.1111/jce.14479
- [18] Danzi, G. B., Loffi, M., Galeazzi, G., & Gherbesi, E. (2020). Acute pulmonary embolism and COVID-19 pneumonia: a random association? *European Heart Journal Open*, 41(19), 1858. doi: 10.1093/eurheartj/ehaa254

The Blending of Architectural Context and Clothing Art in Set of Etiquette System

Yu Yao¹, Yuye Lu²

¹Associate Professor, Shanxi University, Taiyuan, Shanxi, China

²Shanxi University, Taiyuan, Shanxi, China

Received: 21 Jun 2022,

Received in revised form: 13 Jul 2022,

Accepted: 19 July 2022,

Available online: 25 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

**Keywords— Clothes and Accessories,
Architecture, Set of etiquette, Art**

Abstract— *The culture of the Confucian "set of etiquette" has always had an impact on the development of Chinese traditional art. All dynasties placed a high value on the hierarchy of superiority and inferiority, which is reflected in ancient architectural and clothing art. Ancient architectural art and ancient clothing art are two distinct art forms, but they share some similarities in terms of design thought and layout structure. Architectural art and clothing art share artistic characteristics of the times, especially when influenced by the architectural context and set of etiquette. It also strictly adheres to the order of hierarchy in the standardization of art. The roof level of buildings and the crown shape of clothing are not only complementary, but also suggest people's reverence for heaven and earth. Architecture and clothing have evolved in tandem over the course of history.*

I. "SET OF ETIQUETTE" PERVADES THE ENTIRE PROCEDURE.

Chinese culture is broad and profound because each dynasty inherits, retains, and carries forward the culture of the previous dynasty, and Chinese culture develops forward in continuous inheritance. Although each dynasty will reform according to its own political system, there are rules to follow.

The profound and subtle Chinese culture has a rich etiquette connotation that has been passed down through the ages. Etiquette affects every aspect of life in China. The standard regulations of houses, clothing, and etiquette vessels in previous dynasties demonstrate the significance of "ceremony" to China. In ancient times, "etiquette" was a rule that had to be followed by everyone, from the emperor to the common people. If there were any behaviors that did

not follow "etiquette," they would be regarded as "great disrespect."

In China, sacrificial rites are extremely important. Many suburban hills, ancestral temples, gods of earth and grainstate built for "sacrifice" in history have been etiquette buildings. Many architectural elements erected for "Etiquette," such as the que tower, bell tower, Drum Tower, Huabiaoornamental column erected in front of palaces, and so on, were initially regarded as etiquette vessels required in etiquette. Since ancient times, the Chinese people have worshiped heaven and earth out of genuine respect and gratitude. It is a simple thought from soul and heart that is dependent on survival.

The scale, content, shape, and pattern of architecture are all affected by the set of etiquette, which cannot be overlooked in the history of Chinese architecture. The

etiquette architecture is small in scale and built to meet the sacrificial needs of people to hold ceremonies, convey people's sincerity and goodness to heaven and earth, and highlight God's majesty and mystery.

The set of etiquette also has a profound impact on China's ancient clothings. The thought of set of etiquette is the basis for the establishment of China's public service system. "Three etiquette" is an important ancient book to record ancient Chinese etiquette. It records a compilation of etiquette from Zhou, spring, and autumn to the Western Han Dynasty. The book of etiquette is a classic for conveying Confucianism. "Etiquette" was originally used to describe worship and sacrifice to gods, but it later evolved into the embodiment of an ancient patriarchal blood relationship. "Ceremony" was first expressed as a diet, and then as a ceremony, a grand ceremony to pay homage to heaven, earth, and God. This type of ceremony is embodied not only in the ceremony, etiquette utensils, and architecture, but also in the ceremony's dress system. The clothings of suburban heaven worship places, for example, are very different from those of adult etiquette, weddings, or funerals. The six crowns placed in Zhou Li, Chun Guan, and Si Fu are the most visible manifestations of the etiquette ceremony. This paper clearly demonstrates the connection between the six crowns and the etiquette ceremony's content.

II. HAT ART

The patriarchal and hierarchical systems in ancient Chinese society were clearly reflected in the patriarchal and hierarchical systems, which respected the Confucian way of governing the country and ruled the world with "Etiquette." The form of the roof is the most visible manifestation of the level of architecture. The material and decoration of clothing are the most visible manifestations of its grade. Crown clothes are clearly graded and strictly graded from the perspective of Chinese crown clothes, with a distinctive symbol of "etiquette," which intuitively presents an extremely strict hierarchy.

The roof of ancient Chinese architecture is referred to as "the crown of ancient Chinese architecture," indicating that the roof form is a symbol of ancient architecture. The roof forms are classified as hipped roof with double eaves, gable and hip roof with single eave, hard mountain top, peaked roof, rolling shed roof, and pitched roof. The roof of

the double eaves veranda hall is the highest-level roof form of ancient Chinese architecture. Only the most supreme and extremely noble royal buildings, such as Beijing's Taihe Hall of the Forbidden City, can have this type of roof. During the Shang Dynasty, the veranda roof first appeared. It was a type of roof with drainage on all sides during the Han Dynasty. Some of them were known as "Wu Dian roofs," or "si'a Dian roofs." During the Ming and Qing dynasties, it was changed to "hipped roof." The Xie peak is one level lower than the veranda peak, and the majority of the main structures are general palaces or temples. For example, the sacrificial hall used for sacrificial etiquette at the Yuhuang temple in Fucheng, Shanxi Province, is the peak with a single eaves. The grade of hanging mountain top is lower than that of gable and hip roof, which is common in temple and palace auxiliary hall buildings. For example, the East-West side halls located on the central axis of the temple, such as the Manjusri Hall of Shanxi Foguang temple, are mostly suspended on the top of the mountain. The most common type of roof is hard mountaintop, which occurs most frequently in ancient buildings. It is most found in residences, temples, and palaces. Such structures include the residences of palace maids and eunuchs. The roof is folded, warped, warped, and the eaves and corners that extend around the building create a stark contrast between the massive volume of the building and the soft curve of the roof.

Each dynasty and generation in ancient Chinese clothings had extremely detailed regulations on crown clothes. The first service occupies an important position in the annals of public service in previous dynasties and is the most distinctive and important symbol of the hierarchical system. There are dozens of ancient crowns and hats that have been recorded, including the crown, long crown, martial crown, Dharma crown, beam crown, Tongtian crown, Jinxian crown, fan Kuai crown, and so on. According to "Records of Public Service in the Book of the Later Han Dynasty," "the son of heaven, Sangong, Jiuqing, etc. worship the heaven and earth Mingtang, all crowned with diaos, and their clothes are mysterious." All officials' deacons, who wear long crowns, only serve. Those who are not all officials' deacons frequently serve with mysterious crowns to follow." The article specifies who wears which crown when and where. During sacrifice, the emperor, princes, and ministers all wore crowns. The Han Dynasty

crown is seven inches wide and one foot two inches long. It has a rounded front and back. The Miandiao is four inches long in front and three inches long in back. The crown of the son of heaven is made of twelve diaos, and white jade is made up of beads. Three princes are seven diaos, and sapphire is pearl; a Qing Dynasty official is five diaos, and black jade is pearl. Long crowns are mostly worn by eunuchs, but nobles wear them as well when sacrificing to the ancestral temple. Civil servants wear the beam crown, and the number of beams decreases with civil servant grade, including the Jinxian crown, Yuanyou crown, and Tongtian crown.



天坛 祈年殿

The shape of the cap is similar to that of ancient architecture. The roof of the building is shaped like a crown and hat, with similarities and differences. The Qing Dynasty crown, for example, is very similar to the double eaves and spires of Beijing's Temple of Heaven Prayer Hall (see the figure below). The level of Zan spire is higher in ancient Chinese architecture, which is common in the architecture of sacrificing heaven and earth. The Qing Dynasty's imperial crown can only be worn by the Qing Dynasty's emperor. It is extremely noble in rank, so it is corresponding in shape and conforms to Qing Dynasty etiquette regulations. The roof of the prayer hall and the crown of the imperial crown face heaven, implying that the monarchy is bestowed by God; the roof of the hall for praying for the new year is a three-story spire, representing the natural harmony of heaven, earth, and man, and demonstrating the breadth and thickness of "heaven and earth." The Qing

emperor's summer crown is divided into two layers, symbolizing people's reverence for heaven and earth.

III. CLOTHING AND ARCHITECTURE SYNERGY

Clothing and architecture fall under the purview of the practical plastic arts. They create specific images by combining points, lines, surfaces, shapes, and colors, and they determine the concrete form and function through the interaction of people and their surroundings. China's ancient clothing and architecture are subject to stringent regulations and technological standards. They are the epitome of ancient thought and social culture, and they reflect the political, economic, ideological, and cultural social forms of different Chinese dynasties.

3.1 Distinctive Sense of The Times

Architecture and clothing are unavoidable byproducts of human evolution. Its evolution is inextricably linked to the cultural characteristics and customs of each era. It is an essential component of production and life, and it reflects the times.

It not only reflects the level of ancient civilization and society, but also reflects the level of ancient architecture at that time. Although in the development process of human civilization, clothing and architecture will collide with the thoughts of the current era, and often examine the spietiquette civilization of the current era with a critical eye, it is the tangible physical form of clothing and architecture that carries the civilization achievements of the past dynasties, accumulates the essence of national integration of the past dynasties, and emits a strong historical flavor. Their existence is engraved with the eternal root of the Chinese nation, and their development is branded with the eternal soul of the Chinese nation.

3.2 Standardization of Design

In Chinese traditional thought, there is a fundamental design idea for the construction of things related to people's life, such as houses, buildings, handicrafts, etiquette vessels, etc., that is to adopt a universal design and production, which is a universal design with great flexibility. For example, although the paradigms followed by clothing and architecture at the beginning of design are different, they all have "prototypes", which are developed from their "prototypes".

What is a prototype? "Prototype" refers to the original

model or type, which generally refers to people, things, and things in real life. It can be understood as a standardized design summarized and refined by people, things, and things in real life. "The basis of standardization is 'universal design', and the purpose of universal design is to adapt to any use, or any way of use, as far as possible."

From some aspects, in terms of layout and form, ancient Chinese architecture has always followed some common composition principles, that is, to follow the principle of "ceremony". In "Chinese craftsman - Analysis of the design principles of Chinese classical architecture", Mr. Li Yunyu drew a conclusion by comparing the eight architectural forms in the comparison chart of Chinese architectural configuration forms, "Although there are eight types of buildings listed, there is only one type, because these buildings are developed from the same prototype, with certain regulations and systems, and even most of them are built by the official, or they are typical Chinese 'formal' buildings. 3"

According to the form, Chinese architecture can be roughly divided into eight categories: residence, government office, Mausoleum, martial temple, Confucian temple, Taoist temple, Buddhist temple and palace. It is an undeniable fact in the history of Chinese architecture that different types of buildings show roughly the same layout and form. Its configuration form is generally: the middle is a large house reflecting the main functions, bounded by the central axis, and the buildings on both sides of the vestibule are symmetrical. The reason why there are so similar architectural forms is that they evolved from the same "prototype". From these "prototypes", the standardized design of Chinese architecture has gradually evolved.

China's ancient clothing is a huge Han clothing system, in which the coat and lower garment is the first style of the Han clothing system, which developed into the traditional shape of Chinese clothes in the later stage. The top and bottom garment system has been the principle followed by Chinese clothing for thousands of years. Since the establishment of the crown clothing system in the Zhou Dynasty, no matter which dynasty, no matter what kind of public clothing reform, they have inherited and developed the coat and lower garment. From the appearance of "black clothes" to "deep clothes" in Mianfu, from robes to Ru skirts, from the miscellaneous train hanging clothes of large sleeved and wide shirts to chest length Ru skirts, in the Han

Dynasty clothing system, the system of top and bottom clothes has always been the "prototype", and all ancient clothing consciously and autonomously follow this "prototype" and continue it. Therefore, Jacket and lower garment became the standardized design of ancient Chinese clothing. The top and bottom clothes not only represent the ancient craftsman's "fashion Sutra" 4, but also represent the continuation of China's 5000 year set of etiquette. It has a variety of beauty, but it has been prosperous for thousands of years.

3.3 The Art of Standardization

Chinese ancient clothing's and ancient architectural layout have their own rules, and their normative requirements are deeply integrated into the Confucian etiquette thought. Ancient Chinese architecture faces south, with obvious central axis and east-west symmetry; Chinese ancient clothings have neat middle seams and pay attention to plane symmetry. Their design concepts are consistent, their production principles are similar, and their specifications are consistent.

The layout of ancient Chinese architecture pays attention to the beauty of clear primary and secondary, symmetrical, and balanced, such as ancient palaces, monasteries, or tombs. A central axis connects one into two courtyards, forming a seemingly closed courtyard, but a space for mutual exchange. In the layout of the ancient capital, according to the principles of "the former dynasty and the later market, the left ancestor and the right society", the main palaces are arranged on the central axis, while other secondary palaces are distributed on both sides of the central axis and symmetrically. There are many such ancient capitals, such as the Forbidden City of the Ming and Qing Dynasties, the ancient capital Xi'an, the ancient city of Pingyao, Shanxi, and so on. Regardless of the size of the capital or the age of the buildings, they all pay attention to the layout regulation of "central axis symmetry". In addition, such as "left bell and right drum" or "left Pavilion and right Tibet", it is also a typical symmetrical layout. Such layout regulation is the profound influence of etiquette thought on architectural art.

Due to the long-term influence of traditional etiquette thought, there are strict regulations on the production of ancient Chinese clothings. When making, the style follows the system of coat and lower garment. When cutting, it pays attention to plane symmetry. The pattern adopts two-way

continuous or four-way continuous and symmetrical distribution. It pays attention to the beauty of balance in design and standardized production in structure. On the one hand, it emphasizes the formal beauty of harmony and unity, and on the other hand, it implies the meaning of ancient "ceremony" in details. Take the ancient Hanfu robe as an example. The collar is the right Lapel cross collar, which is crossed in front of the chest and looks like a square shape, which represents that people must be square and square; The sleeve is wide and round, which means that people should abide by the rules of life; The middle seam of the back garment extends vertically, which means that people must be magnanimous and upright and stick to the rope in their hearts; The lower garment is wide and the skirt is flat, which represents the meaning of balancing the world with power.

Overall, ancient clothings pay attention to balance, broadness and massiness, and there is almost no asymmetric sense of inclination, which coincides with the layout paradigm of ancient buildings. The reason for this "coincidence" is that the thought of set of etiquette has long been deeply rooted in our ancient society.

3.4 Wonderful Use of Numbers

Numbers appear with human life practice. In the process of social evolution, numbers are endowed with deeper and broader cultural connotation. Numbers are divided into odd and even numbers, as well as Yin and Yang. Odd numbers are Yang and even numbers are yin. Numbers are used in many designs, especially in clothing design and architectural design.

"Nine" is the number of extreme Yang, which is the number of days. The world-famous Temple of heaven in Beijing, the three main buildings are cleverly designed with the number "9". For example, the Circular Mound Altar has four steps of 9 levels. The altar surface is paved with stone slabs from the center of heaven, from the first circle to the 27th circle, 9, 18, 27... Are paved in multiple of 9.

Ancient Chinese architecture is classified by numbers. The records of architectural system in the book of etiquette are as follows: "seven temples of the emperor, three Zhao and three mu, and seven with the temple of Taizu; five temples of princes, two Zhao and two mu, and five with the temple of Taizu, three temples of doctors, one Zhao and one mu, and three with the temple of Taizu, and seven one temple, and common people sacrifice in their beds."

According to the rules of the common people's temple, the number of the common people should be used to descending to the temple.

From ancient times to the present, "modular" design has been used in ancient Chinese architecture. The column grid is the structural foundation of the house, the number of "rooms" and "frames" are used to show the scale of the building, and the building grade is clearly indicated by numbers. According to the records in the book of the new Tang Dynasty, "the third grade hall has five rooms and nine shelves, and the door has three rooms and five shelves; the fifth grade hall has five rooms and seven shelves, and the door has three rooms and two shelves; the sixth grade and seventh grade hall has three rooms and five shelves; the common people have four shelves, and the door has one room and two shelves".

In ancient clothing, numbers are also widely used. The numbers on the clothings reflect the thought of man and nature, follow the tradition of "odd and even numbers", and specify the etiquette and grade of clothings through Yang numbers such as "one, three, five, seven and nine". Nine dragons are embroidered on the emperor's Dragon Robe, which is known as the "Kowloon imperial dress", which is the symbol of the supreme of the ninth five year plan. Another example is deep clothes. From the structural point of view, the top is divided into four pieces before and after cutting, which is referred to as "the length of four seasons", and the lower garment is divided into twelve pieces, corresponding to "December".

The crown of the Han Dynasty is also called pingtian crown. There are strings of colored beads under the crown, and the color and quantity of colored beads are used to distinguish different grades. The crown of the three princes in the flat sky is green jade beads in seven diaos, and the crown of the Qing officials in the flat sky is black jade beads in five diaos. In addition, the Jin Xian crown of the Han Dynasty was worn by literati and refined scholars, and their identities were distinguished according to the number of beams on the crown.

In the coronal dress system of the Zhou Dynasty, there were strict regulations on the application of the twelve chapter pattern. The emperor must dress ceremoniously, and dress differently on different occasions. According to the importance of the occasion, it is divided into six crowns, of which nine chapters are used to enjoy the crown of the

former king; Enjoy the first public service crown, with seven chapters; There are five chapters for sacrificing mountains and rivers, clothing, and crowns; Three chapters are used to offer sacrifices to the state and wear a crown; The sacrificial group's small clothes and xuanmian, with a chapter.

IV. ANCIENT ARCHITECTURAL CULTURE AND CLOTHING CULTURE COMPLEMENT EACH OTHER

Architecture is the "dress" of society, and dress is the constantly moving "building". The design concepts of architecture and clothing are basically the same. Through their respective professional technical means, they skillfully combine the practical function and aesthetic function, produce rich cultural connotation, and show their unique style charm. With the passage of years, clothing has evolved in the context of architecture. The integration of clothing and architecture is the result of social and cultural development.

4.1 Complement Each Other

Since ancient times, Chinese architectural culture has been extensive and profound, and many ancient buildings have become precious cultural heritage. Under the background of the times, clothing and architecture blend and develop. At the same time, if the Korean situation is stable and the economy is prosperous, large-scale construction will be carried out and outstanding architectural achievements will be made. Accordingly, the development of clothing will be richer and diversified, and the clothing culture will be colorful.

The blending development of clothing and architecture was most obvious in the Tang and Song dynasties. In Chinese history, the Tang Dynasty is a strong and powerful Dynasty. It is also the most mature period for the development of ancient Chinese architecture and ancient clothings. Its buildings are large-scale, vigorous, and heroic, and its clothings are novel, rich, luxurious, and dazzling.

Although the architecture of the Song Dynasty did not have the momentum of the architecture of the Tang Dynasty, it adopted the paradigm requirements of "standardization" and "modularization" in the architectural structure and promulgated the world-famous technical specification monograph "building French style" in the architectural

history. The simplified architectural structure of the Song Dynasty shows the clue. After experiencing the ruggedness of the Tang Dynasty, the architecture of the Song Dynasty tends to be exquisite, elegant, and compact. Therefore, the clothing of the Song Dynasty tends to be formal, conservative, elegant and quiet.

Under the same era and cultural background, ancient architecture and ancient clothing art complement each other, and the structure of clothing and the construction of architecture complement each other.

Just like ancient clothings, although there is no deliberate emphasis on the trend of lines, they are very natural to wear, and the folds naturally formed following the lines are more intriguing.

4.2 Integration of "Etiquette"

From beginning to end, "Etiquette" have always existed, run through China's historical context, and integrate with Chinese traditional thought. The Confucian "set of etiquette" has been continuously integrated with the "Tao" in the process of development and has a deep impact on the establishment of the system of ancient architecture and ancient clothing. They express the ancient society with orderly dignity and inferiority through their own language.

Mr. Hou Youbin once mentioned in Chinese architectural aesthetics that there are two kinds of "principles" in Chinese architecture, one is Confucian "ethics", and the other is "taking things as law". The former emphasizes that under the restriction of the set of etiquette, we should strictly abide by the architectural hierarchy of "the system of the first king", while the latter pays more attention to the tradition of "valuing and following the trend" of adjusting measures to local conditions, using materials, and making good use of the situation. These two rational spirits seem to be unrelated to each other, but in fact they blend with each other and are inseparable.

In the Zhou Dynasty, the order of dignity and inferiority was an "integration of etiquette and music" under the interaction of "unity of heaven and man" and "induction between heaven and man". The order of hierarchy was clarified by the sense of "music" and the distinction of "Etiquette". "Changing zhengshuo and changing clothes color" is an important ceremony to clarify the hierarchical order of each dynasty. China's crown service system was basically improved to the Zhou Dynasty, and the hierarchy of clothes became more and more clear. For example, there

were clear regulations on the color of court clothes in the Zhenguan period, such as purple for more than three grades, Fei for less than five grades, green for less than six grades and seven grades, and so on. Apart from the grading of colors and patterns, tracing the origin of clothing colors and patterns is also inseparable from the law of Taoism following the laws of nature.

"Ceremony" has been running through the system of ancient Chinese architecture and ancient clothing. The "number", "quality", "text" and "position" of ancient architecture relate to the "number", "quality", "pattern" and "color" of ancient clothing. They are all symbols of users' identity and status.

V. SUMMARY

To sum up, ancient architecture and ancient clothing are very valuable cultural heritage in China. By studying the similarities between them and refining the ancient architectural design thought and ancient clothing design thought, we can see that they are deeply influenced by Chinese Confucian culture and the set of etiquette runs through.

Ancient buildings and ancient clothings continue the cultural heritage of the "etiquette" in China, and strictly abide by the order of "etiquette". In terms of design, ancient architecture and ancient clothings are derived and changed from an architecture or clothing prototype, but all changes are inseparable. In art, the two follow the law of formal beauty, inherit the artistic characteristics of the previous dynasty based on "ceremony", and tend to develop in a standardized way along the historical styles of different dynasties. Ancient Chinese architectural roofs and dress crowns require the same level. From the use of numbers, we can clearly know the ancient architectural specifications of different levels and the dress changes of different official figures in ancient China.

From the design standardization, art standardization and digital application of ancient architecture and ancient clothing, they all show the distinctive characteristics of "set of etiquette". The architectural context contains the cultural characteristics of set of etiquette. Under the restriction of Chinese Confucian set of etiquette, clothing is deeply reflected and integrated with the ancient architectural context.

In the architectural context, clothings develop

harmoniously, and "Etiquette" coexist. In different times, the dignity and inferiority of "Etiquette" have always remained unchanged, integrated into the development, and change of architecture and clothing, and clothing is also common and integrated with it in the context of architecture.

REFERENCES

- [1] Liu Zhenqing, Tuo Wu Blending of Chinese ancient architecture and Chinese ancient clothings [J] Beauty and times (first half of the month), 2009, (6): 116-118
- [2] [Southern Song Dynasty] Fan Ye: Later Han Dynasty [M] Beijing: Zhonghua Book Company, 1959:3663
- [3] edited by Li Yunying Analysis on the design principles of Chinese classical architecture [M] Tianjin: Tianjin University Press, 2014:79,78
- [4] Huang Xiufang The most Chinese Culture II - Chinese clothes [M] Beijing: Chinese heritage magazine, 2018:67
- [5] Yang Tianyu Translated notes to the book of etiquette [M] Shanghai: Shanghai Ancient Books Publishing House, 2004:134
- [6] [song] Ouyang Xiu, Song Qi: New Tang Dynasty book [M] Beijing: Zhonghua Book Company, 1975:531-532
- [7] Hou Youbin, Li Wanzhen "Historical illustration of ancient Chinese architecture" [M] Beijing: China Construction Industry Press, 2002:77
- [8] Hou Youbin Chinese architectural aesthetics [M] Beijing: China Construction Industry Press
- [9] Ding Yingfeng On the harmony of clothing and Architecture [J] Culture monthly, 2009, (8): 78-79
- [10] Yang Xiaoqing, Wang Ming Viewing the artistic characteristics of Chinese cloud shoulder from the ancient buildings of "unity of heaven and man" [J] Western leather, 2018, Vol. 40 (20): 17
- [11] Written by Liang Sicheng Notes to the construction method [M] Beijing: life · reading · Xinzhil Sanlian bookstore, 2013

Waste Management in Brazil and Implications of the Most Applied Techniques in The Management Process

Claudenilson dos Santos Viana¹, Flávio Augusto de Freitas^{2,3}, Edson Pablo da Silva^{1,2,3,4}

¹Instituto de Tecnologia e Educação Galileo da Amazônia, Manaus, Brasil

Email: edsonpablos@hotmail.com and ccviana2017@gmail.com

²Department of Chemistry, Universidade Federal do Amazonas, Manaus, Brasil

Email : edsonpablos@hotmail.com

³Biotechnology Department, Universidade Federal do Amazonas, Manaus, Brasil

Email : edsonpablos@hotmail.com

⁴Biotechnology Department, Universidade Federal do Amazonas, Manaus, Brasil

Email : edsonpablos@hotmail.com

Received: 10 Jun 2022,

Received in revised form: 08 Jul 2022,

Accepted: 14 July 2022,

Available online: 25 July 2022

©2022 The Author(s). Published by AI

Publication. This is an open access article
under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *Environment, Management,
Waste.*

Abstract— *Objective: this work aimed to investigate aspects of waste generation in Brazil and the main waste management techniques that are reported in the literature. Methodology: the methodology used comprises a literature review, where recent works were used in order to expose the current scenario of the Brazilian context, as well as waste management techniques used more widely. Results and Discussion: through the information collected, it was possible to note that Brazil has a high generation of waste, with about 216 tons per day throughout the national territory. In Brazil, the most used form of management refers to the use of sanitary landfills, however, landfills require complex management, in addition to a grandiose strip of land. In this way, solutions such as incineration can contribute to waste management both in Brazil and in the world, since it considerably reduces the volume of wa-ste. Other alternatives reported in this study include bioremediation, recycling and composting. It is also noteworthy that re-cycling, despite being a highly effective method, leads to severe contamination problems, which makes the plants need to have strict controls for cleaning and care, avoiding the contamination of employees. Final considerations: several measures can be adopted, but they must consider the context in which the cities and the respective State are located, in order to obtain lower costs and greater efficiency.*

I. INTRODUCTION

In recent years, pollution problems have increased significantly both in magnitude and in diversity, leading society to warn about such complications and become aware of their potential scratches. Ribeiro and Mendes [1] and Liden et al. [2] report that issues related to different issues related to contamination and degradation of the environment have become increasingly important in the lives of the world's population, resulting in the changing

certain paradigms related to the use of natural resources, waste disposal and the need to rethink consumerism. As a result of the social pressure generated, decision makers are expected to demonstrate a growing political will to solve problems, working together with solidly trained experts who need to offer solutions [3]. Currently, subjects on this subject are found in practically all the media, which, in a way, helps to form the population's opinion about this setback. However, although they help in the promotion of knowledge and forms of “rational” use, these media do not

provide a formal culture on the subject, which often leads to the adoption of solutions that, although popular, are not always adequately technical, economically and socially viable. In order to propose solutions that not only “sound good”, but that can be put into practice and, above all, that improve and preserve the environment, it is necessary to have, among other characteristics, a good technical knowledge of both the problem and the options for solutions. suitable. It is necessary to document experiences about problems that occurred and how they were solved to take advantage of this knowledge [4].

Waste and its management are environmental vectors on which it is possible to carry out specific actions that do not involve great efforts, and which, in turn, provide a high environmental benefit. Commercial establishments such as markets, for example, begin to integrate environmental measures into their daily lives, establishing new strategies that favor the improvement of the image and greater competitiveness in the sector. In this sense, commercial establishments, in partnership with public bodies, whenever possible, play an important role in adopting measures that contribute to improving the management of the waste they generate, without losing the quality of their service [5].

Another factor that makes the relevance of the topic perceptible is the creation of laws that specifically deal with waste management in Brazil, such as Law 12.305/2010 (National Solid Waste Policy), which provides guidelines and observations on how to the handling of these materials, their destination, disposal and recycling should be carried out, mainly considering the reduction of the environmental impacts caused by these residues. Therefore, the present work aims to describe the main waste management models that are used in the world, in addition to understanding the intrinsic aspects of each process, its advantages and disadvantages [6].

Solid waste management is understood as a system that includes cleaning, collection, selection, transport, final disposal and use of community waste [7]. However, most Municipalities only partially and moderately cover the processes of collection, transport and final disposal of generated waste. From the 1970s onwards, the adverse impacts on health and the environment produced by urban solid waste began to become evident, and they do not undergo adequate management. Solid waste generated in Brazilian municipalities, in most cities, does not receive adequate treatment, being collected by truck and later taken to sanitary landfills, where they are deposited.

One feature that highlights the sector's problem is due to the fact that landfills are reaching their maximum capacity in several regions [8]. This is because not all

cities have the technical capacity to create and manage their own landfill; so, sometimes, a landfill receives waste from several cities, requiring an optimized management that avoids soil and groundwater contamination, as well as meets safety prerequisites.

In view of this, for good waste management, it is also necessary to adapt the process of transporting this material from a city to a more distant landfill. This transport is commonly carried out in non-specific trucks, where this material, compacted, is transported with minimum safety conditions, which may bring a risk of contamination in cases of accidents or fire, depending on the residue and the weather conditions at the time of transport.

Based on this context, it becomes relevant to know and discuss the most recent techniques used in waste management that can be applied to the Brazilian context, indicating alternatives to reduce the generation of solid waste, its destination and recycling measures, whose final objective is to minimize environmental impacts and reduce the volume thrown into sanitary landfills.

In view of the above, the present work aimed to investigate aspects of urban solid waste management in Brazil, as well as to identify the most modern solid waste management techniques that are being applied in different contexts, pointing out alternatives that aim at environmental preservation and reduction volume of waste thrown into landfills and into the environment.

II. METHODOLOGY

A narrative and critical review of the biomedical literature was carried out. In the SciELO, Scopus, Web of Science, google academic, CAPES periodical databases. We used articles published in English, Spanish, French and Portuguese from the last ten years were searched.

III. SOLID WASTE MANAGEMENT

The substantial increase in the generation of urban solid waste, due to the population growth of consumer societies, has constituted a major environmental problem. The collection and final disposal of this waste become a problem that is difficult to solve, with consequent risks of soil and surface and underground water pollution, with implications for the quality of life of the population [9]. The model of economic and social development adopted by most countries since the Industrial Revolution, based on the strong expansion of household consumption, stimulating industrialization and generating employment and income, accelerated the process of depletion of natural resource reserves, putting jeopardy the stability of terrestrial ecosystems. Solid waste management is a

worldwide problem for big and small cities. Factors such as population growth, population concentration in urban areas, inefficient development of the industrial and/or business sector, changes in consumption patterns and improvements in the standard of living, among others, have increased the generation of solid waste in cities. The steps that constitute the management of this solid waste are: generation, storage, collection, transport, transfer, treatment and final disposal [10]. The international report released in 2016 by the United Nations Environment Program (UNEP), the Global Waste Management Outlook, estimated that 2 billion tons of waste are produced worldwide and that almost 50% of these are not disposed of properly. With regard to the importance of the high generation of solid waste and its inadequate management, there are the consequent environmental and health problems, which have been accentuated in recent years due to the increase in population and production and consumption patterns. Garbage not only generates an unpleasant image in the countryside and in cities, but also contaminates the soil, water and air and, due to its confinement, occupies large spaces, which is why it has become a social and public health problem [11].

Solid waste management comprises all functional or operational activities related to the handling of solid waste from the place where it is generated to its final disposal [12]. According to the deposition and type of waste, different techniques are used for waste management. They can vary from person to person, from place to place, and from country to country, since the technologies involved in the processes must be considered, as well as the existence of trained professionals to perform the related tasks. In Brazil, more than 50% of solid waste generated in households is organic. Such a profile is typical for countries with large agricultural production and food waste, and decentralized composting is an option increasingly considered to address such waste. In addition to reducing the volumes that would be disposed of in landfills, it reduces the demand for transport, impacts to the environment, among others, being an environmental education tool [13]. The National Solid Waste Policy (PNRS) has as one of its objectives the observance of the following order of priority: “Non-generation, reduction, reuse, recycling and treatment of solid waste, as well as the environmentally adequate final disposal of waste” [14]. It structures a whole set of scaffolding on which the reconstruction of everything related to the sector must be supported, until now, matters very disseminated in the multiplicity of official entities. The PNRS is theoretically based on a practical and coherent guiding philosophy, which should provide the basis for sectoral planning and management that includes, as a reason for being, the

protection of the environment and its resources and that of communities, all within a framework geosystemic and integrated. The Diagnosis of Urban Waste Management – 2015, compiled by the National Secretariat for Environmental Sanitation of the Ministry of Cities, revealed that, of the 77,997,025 tons of waste that arrived at some processing unit (landfills, controlled landfills, dumps, sorting, etc.), only 0.3% was directed to existing composting units in the country [3] [15]. In this context, the integrated and sustainable management of solid waste must start from the premise of avoiding, as much as possible, the generation of waste. When it is not possible to carry out this action, the waste that has been generated must follow an order of priority: be reused, recycled, treated and disposed of. Therefore, the act of disposing of waste is considered the last option, and only what is rejected should be landfilled, that is, everything that could not be recycled or treated [16].

IV. SANITARY LANDFILE

Landfills are an important part of any municipal waste management system, irrespective of other waste disposal solutions used. Even cities that recycle much of their waste, or rely heavily on incineration, need to deposit residual ash in landfills. Landfills are mature and proven waste management techniques. However, they are still quite uncommon in some low- and middle-income countries, due to the costs involved in infrastructure and operation and inadequate regulatory oversight. In these areas, it is very common to find uncontrolled or open-air dumps without basic environmental controls, putting public health and safety at risk [17]. Worldwide, nearly 40% of all waste discarded goes to some type of landfill. The rate is even higher in upper-middle-income countries, at 54%. Along with open-air landfills at 33%, landfills are the most common form of waste disposal. They require a design (as opposed to open dumps) and must be constructed and operated with care to ensure they do not create problems that threaten human or ecosystem health [18].

A properly designed landfill includes an area of land with an impermeable lining at the bottom. The coating prevents liquid contaminants (leachate) from coming into contact with groundwater (aquifers) and seeping into the soil. Slurry forms from moisture from garbage or rainwater that flows into the landfill, and must be collected and treated. In a well-managed landfill, waste is compacted to save space; a covering material is applied over the waste regularly to control odor, spread litter and other nuisances; and gas control systems are used to capture flammable

landfill gas that forms as organic material decomposes within the landfill [19].

Several aspects must be considered and one of them is the landfill capacity. Landfills are generally built to last approximately 30 years; however, they must be scaled to account for anticipated changes in local waste generation levels as the population grows or household income levels increase. Ideally, the plan should create and fill a cell every 18 months – 2 years before it is closed and used as a landfill gas for energy [19].

The location of a landfill is geographically isolated from residential areas, airports and drinking water aquifers. Depending on the area served by the landfill, proximity to railway lines or roads capable of handling heavy truck loads or volumes may be required. The selected site must be evaluated by engineers and geologists to ensure low risk of floods, earthquakes and landslides. Access to a regular supply of roofing material is also critical. Communities near the selected site should be consulted to understand and address their concerns before the facility begins operating. Some communities may need to be resettled once a site is selected, and must be compensated for any loss of land, livelihoods or cultural identity caused by the settlement [20].

Landfill life can be extended if recyclables and organic materials are removed or recovered before the waste reaches the landfill, and will likely result in lower costs. This can be done at the community level, at a materials recovery facility, or at the landfill itself. Landfill operators could benefit from partnering with waste pickers at the landfill site to ensure that these materials can be diverted, and must ensure that livelihoods are not displaced without making alternative provisions for them [21].

In order for a landfill to function properly, specialized labor is required, in addition to equipment that reduces the use of masonry tools or utensils, such as: pneumatic wheelbarrows, shovels, pickaxes, hoes, bars, wood compactors. In addition to forks or rakes and roller-compactors. The number of these tools depends on the number of workers, which in turn depend on the amount of solid waste to be buried in the landfill. In the transport of covering material or waste, in the cells already built, it is recommended to place some boards on the surface of the landfill, in a linear way to facilitate the movement of the forklifts, especially in the rainy season, thus improving the performance in the operation [22].

In manual landfill, as the name implies, all operations are based on work performed by workers from the municipality or the community. The number of workers needed depends on the amount of solid waste to be buried, the weather conditions and the form of construction of the

landfill, among others. It is also necessary to have a cleaning manager or supervisor who has the necessary knowledge to direct this work in constant operation [23].

Unlike manual landfills, mechanized compaction landfills are the appropriate technology for medium and large municipalities, which produce a daily amount of garbage that would not be feasible to be handled entirely by hand. Generally, one or two compactor tractors work in the mechanized landfill to carry out the work of placing, compacting and covering the waste; and the excavations and transport necessary for the supply of new roofing material [24].

Maintenance work can be done manually or with the support of machines, depending on the availability and need of these machines (for example, digging ditches manually or with a backhoe), thus aiming to obtain the greatest efficiency of the respective landfill [25].

Advantages and disadvantages

Below (Table 1) some advantages and disadvantages are mentioned in relation to the implantation of the sanitary landfill as a form of waste management, being one of the most convenient alternatives for Brazil. Siqueira and Assad [26] emphasize that it is essential to allocate adequate financial and technical resources for their planning, design, construction, operation and maintenance. Despite many advantages, the landfill also brings with it several disadvantages that make its implementation demand a high level of specialization and care. The first disadvantage to be mentioned, as shown in Table 1, refers to the acquisition of land, which constitutes the first barrier to the construction of a sanitary landfill, due to the opposition that arises from the public, caused in general, according to Lima et al., [27] by factors such as, for example, regarding the generation of landfill gases and leached liquids, as caused by the biological decomposition of degradable organic matter, chemical oxidation, decomposition and transport of organic materials and inorganic due to the action of infiltrated water and existing percolation, movement of the material by molecular diffusion, differential settlements, etc. If not well managed, people who live around the landfill suffer the consequences of bad smells, birds, percolating liquids, increased traffic of collection trucks and so on.

Table 1 - Advantages and Disadvantages of Landfills [27.]

Advantages
<ul style="list-style-type: none"> •Initial capital investment lower than necessary to implement any of the treatment methods: incineration or composting; •Low cost of operation and maintenance; •Economic advantages for the Municipality, because with the proper management of the sanitary landfill, the land can be used to the fullest. Waste compaction and planned construction increase landfill life and allow for longer land use; •Better protection of the environment (drainage and treatment of leached water, gas drainage through chimneys, waste cover) avoids the problems

of incineration ash and non-decomposing material in compost;

- Less nuisance and pollution for citizens: proper management starts with the selection of land for the landfill, which should not be close to inhabited places, however, when a landfill is well managed, it can be close to the urban area, thus reducing the transportation costs. And facilitating community oversight;
- Greater safety for workers (defined slopes, compaction of garbage, lower risk of falling waste, less contamination in the work environment);
- It allows the recovery of methane gas, which is an alternative source of energy.
- It allows the recovery of land considered unproductive or marginal, making it useful for the construction of a park, leisure area, sports field, etc.; and
- It is flexible in that it does not require permanent and fixed installations, and also because it receives larger amounts of additional waste with little addition of personnel.

Disadvantages

- Lack of knowledge about the sanitary landfill technique;
- The term "sanitary landfill" is associated with "open dump";
- The evident distrust of local administrations; and
- The rapid urbanization process that increases the cost of the few available land, having to locate the sanitary landfill in places far from the collection routes, which increases the transport costs.

Finally, through the information presented, it can be said that the implementation of the sanitary landfill is highly conflicting both in terms of approval by the authorities and in the perception of citizens, and can be an interesting management alternative when implemented in conjunction with other forms of management as the recycling process.

V. RECYCLING

Recycling consists of reusing the solid waste generated in order to obtain from them a raw material that can be incorporated directly into a production or consumption cycle. It is an activity that involves the use of energy to obtain new products in a recycling plant. The importance of recycling can be associated with mitigating indiscriminate cutting of trees, reducing air, water, and soil pollution and, ultimately, living on a pollution-free planet [28], involving a series of steps to in order to give the proper destination, as shown in Figure 1.

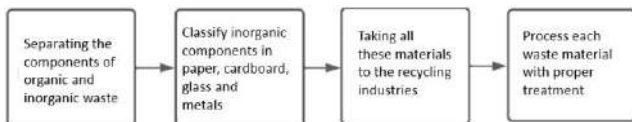


Fig. 1 – Stages of the recycling process [28].

One of the alternatives to solve the problem of pollution and contamination of the environment is through recycling, where waste is collected and transformed into new materials that can be used or sold as new products or materials. raw materials such as paper, cardboard, glass and metals, among others [28]. The adoption of measures to conserve natural resources such as minerals, water and wood guarantees a sustainable and ideal use [29]. Recycling minimizes pollution All forms of pollution in

the modern world emanate from industrial waste. The recycling of industrial waste, such as plastics, cans and chemicals, contributes to significantly reducing pollution levels, as these wastes can be reused in the production of new products or used in other recycling processes. use, reducing reckless disposal, in addition to being able to contribute to the generation of jobs [20].

It is important to point out that the proposal to consider recycling as a niche for innovation and entrepreneurship gains more strength when verifying that in Brazil abundant inorganic residues are produced daily, which go to the garbage collector, where they could be used to create new products and subsequent commercialization, generating income that can be invested to cover expenses of a small industry or any other business that operates in this field. Recycling old and used materials into reusable products greatly reduces the chance of suffocation in landfills. This is beneficial because it helps to minimize soil and water pollution, as landfills greatly contribute to environmental degradation [7].

However, it is also worth mentioning that although they contribute to the sustainability process, some recycling processes, although they reduce the release of toxic waste, cannot eliminate this process, and may also emit greenhouse gases because once the same waste recycling industries burn few fossil fuels. Despite being extremely advantageous, recycling also has some disadvantages, so that it is not always profitable, making it interesting to develop processes and/or use other more profitable technologies with less damage, depending on the waste material generated. In addition to recycling, one of the techniques that has drawn attention is composting, which aims to use organic waste as a source of nutrients for use in vegetable gardens, plantations and other agricultural activities [29].

VI. COMPOSTING

Composting is the controlled aerobic biological decomposition of organic matter into a stable humus-like product called compost. It is essentially the same process as natural decomposition, except that it is enhanced and accelerated by mixing organic waste with other ingredients to optimize microbial growth [26]. According to Valente et al. [30], composting is a process of controlled aerobic decomposition and stabilization of organic matter under conditions that allow the development of thermophilic temperatures, resulting from a calorific production of biological origin, obtaining a stable, sanitized final product, rich in humic compounds and whose use in the soil does not pose risks to the environment. The potential benefits of composting manure and other organic waste are

improved manure handling; reduced odor, flies and other problems; and reduction of weed seeds and pathogens. According to Souza et al. [31], during composting, as a result of the action of microorganisms, carbon dioxide, energy and water (in the form of steam) are released. Part of this energy is used for the growth of microorganisms, the rest being released as heat. Consequently, the material being composted heats up, reaches a high temperature, cools down and reaches the maturation stage. After maturation, the organic compost will be ready, consisting of resistant parts of organic residues, decomposed products and dead and alive microorganisms. Compost applied to land improves soil fertility, tillage and water holding capacity. It is also odor free and can be stored for long periods. These qualities make it suitable for use in agriculture or for sale [10]. The use of biodigesters has the advantage of producing sustainable energy that ends up reducing the producer's costs with other energy sources, being also sustainable from an environmental point of view, since it reduces the amount of polluting waste in the environment [32]. Biodigesters can be used for the three types of animal production (cattle, poultry and swine), but they are more frequently used for cattle and swine, which, because they have a higher production of manure per animal per day, have a greater production of biogas [33].

Composting is easily adapted to agricultural operations because crops generally produce adequate amounts and types of waste for composting, have adequate land, will benefit from the application of compost to the soil, and already have the necessary equipment available [34].

Key elements in planning a composting facility include conducting site investigations and developing the recipe design, facility design, waste utilization plan, and an operation and maintenance plan. As composting is a relatively flexible process, it is necessary to decide between alternative methods, locations and materials. The decision depends on the management and economic aspects of the farm or the place where the plantations take place, as well as the physical limitations of the place. The planner needs to present the different alternatives to the owner so that the owner can make the final decision [26].

Regarding the composting process, this is carried out by a diverse population of predominantly aerobic microorganisms that decompose organic matter to grow and reproduce. The activity of these microorganisms is stimulated through the management of the carbon-nitrogen ratio (C:N), oxygen supply, moisture content, temperature and pH of the formed compost pile. Properly managed compost increases the rate of natural decomposition and generates enough heat to destroy weed seeds, pathogens and fly larvae [37]. The composting process there is an acceleration of the decomposition of organic matter,

triggering a sudden increase in temperature (thermophilic phase) due to an intense proliferation of microorganisms (fungi and bacteria). of pathogens (total coliforms and bacteria of the genus Salmonella) and weed seeds.

The initial stage of composting is marked by temperatures below the mesophilic phase, depending on the ambient temperature and the temperatures of the material in the compost mixture. A short period of delay is typical at the beginning of the composting process, before the temperature starts to rise rapidly. This latency period is the time required for the development of the microbial population [38]. As the temperature varies (Figure 2), the conditions become unsuitable for some microorganisms and, at the same time, they become ideal for others [26]. The active composting period has three temperature ranges. These intervals are defined by the types of microorganisms that dominate the pile during these temperatures, as shown in Figure 2, and are called the mesophilic and thermophilic phases. Mesophilic temperatures are between 20 and 40°C and thermophilic above 40°C [39].

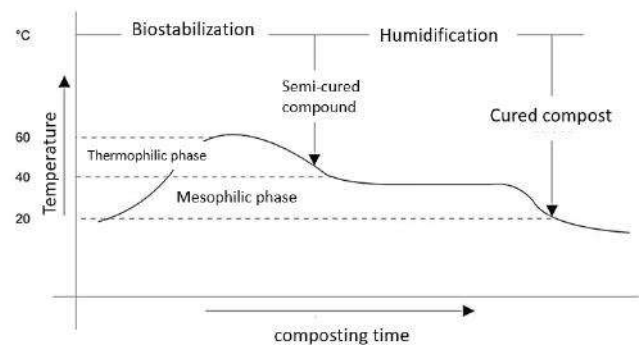


Fig. 2 - Compost temperature range [39].

From an ecological and industrial point of view, the main advantage of using compost is that it allows us to safely eliminate and recycle many types of biodegradable organic waste into inputs for agricultural production, avoiding environmental pollution problems that would trigger their abandonment or dumping. Other advantages refer to the fact that it allows a second use of organic matter, recovering and recycling it. In addition, the amount of Urban Solid Waste (MSW) that goes to landfills and treatment plants is reduced, avoiding problems of soil contamination or the emission of harmful gases into the atmosphere [40]. According to Sena et al., [41], composting favors land productivity is favored without the need to apply other synthetic chemicals, which is why it produces a series of effects with very favorable agro-biological repercussions, improving physical properties. - chemical properties of the soil, since, in the chemical sense, it provides macronutrients such as N, P and K, in

addition to micronutrients, and improves the cation exchange capacity of the soil. It also has the factor of the organic matter supplied to contribute favorably to improve the stability of the structure of agricultural soil aggregates, increase the permeability to water and gases and contribute to increase the water holding capacity of the soil through the formation of aggregates.

VII. INCINERATION

Incineration means the act of burning something until there is nothing left but ashes. An incinerator is a unit or facility used to burn used waste and some other different type of waste until it is finally reduced to just ash. An incinerator is constructed of strong, well-insulated material so that, during combustion, extreme heat is not lost, but contained. Heat is left inside the kiln so that all waste inside the incinerator plant can be burned very quickly and efficiently. But when heat is not well contained, waste is not burned completely with the expected level of efficiency [42].

Incineration refers to a process of direct controlled burning of waste in the presence of oxygen at temperatures of around 8000°C and higher, releasing thermal energy, gases and inert ash. To avoid the shortcomings of conventional incinerators, some modern incinerators use higher temperatures of up to 16,500°C using auxiliary fuel. This reduces the volume of waste by almost 97% and converts some inorganic contents, such as metal and glass, into inert ash [43]. The net energy yield depends on the density and composition of the waste. Relative percentage of moisture and inert materials, which increase heat loss; Ignition temperature; size and shape of constituents; combustion system design, etc. In practice, about 65% to 80% of the energy content of organic matter can be recovered as thermal energy, which can be used for direct thermal applications or for energy production with the help of steam turbine-generators [44].

Although incineration is widely used as an important method of waste disposal, it is associated with some polluting discharges that are of environmental concern, albeit in varying degrees of severity. Fortunately, these can be effectively controlled by installing proper pollution control devices and through proper furnace construction and combustion process control [44].

The basic operational steps of a waste incineration plant can include the following steps, as pointed out by Silva et al., 45 in Figure 3:

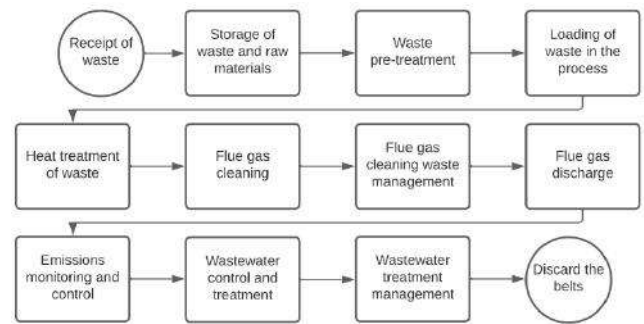


Fig. 3 – Solid waste processing steps in an incineration plant [45].

It is important to note that several technologies are required for the operation of a Municipal Solid Waste (MSW) incineration plant. The main residue from RSM incineration is slag. The amount generated depends on the ash content of the waste. In the combustion process, the volume of waste from high-income cities will, by experience, be reduced by approximately 90% and the weight by 70% to 75%. For low-income areas, the amount of ash in the waste can be high; for example, in areas that use coal, wood or similar for heating. In addition to the slag, the plant generates residues from more or less advanced processes for cleaning dry, semi-dry or wet flue gases. The amount and its environmental characteristics will depend on the technology applied [46].

One of the most attractive features of the incineration process is that it can be used to reduce the original volume of fuels by 80% to 95%. Controlling air pollution remains a major issue in the implementation of incineration for solid waste disposal. In Brazil, the cost of the best available technology for the incineration plant can reach 35% of the project cost. The cost of control equipment, however, will depend on existing air pollution regulations in a given least developed country [47].

Regarding the use or disposal of ash, modern waste incineration facilities differ in technical solutions, but it can be assumed that emissions are kept within the limits of legal restrictions, regardless of the composition of the incinerated waste. This suggests that, despite a site-specific approach, the model is quite general with regard to emissions to air and water, for plants working under the same legal restrictions. Waste products, additive consumption and energy recovery are more site specific [48]. Companies and researchers have been investigating ways to treat ash waste from facilities. Ash consists of residue left in the combustion chamber (bottom ash) and its pollution treatment devices (fly ash). Post-treatment of ash produced by low-temperature combustion chambers, such as fluidized beds, usually involves vitrification at high temperatures to immobilize the metals [49].

The main objective of ash treatment is to prevent the toxic constituents of the ash, especially dioxins, furans and heavy metals, from escaping into the environment after disposal. Solidification through vitrification or application of various chemicals is another means of decreasing the chances of metal leaching. Phosphate has been shown to stabilize heavy metals in dust that results from vitrification of incinerator ash. Ash treatment is a much more mature technology than reuse [50]. The bottom ash produced at the plant resembles clinker ash and, after mechanical separation of ferrous and non-ferrous metals, has a relatively high density (typically 2.25); and according to reports, contains less than 2% carbon and less than 1% fines. The leach test of toxicity characteristics based on the EPA standard showed that the metals in the bottom ash are not leachable [48].

Regarding the advantages that can be cited considering the above, it is known that incineration is an efficient way to reduce the volume of waste and the demand for landfill space. Incineration plants can be located close to the center of gravity of waste generation, reducing the cost of transporting waste. Using the ash from RSM incinerators for environmentally sound construction not only provides a low-cost aggregate, but further reduces the need for landfill capacity. In particular, incineration of waste containing heavy metals and so on should be avoided to maintain adequate slag quality. The slag quality must be checked before use. Energy can be recovered for heating or energy consumption [50].

All waste disposal alternatives eventually break down organic materials into simpler carbon molecules such as CO₂ (carbon dioxide) and CH₄ (methane). The balance between these two gases and the time period for the reactions vary depending on the alternative. Incineration provides the best way to eliminate methane gas emissions from waste management processes. In addition, energy from waste projects provides a substitute for fossil fuel combustion. These are two ways in which incineration helps reduce greenhouse gas emissions [1].

As far as disadvantages are concerned, an incineration plant involves heavy investments and high operating costs and requires local and foreign currency throughout its operation. The resulting increase in waste treatment costs will motivate waste generators to look for alternatives. In addition, waste incineration is only applicable if certain requirements are met. The composition of waste in developing countries is often questionable in terms of its suitability for automatic combustion. The complexity of an incineration plant requires qualified personnel. In addition, waste from flue gas cleaning can contaminate the environment if not treated properly and should be disposed

of in well-operated, controlled landfills to avoid soil and surface pollution.

VIII. BIOREMEDIATION

The term Bioremediation is divided into two parts: "bios" means life and refers to living organisms and "remediation" means solving a problem. "Bioremediation" means using biological organisms to solve an environmental problem, such as contaminated soil or groundwater. Bioremediation is the use of live microorganisms to degrade environmental pollutants or to prevent pollution. In other words, it is a technology to remove pollutants from the environment, thus restoring the original natural environment and preventing further pollution [51]. According to Leonel [52], bioremediation can be defined simply as a biological process of decontaminating a contaminated environment. Bioremediation as a technique can include biodegradation as just one of the mechanisms involved or applied in the bioremediation process. Only some of the contaminants are biodegradable and only some of the microorganisms can degrade a fraction of the contaminants. Therefore, it would be worthwhile to study the biodegradation potential of microorganisms. Morais Filho & Coriolano [53], report that although microorganisms have been used for the treatment and transformation of waste for at least a century, bioremediation is considered a new technology for the ecologically correct decontamination of polluted environments. As a popular case of application of this technology, municipal wastewater is microbiologically decontaminated under controlled conditions so that, depending on the metabolic activities of microorganisms, different activated sludge systems and fixed films are applied in wastewater treatment facilities. Waste and pollution can be permanently eliminated). Treatment residues are generally harmless products and include carbon dioxide, water and cellular biomass [54].

In bioremediation, living organisms such as microorganisms (bacteria, fungi and algae) or plants are used to degrade and detoxify harmful pollutants present in the environment and convert them into CO₂, H₂O, microbial biomass and metabolites (by-products that are less toxic than than the original compound) [55], as shown in Figure 4.

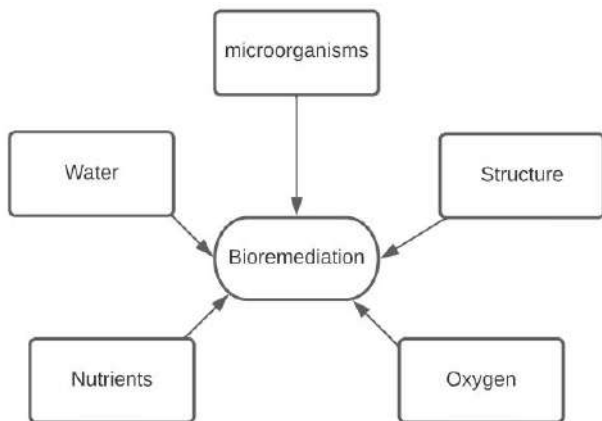


Fig. 4– Principle of bioremediation [55].

These microorganisms may be native to this contaminated site or they may be isolated and brought from outside to this contaminated site for bioremediation. Microorganisms degrade and transform these pollutants through their metabolic reactions and use them for their growth. The complete degradation of a pollutant requires the action of several microbes, therefore, sometimes, potential microbes can be added to the contaminated site for the effective degradation process and this process is called bioaugmentation [56].

The biodegradation process depends on favorable environmental conditions, the type and solubility of the pollutant, and the bioavailability of the pollutant to the microbes, therefore, environmental conditions are controlled or manipulated to allow sufficient microbial growth and therefore rapid and effective biodegradation [56].

In bioremediation, microbes inhabit varied environments such as hot springs, deserts, glaciers, saline lakes and oceans. Microbes with degradation potential can be isolated from contaminated environments such as heavy metal polluted sites, landfills, petroleum contaminated sites, pesticide contaminated sites due to agricultural activities and wastewater treatment plant, for the degradation of various pollutants. Microbes use the hazardous pollutant as their energy and carbon source under both aerobic and anaerobic conditions and therefore, through metabolic activity, can degrade or convert the pollutant into less or non-toxic metabolites. Microbes and soil pollutants are not evenly distributed in the soil, so the pollutant must be available or in contact with the microbes for the effective degradation of the pollutant and this can be done by the application of surfactants [57].

Aerobic bacterial species such as *Mycobacterium*, *Alcaligenes*, *Sphingomonas* and *Pseudomonas* are known for their aerobic degradation of hydrocarbons (alkanes and

polycyclic aromatic hydrocarbons) and pesticides. Along with this, some of the aerobic methyltrophs are also recognized for degradation of dichloroethane and trichloroethane (chlorinated aliphatics). Some of the anaerobic bacterial species are known to degrade PCBs and trichloroethylene (chlorinated solvent). In addition to bacterial species, some fungal species, such as *Phanerochaete chrysosporium*, have also been reported to be effective in remediating a variety of toxic and persistent pollutants [57].

From the point of view of future bioremediation prospects, it appears that the development of knowledge of microbial populations, their interactions with the natural environment and contaminants, the enhancement of their genetic capabilities to degrade contaminants, long-term field studies of new economic bioremediations techniques can increase the potential for significant advances. There is no doubt that bioremediation is a necessity in today's world and can lead to the protection and preservation of the natural resources that we navigate for generations to come. Ahead, some of the most used types of bioremediation are highlighted [56].

Most of the time, in situ is applied to eliminate pollutants from contaminated soils and groundwater. It is a superior method for cleaning contaminated environments as it saves transportation costs and uses harmless microorganisms to eliminate chemical contamination. These microorganisms are more likely to have a positive chemotactic affinity for contaminants. This feature increases the likelihood of bioremediation at nearby points where bioremediators have not been distributed. Furthermore, the method is preferred because it causes minimal disturbance to the contaminated area. This would be of great relevance when minimal investment and pollution is preferred (for example, in factories) or in areas contaminated with dangerous contaminants (for example, in areas contaminated with chemical or radioactive materials) [57].

bioremediation in situ is the feasibility of synchronized soil and groundwater treatment. However, this bioremediation has some disadvantages: the method is more time consuming compared to other correction methods and leads to a seasonal variation in microbial activity due to direct exposure to variations in uncontrollable environmental factors, and the use of additives can lead to problems additional. The yield of bioremediation is determined by the type of waste, that is, if the waste could provide the necessary nutrients and energy, then the microorganisms would be able to make the intermediate correction [58].

However, according to Silveira [59], in the absence of favorable residues, the loss of bioactivity can be compensated through the stimulation of native microorganisms. Another less preferred option is the application of genetically modified microorganisms. Two types of in situ are differentiated based on the origin of the microorganisms applied as bioremediators:

I. Intrinsic bioremediation - This type of in situ is performed without direct microbial correction and through intermediation in ecological conditions of the contaminated region and fortification of natural populations and the metabolic activities of native or naturally existing microfauna, improving nutritional and ventilation conditions [59].

II. Bioremediation In Situ - This type of bioremediation is performed by introducing certain microorganisms into a contamination site. As the conditions of the contamination sites are most often unfavorable for the establishment and bioactivity of exogenously altered microorganisms, therefore, here as intrinsic bioremediation, the environment is modified so that improved physicochemical conditions are provided. Oxygen, electron acceptors and nutrients (eg nitrogen and phosphorus) are needed to enhance microbial growth [59].

The bioremediation process here takes place somewhere outside the contamination site and therefore requires transporting contaminated soil or pumping groundwater to the bioremediation site. This technique has more disadvantages than advantages. Depending on the state of the contaminant in the bioremediation step, ex situ bioremediation is classified as [60]:

I. Solid phase system (including soil treatment and soil piles) - The system is used for bioremediation of organic waste and problematic domestic and industrial waste, sewage sludge and municipal solid waste. Solid phase soil bioremediation includes three processes including tillage, soil biopilation and composting.

II. Sludge phase systems (including solid-liquid suspensions in bioreactors) - Sludge phase bioremediation is a relatively faster process compared to other treatment processes.

Contaminated soil is mixed with water and other additives in a large tank called an abioreactor and mixed to bring indigenous microorganisms into close contact with soil contaminants. Nutrients and oxygen are corrected, and conditions in the bioreactor are adjusted so that an optimal environment for microbial bioremediation is provided. Upon completion of the process, the water is removed and the solid waste is disposed of or further processed to decontaminate the remaining pollutants.

It is important to point out that different techniques are employed depending on the degree of saturation and aeration of an area. Techniques In situ are defined as those that are applied to the soil and groundwater of the site with minimal disturbance. Techniques Ex situ are those applied to site soil and groundwater that have been removed from the site through excavation (soil) or pumping (water). Bioremediation In situ by the indigenous microbial population is an increasingly popular and environmentally friendly option for cleaning up contaminated sites and currently considerable effort is being spent to design inexpensive and viable strategies using this technology, which shows promise as a relatively good alternative. Mercury-resistant bacteria were considered as a potential approach to biological remediation [61].

Based on the post, bioremediation offers many advantages over the physical and chemical treatments used to treat contaminated water and soil. Bioremediation tends to have lower costs than other treatments, such as incineration, used to remove toxic substances from the soil. Another advantage is that bioremediation aims to degrade and detoxify dangerous pollutants, while other technologies simply transfer the pollutants to a different location. Therefore, it is a simple technology compared to the others [62].

One of the disadvantages of bioremediation is the difficulty in predicting the realization of this treatment. The success of such a project depends on the ability of the process operators to create and maintain the environmental conditions necessary for microbial growth. Microorganisms are sensitive to temperatures, pH, toxicity of the pollutant and its concentration, moisture content, nutrient concentration and oxygen concentration. A decrease in microbial activity will decrease degradation and prolong the period. If microbial activity stops, it would be very difficult to restart treatment [63].

Sometimes bioremediation will not be useful when contaminants are not degradable, or partially biodegradable, or because contaminant levels are so high that microbial activity is affected. As pollutant levels decrease, biological degradation decreases and microorganisms need to change energy sources or stop growing together. In this case, bioremediation is not sufficient to treat a site and therefore another treatment will have to be used, therefore it is time consuming, i.e. the time required to remediate a site usually depends on the rate at which the pollutant is degraded [64].

IX. CONCLUSION

Waste management has been a challenge for all nations around the world. The production of garbage has increased

in a generalized way, as it was possible to notice in the information pointed out in the Brazilian context. As the production of waste increases, more investments are needed for proper treatment to be carried out, preventing environmental damage from occurring due to incorrect management of different types of waste.

In recent decades, the high production of consumer goods and population growth have had a direct impact on the growing generation of solid waste, many of which lack adequate final disposal to avoid harmful impacts to society and the environment; and this fact is what currently represents one of the greatest challenges. Given this scenario, for some countries such as Brazil, the fourth largest generator of waste in the world per year, with a total of 216,629 tons per day, the scale of this challenge is even greater.

Current public policies require concrete actions in search of higher rates of recycling and reuse of waste, as well as a rearrangement in the planning of public spending and costs related to its management. In fact, Brazilian regions have high levels of solid waste generation, which means that if its management is carried out improperly, the recycling and reuse process is compromised, generating high environmental and social impacts.

As existing alternatives, the Composting and Bioremediation processes are recommended, given their efficiency in the reuse of organic waste. These alternatives contribute to the projection of a circular model of the economy, both in terms of energy and soil fertilization, vital processes for the current reality in Brazil.

In addition, other processes can be adopted in Brazilian policies, such as Incineration, which is efficient in different contexts, promoting the conversion of waste into energy that can be used to supply electricity, or even compose the energy matrix of a city when well designed.

Finally, several alternatives can be taken with regard to solid waste management, but in the Brazilian case, due to the extension of territory and the diversity of types of waste generated in different states and regions, an elaborate study is necessary to point out which alternative best suited to the country's needs.

Another important aspect is the transparency in expenditures and in the numbers raised on the production of waste and its destination. As noted, data and studies are released vaguely and sporadically, emphasizing that the sector needs more rigorous political support, with solid projects, which consider the various forms of management presented in this research, and recycling techniques can be adopted, Incineration, Bioremediation, Composting and Sanitary Landfills, which can be efficient and environmentally friendly when well managed.

REFERENCES

- [1] Ribeiro, B. M. G., & Mendes, C. A. B. (2018). Avaliação de parâmetros na estimativa da geração de resíduos sólidos urbanos. *Revista Brasileira de Planejamento e Desenvolvimento. Curitiba: Universidade Tecnológica Federal do Paraná. v. 7, n. 3 (ago. 2018), p. 422-443.*
- [2] Liden, T., Clark, B. G., Hildenbrand, Z. L., & Schug, K. A. (2017). Unconventional oil and gas production: waste management and the water cycle. In *Advances in Chemical Pollution, Environmental Management and Protection* (Vol. 1, pp. 17-45). Elsevier.
- [3] de Albuquerque Silva, F. A., Lima, M. O., & Alves, C. N. (2017). Análise do processo de descarte e reciclagem de vidro em uma distribuidora de bebidas da cidade de Manaus, estado do Amazonas. *ITEGAM-JETIA, 3(11)*, 119-124.
- [4] Santos, T., & Rovaris, N. R. S. (2017). Cenário brasileiro da gestão dos resíduos sólidos urbanos e coleta seletiva. *Anais do VI SINGEP-São Paulo-SP-Brasil-13 e, 14(11)*.
- [5] Pereira, S. S., Curi, R. C., & Curi, W. F. (2018). Uso de indicadores na gestão dos resíduos sólidos urbanos: uma proposta metodológica de construção e análise para municípios e regiões. *Engenharia Sanitária e Ambiental, 23*, 471-483.
- [6] Silva, C. (2014). *Gestão de resíduos sólidos: o que diz a lei*. Editora Trevisan.
- [7] Nascimento, MCB, Freire, EP, Dantas, FDAS, & Giansante, MB (2019). Estado da arte dos aterros de resíduos sólidos urbanos que aproveitam o biogás para geração de energia elétrica e biometano no Brasil. *Engenharia Sanitária e Ambiental, 24*, 143-155.
- [8] Gurjão, R. Í. L.; Neto, CLA; Paiva, W. (2019). Avaliação do tempo de vida útil do aterro sanitário em Campina Grande – PB. In: *Congresso Nacional de Pesquisa e Ensino em Ciências- CONAPESC*, 2019.
- [9] Zanatta, F., Ziero, H. D. D., de Castilho Bertani, T., de Oliveira Andrades Filho, C., Tubino, R. M. C., & Tramontina, A. C. (2020). Resíduo sólido industrial na Serra Gaúcha: Geração, tipologia e destinação. *Brazilian Journal of Development, 6(6)*, 32805-32821.
- [10] Rodrigues, A., França, J., Silveira, R., Silva, R., Ros, C., & Kemerich, PD (2015). Compostagem de resíduos orgânicos: eficiência do processo e qualidade do composto. *Enciclopédia biosfera, 11(22)*.
- [11] Silva, PHB; Souza, AC. (2020). Caracterização da reciclagem do pó de vidro blindex® para obtenção de um novo compósito a base de celulose, que será aplicado na indústria da construção civil. *Anais Do Enic*.
- [12] Araújo, CS, & Silva, VF (2020). A gestão de resíduos sólidos em época de pandemia do Covid-19. *GeoGraphos: Revista Digital para Estudantes de Geografia y Ciencias Sociales, 11(129)*, 192-215.
- [13] Vich, D. V., Miyamoto, H. P., Queiroz, L. M., & Zanta, V. M. (2017). Household food-waste composting using a small-scale composter. *Revista Ambiente & Água, 12*, 718-729.
- [14] Brasil. Lei n. 12.305, de 2 de agosto de 2010. Institui a política nacional de resíduos sólidos; altera a Lei n. 9.605, de 12 de fevereiro de 1998; e dá outras providências. *Diário Oficial da União, Poder Legislativo*, Brasília, DF, 3 ago.

2010. Seção 1, p. 3. Disponível em: <<https://bit.ly/2HVJNdW>>. Acesso em: 15 junho 2021.
- [15] Brasil _____. (2015) Ministério das Cidades. Diagnóstico do Manejo de Resíduos Sólidos – 2015. Brasil: Ministério das Cidades. Disponível em: . Acesso em: 14 abr. 2017
- [16] Miranda Júnior, N. D. S. (2020). Nada se cria, nada se perde, tudo se transforma: a resiliência de uma região industrial têxtil e de confecção..
- [17] Gomes, LP, Kohl, CA, Souza, CLDL, Rempel, N., Miranda, LAS, & Moraes, CAM (2015). Avaliação ambiental de aterros sanitários de resíduos sólidos urbanos precedidos ou não por unidades de compostagem. *Engenharia Sanitaria e Ambiental*, 20, 449-462.
- [18] Nunes, RR, & Silva, RD (2015). Transbordo de resíduos sólidos. *Revista Pensar Engenharia*, 3(1), 1-18.
- [19] Goes, D. (2016). A contribuição do aterro sanitário na gestão de resíduos sólidos. *Revista Científica da FASETE*, 90.
- [20] Silva, WKAS, & Tagliaferro, ER (2021). Aterro sanitário-a engenharia na disposição final de resíduos sólidos. *Brazilian Journal of Development*, 7(2), 12216-12236.
- [21] Piñas, JAV, Venturini, OJ, Lora, EES, Oliveira, MAD, & Roalcaba, ODC (2016). Aterros sanitários para geração de energia elétrica a partir da produção de biogás no Brasil: comparação dos modelos LandGEM (EPA) e Biogás (Cetesb). *Revista Brasileira de Estudos de População*, 33, 175-188.
- [22] Nascimento, VF, Sobral, AC, Andrade, PRD, & Ometto, JPHB (2015). Evolução e desafios no gerenciamento dos resíduos sólidos urbanos no Brasil. *Revista Ambiente & Água*, 10, 889-902.
- [23] Reichert, G. (2018). Projeto, Operação e Monitoramento de Aterros Sanitários: Manual 2007. 117 p. Acesso em, 11.
- [24] Ferreira, CFA; Jucá, JFT. (2017). Metodologia para avaliação dos consórcios de resíduos sólidos urbanos em Minas Gerais. *Engenharia Sanitária e Ambiental*, 2017, vol. 22, p. 513-521.
- [25] Santos, CPD (2015). *Gestão de Resíduos Urbanos e Projetos de Recolha Seletiva: Uma abordagem para o Município de Gondomar no âmbito do PERSU 2020* (Doctoral dissertation).
- [26] Siqueira, TMOD, & Abreu, MJD (2016). Fechando o ciclo dos resíduos orgânicos: compostagem inserida na vida urbana. *Ciência e Cultura*, 68(4), 38-43.
- [27] Lima, PG, Destro, GE, Junior, SB, & Forti, JC (2018). Análise gravimétrica dos resíduos sólidos urbanos de um aterro sanitário/gravimetric analysis of urban solid waste from a sanitary landfill. *Revista Brasileira de Engenharia de Biosistemas*, 12(4), 410-426.
- [28] Zonatti, WF (2016). *Geração de resíduos sólidos da indústria brasileira têxtil e de confecção: materiais e processos para reuso e reciclagem* (Doctoral dissertation, Universidade de São Paulo).
- [29] Mostardeiro, MES, Oderich, AL, & Cidade, MK (2019). Desenvolvimento de joia mediante a reciclagem de vidros e processos de fabricação multidisciplinares. *Plural Design*, 2(1), 69-79.
- [30] Demajorovic, J.; LIMA, M. *Cadeia de reciclagem: um olhar para os catadores*. Editora Senac São Paulo, 2019.
- [31] Valente, B. S., Xavier, E. G., Morselli, T. B. T. G. A., Jahnke, D. S., Brum Jr, B., Cabrera, B. R., ... & Lopes, D. C. N. (2009). Fatores que afetam o desenvolvimento da compostagem de resíduos orgânicos. *Archivos de zootecnia*, 58(224), 59-85..
- [32] Souza, HD, Oliveira, EL, Faccioli-Martins, PY, Santiago, L., Primo, AA, Melo, MD, & Pereira, GAC (2019). Características físicas e microbiológicas de compostagem de resíduos animais. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, 71, 291-302.
- [33] de Luca Bonturi, G., & Van Dijk, M. (2012). Instalação de biodigestores em pequenas propriedades rurais: análise de vantagens socioambientais. *Revista Ciências do Ambiente On-Line*, 8(2).
- [34] Colatto, L., & Langer, M. (2011). Biodigestor-resíduo sólido pecuário para produção de energia. *Unoesc & Ciência-ACET, Joaçaba*, 2(2), 119-128.
- [35] Siqueira, TMOD, & Assad, MLRCL (2015). Compostagem de resíduos sólidos urbanos no estado de São Paulo (Brasil). *Ambiente & Sociedade*, 18, 243-264.
- [36] Monteiro, JAV (2016). Benefícios da compostagem doméstica de resíduos orgânicos. *Revista Educação Ambiental em Ação*, (56).
- [37] Souza, LA, do Carmo, DDF, & da Silva, FC (2020). Uso de microrganismos eficazes em compostagem de resíduos sólidos orgânicos de feira e restaurante. *Revista Tecnológica da Universidade Santa Úrsula*, 2(2), 42-54.
- [38] de Oliveira Filho, J. G., da Camara, C. P., de Sousa, T. C. F., de Almeida Cruz, Í., Egea, M. B., de Sousa Falcão, H. A., & da Silva, E. R. (2017). Caracterização microbiológica do processo de compostagem de resíduos orgânicos em pequena escala. In *Colloquium Agrariae. ISSN: 1809-8215* (Vol. 13, No. 2, pp. 130-136).
- [39] Peixoto, AA, & Fernandes, JG (2016). Utilização da Técnica de Compostagem: uma proposta para destinação final dos resíduos orgânicos gerados em um restaurante universitário. *XIII SEGeT-Simpósio de Excelência em Gestão e Tecnologia*. Disponível em < <https://www.aedb.br/seget/arquivos/artigos16/8524288.pdf>>. Acesso em, 7.
- [40] Cardozo, BC, Mannarino, CF, & Ferreira, JA (2021). Análise do monitoramento ambiental da incineração de resíduos sólidos urbanos na Europa e a necessidade de alterações na legislação brasileira. *Engenharia Sanitaria e Ambiental*, 26, 123-131.
- [41] Zambon, MM (2017). Alternativas para a gestão dos resíduos orgânicos urbanos: um estudo de caso na cidade de Florianópolis. Zanin, M., & Mancini, SD (2015). *Resíduos plásticos e reciclagem: aspectos gerais e tecnologia*. SciELO-EdUFSCar.
- [42] Oliveira, TBD, & Galvão, ADC (2016). Planejamento municipal na gestão dos resíduos sólidos urbanos e na organização da coleta seletiva. *Engenharia Sanitária e Ambiental*, 21, 55-64.
- [43] Silva, ERD, Toneli, JTDCL, & Palacios-Bereche, R. (2019). Estimativa do potencial de recuperação energética de resíduos sólidos urbanos usando modelos matemáticos de biodigestão anaeróbia e incineração. *Engenharia Sanitaria e*

- Ambiental*, 24, 347-357.
- [44] Leite, CB (2017). *Tratamento de resíduos sólidos urbanos com aproveitamento energético: avaliação econômica entre as tecnologias de digestão anaeróbia e incineração* (Doctoral dissertation, Universidade de São Paulo).
- [45] Maiello, A., Britto, ALNDP, & Valle, TF (2018). Implementação da Política Nacional de Resíduos Sólidos. *Revista de Administração Pública*, 52, 24-51.
- [46] Schramm, JS, & Bazzo, E. (2016). Análise do potencial energético e do processo de incineração como alternativa na gestão de resíduos sólidos urbanos em Florianópolis. *Anais dos Encontros Nacionais de Engenharia e Desenvolvimento Social-ISSN 2594-7060*, 13(1).
- [47] Neiverth, C., da Silva, RGDS, Santos, LFAS, de Oliveira Oliveira, JC, Pedroso, CPPP, & SCHNEIDER, F. (2020). Análise do potencial de geração de energia elétrica a partir da incineração de resíduos sólidos urbanos. *Anais do EVINCI-UniBrasil*, 6(1), 138-138.
- [48] Leitão, JRC (2018). *Misturas binárias de betão auto-compactável com incorporação de cinzas de fundo resultantes da incineração de resíduos sólidos* (Doctoral dissertation, Instituto Superior de Engenharia de Lisboa).
- [49] de Souza, L. H. N., & Arruda, R. D. O. M. (2021). Revitalização de corpos d'água com o uso da biorremediação. *Revista Engenharia e Tecnologia Aplicada-UNG-Ser*, 4(1), 37-45.
- [50] Hernández-Ruiz, GM, Álvarez-Orozco, NA, & Ríos-Osorio, LA (2017). Biorremediação de organofosforados por fungos e bactérias em solos agrícolas: revisão sistemática. *Ciencia y Tecnología Agropecuaria*, 18(1), 138-159.
- [51] Leonel, LV, do Nascimento, EG, Bertozzi, J., Bôas, LAV, & Bôas, GTV (2018). Biorremediação do solo. *Revista Terra & Cultura: Cadernos de Ensino e Pesquisa*, 26(51), 37-52.
- [52] Morais Filho, MD, & Coriolano, ACF (2016). Biorremediação, uma alternativa na utilização em áreas degradadas pela indústria petrolífera. *HOLOS*, 7, 133-150.
- [53] Coutinho, PWR et al. Alternativas de remediação e descontaminação de solos: biorremediação e fitorremediação. *Nucleus*, 2015, vol. 12, no 1, p. 59-68.
- [54] Berticelli, R., Decesaro, A., Magro, F., & Colla, LM (2016). Compostagem como alternativa de biorremediação de áreas contaminadas. *Revista CIATEC-UPF*, 8(1).
- [55] Mallmann, V., Aragão, LWR, Fernandes, SSL, Fernandes, TCL, Aragão, RFR, & da Silva, RCDL (2019). As Vantagens da Biorremediação na Qualidade Ambiental. *Ensaio e Ciência C Biológicas Agrárias e da Saúde*, 23(1), 12-15.
- [56] Souza, LHN, & Arruda, RDOM (2021). Revitalização de corpos d'água com o uso da biorremediação. *Revista Engenharia e Tecnologia Aplicada-UNG-Ser*, 4(1), 37-45.
- [57] Decesaro, A., Berticelli, R., Magro, F. G., & Colla, L. M. (2015). Biossurfactantes em Processos de Biorremediação. *Revista Ciências Exatas e Naturais*, 17(1), 119-143.
- [58] de Almeida, AR, Coneglian, CMR, Pizi, JF, Torigoe, N., & Figueiredo, H. (2018). Biorremediação de solo contaminado por BTEX com utilização de componente enzimático (Componente B). *Revista dos Trabalhos de Iniciação Científica da UNICAMP*, (26).
- [59] da Silveira, L. R., Tatto, J., & Mandai, P. (2016). Biorremediação: considerações gerais e características do processo. *Engenharia Ambiental: Pesquisa e Tecnologia*, 13(2)...
- [60] Mannarino, C. F., Ferreira, J. A., & Gandolla, M. (2016). Contribuições para a evolução do gerenciamento de resíduos sólidos urbanos no Brasil com base na experiência Européia. *Engenharia Sanitária e Ambiental*, 21, 379-385.
- [61] Marchi, CMDF (2015). Novas perspectivas na gestão do saneamento: apresentação de um modelo de destinação final de resíduos sólidos urbanos. *urbe. Revista Brasileira de Gestão Urbana*, 7, 91-105.
- [62] Moraes, JL (2015). Dificuldades para o aproveitamento energético de resíduos sólidos através da incineração no Brasil. *Geosaberes: Revista de Estudos Geoeducacionais*, 6(3), 173-180.
- [63] Nagalli, A (2016). *Gerenciamento de resíduos sólidos na construção civil*. Oficina de Textos.
- [64] Petarnella, L., do Nascimento, HRF, Facó, J., & Junger, AP (2017). A reciclagem de vidros e o impacto socioambiental: o caso da corporação de apoio à criança queimada (COANIQUEM). *Revista de Casos e Consultoria*, 8(2), e821-e821.

A Multi-Input Power System deployment for Enhanced Rice Production

Nosiri Onyebuchi Chikezie*, Oyibo Uchechukwu Moses, Njoku Elvis Onyekachi,
Ekechukwu Ebere Evelyn

Department of Electrical and Electronic Engineering, Federal University of Technology Owerri, Nigeria
*Email: buchinosiri@gmail.com

Received: 19 Jun 2022,

Received in revised form: 14 Jul 2022,

Accepted: 19 July 2022,

Available online: 25 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Coordinator, Multi-input Power,
Router, Sensor Node, Wireless Sensor
Network, Zigbee.

Abstract— Owing to the energy supply challenges observed when Wireless Sensor Networks (WSNs) are implemented for effective coordination and transmission of packets for enhanced rice production, the study focused on actualizing an effective and coordinated power system configuration for enhanced rice production, where a multi-input power model is designed to complement the power of the coordinator (sink node) and the actuator systems. The amount of power required for effective energy distribution is evaluated in the study. The farmland implementation involves coordinated application of fertilizer, weed control/prevention, pest/disease control, rodents and bird's invasion using a Zigbee-based Wireless Sensor Network (WSN). Modelling of various networks to demonstrate data sensing of different environmental variables and energy consumption in a given farm land was demonstrated.

I. INTRODUCTION

Food production is generally energy intensive when modern technology is deployed for irrigation and other technology driven devices such as in smart monitoring, coordination and control using wireless-based sensor applications. Energy supply shortage or unavailability in modern farming systems in Nigeria has adverse implications for agricultural yields. The acute energy supply shortage has to a greater extent impacted negatively on the country's economy and more especially in agricultural sector. It has adversely paralysed the country's industrial sector by compelling them to adopt to old self-energy generation using fossil fuel generators, leading to increase in the production cost [1].

Rice is undisputedly considered a universal food crop, being a staple food for well over half the world population, particularly of India, China, and a number of other countries in Africa and Asia [2]. Rice remains an essential commodity in Nigeria and is required to be made readily

available to meet up with the consumption rate and as well the population growth. The underlining principal remains on how the growing demands could be met without need for importation. Recently, there was a tremendous improvement in rice production in Nigeria, which has recorded a peak production of 4.9 million Metric Tonnes (MT) by farmers in Nigeria. Notwithstanding the production growth, it has not been able to meet the national demand on rice consumption which stands an all-time high of 7 million Metric Tonnes (MT) [3][4]. This means that a gap of about 2.1 million MT needs to be cushioned. From recent studies, the limited capacity of the Nigerian rice sector to meet the domestic demand has been attributed to several factors, notable among them are the declining productivity due to low adoption of improved production practice and poor implementation of adequate power supply structure on existing modern instruments.

Enhanced productivity is realizable if the observed limited factors could be improved. One of the factors attributable to the limited rice productivity in Nigeria even

with the implementation of modern farm facilities is the inadequacy in power supply to drive the electronic and wireless devices.

Since modern farming is anchored on technology such as Wireless Sensor Networks (WSN), such technological devices would require efficient energy sources for its operations and also in driving some basic units such as the sensing unit, control unit and water source unit. Unfortunately, as stated earlier, most Nigerian improved production farmlands are so poorly energy structured which has been a limiting factor for productivity. For instance, a World Bank report says that businesses in Nigeria loss about \$29 billion yearly due to poor electricity [5]. The situation is far more critical in semi-urban and rural areas where agricultural activities actually take place. It is estimated that about 85 million Nigerians don't have access to grid electricity, hence making the country largest energy deficit in the world with consequential impart of about 2% of GDP [6]. Another consequential effect of non-availability of power in farm areas apart from poor productivity is that rural farmers would resort and rely solely on the crude method of agricultural practices, whose productivity will be limited relative to the consumption demand. On the other hand, it makes the profession unattractive to the younger generation to practice.

To increase agricultural production in such a manner and size that would cater for the ever-increasing population in Nigeria, requires hybrid off-grid power generation solutions where energy would be readily available to power the devices used at the farmland. The best option would be to have multiple energy sources at farm level devoid of grid power. The study tends to address the problem associated with limited power supply on modern farming vis-à-vis in rice production. A typical modern farm structure considered in the study uses wireless sensor network technology capable of carrying out the following functions: (a) automated irrigation of a rice farmland for year-round production, (b) disease control/prevention via automated application of pesticides, (c) weed control/prevention via automated application of herbicides and fertilizer and (d) rodents, birds' and animal control/prevention via automated buzzer activation mechanism. For efficient implementation of a control system would require reliable energy source distribution to power the devices, hence the proposed study on deployment of a multi-input power model for efficient and dynamic energy distribution in an integrated rice farmland.

II. LITERATURE

2.1 Wireless Sensor Network

A Wireless Sensor Network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions (i.e., temperature, sound, vibration, pressure, humidity etc.) and to cooperatively pass their data through the network to a main location [7]. WSN is configured to house a few to several hundreds or even thousands of sensors or nodes, where each node is connected to one (or sometimes several) sensors. Each sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source (i.e., battery or an embedded form of energy harvesting).

A wireless sensor network is made up of three components: Sensor Nodes, Task Manager Node (User) and Interconnect Backbone as shown in figure 1[7].

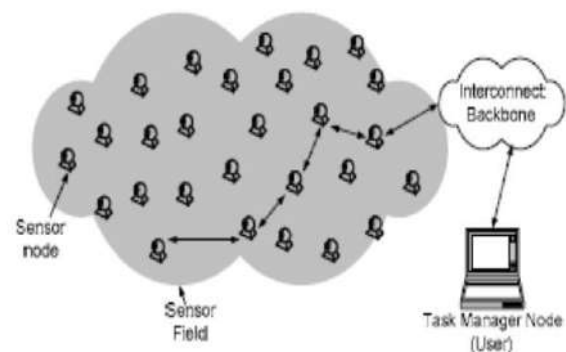


Fig 1: Wireless Sensor Network (WSN) [7].

The basic hardware components of a sensor node include a radio transceiver, an embedded processor, internal and external memories, a power source and one or more sensors [8]. In a sensor node, power is consumed by sensing, communication and data processing. More energy is required for data communication than for sensing and data processing. Power can be stored in batteries or capacitors; batteries remain the main source of power supply for sensor nodes.

Wireless Sensor Network Testbeds

WSN testbeds are deployed in a controlled environment. It serves as an intermediate tool between a real deployment and a simulator or emulator. It provides researchers a way to test their protocols, algorithms, network issues and applications. Preferred standards deployed in this study is Zigbee technology compared with other standards such as Bluetooth and Wireless Local Area Network (WLAN). The choice was because Bluetooth and

WLAN are not well suited for low-power sensor applications. There are three different types of ZigBee devices as shown in figure 2.



Fig. 2: Types of Zigbee devices in OPNET [9]

(a) ZigBee Coordinator (ZC)

The coordinator in every network is responsible for the creation of a network, selection of a channel, and permission to other nodes to connect to the network. All the data transferred from the connected node will be stored in a coordinator. It works like a router or a bridge between different networks [10].

(b) ZigBee Router (ZR)

A router may act as an intermediate device between the end device and Coordinator or between routers for passing data from other End Devices to the Coordinator. In some networks, End Devices may transfer data directly to the coordinator or from End Devices to other routers. A router can act as an end device and during time, its routing functionality will be inactive. Routers use less memory than ZigBee Coordinators, and cost less, and have the ability to work with all types of topologies [11].

(c) ZigBee End Devices (ZED)

The end devices are the end point of any network connected to routers and a Coordinator. It does not have the routing functionality. End devices may have contact with only parent node (either Coordinator or Router). End devices go to sleep mode to save battery power and do not have many duties compared to the Coordinator and Routers, which makes them less costly [11].

ZigBee Specifications

Table 1 presents the basic specifications of the Zigbee standard

Table 1: Specifications of the Zigbee standard [12]

Parameters	Zigbee Value
Transmission Range (meters)	1-100
Battery life (days)	100 – 1000
Network Size(No. of nodes)	>64000
Throughput(kb/s)	20-250
Transmission Band	868MHz,915Mhz,

	2459MHz
Complexity	Low
Wake up Delay	15mSec
Maximum Power	1mW
Maximum Child	254

III. METHODS

To demonstrate data sensing of different environmental variables in a given farm land, network devices were varied at different scenarios using OPNET simulator and understudying the network performances such as traffic sent (bits/sec), traffic received (bits/sec), end-to-end delay(second), throughput (bits/sec) and media access control (MAC) load (bits/sec). The idea of varying network devices is to demonstrate integration of different sensor types, monitoring different environmental variables simultaneously, yet constituting a single unit of WSN working cooperatively [3]. Each new set of network devices are integrated to a Zigbee Coordinator (ZC) which assigns an address to its members and forms a personal area network (PAN), thus representing data sensing of a particular environmental variable

The modeling of the WSN was based on Zigbee standard (IEEE 802.5.4) using OPNET Modeler 14.5A. The Zigbee wireless sensor network consists of three types of nodes: the end device nodes, the router nodes, and the gateway node (coordinator) [3]. The end device and router nodes were used to manage the data collection of various environmental variables (temperature & humidity, soil nutrients level, soil moisture level, presence of pests and rodents) and then the collected data were sent to the coordinator for processing, and control

3.1 System Block Diagram

Figure 3 shows the block diagram of a WSN model, representing a typical farmland of 100m x 100m dimension used as a baseline for the study. Sensors are

assumed to be sparsely distributed across the farmland consisting of Zigbee end devices (ZED), Zigbee routers (ZR), Zigbee coordinator (ZC) and actuators. The WSN is connected to a monitoring point via access point gateway, with a wireless database server and a PC for on-the-premise monitoring while a host computer is connected via an internet protocol (IP) cloud for remote monitoring. Sensed data from individual sensor types are routed through the router to the coordinator (Sink node) for further processing and control. The monitoring sub-network is equally connected to the coordinator for both on-the-premise and remote monitoring as maybe deemed

necessary [3]. Irrigation, pesticide application, herbicide application, and soluble fertilizer application could be done from any of the 4 compartments (Liquid A - D) connected to a water source through the irrigation pipe by the activation of the solenoid depending on the type of instruction received from the controller (coordinator). The other actuator systems could be for the alarming system to deter birds and rodents from the farm. A multi-input uninterrupted energy source is connected to power the sensing unit and the control/actuator units. The system is designed to ensure adequate power supply for proper control and coordination.

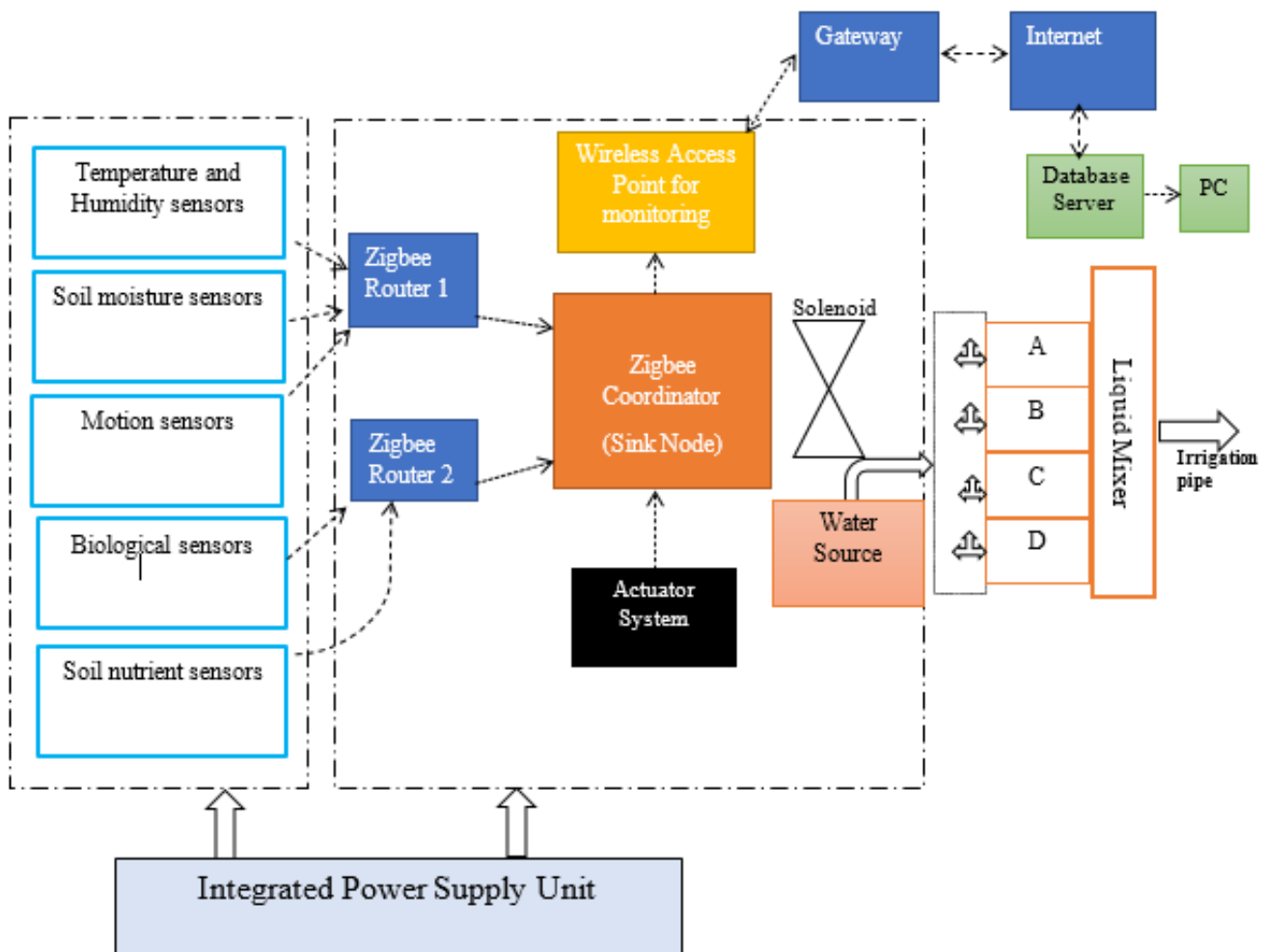


Fig. 3: Block diagram of a Model Farm network with integrated energy supply

3.2 Configured Network Scenarios

Three network scenarios were created to demonstrate data sensing of different environmental parameters by varying number of network devices while watching out for network performance. New set of Zigbee devices were added to the ideal network (network of one sensor type)

and configured to form a personal area network with an identifier for its members.

Scenario 1: consists of 4 Sensor Nodes, 2 Routers, and 1 Coordinator; to represent data sensing of temperature and humidity variables.

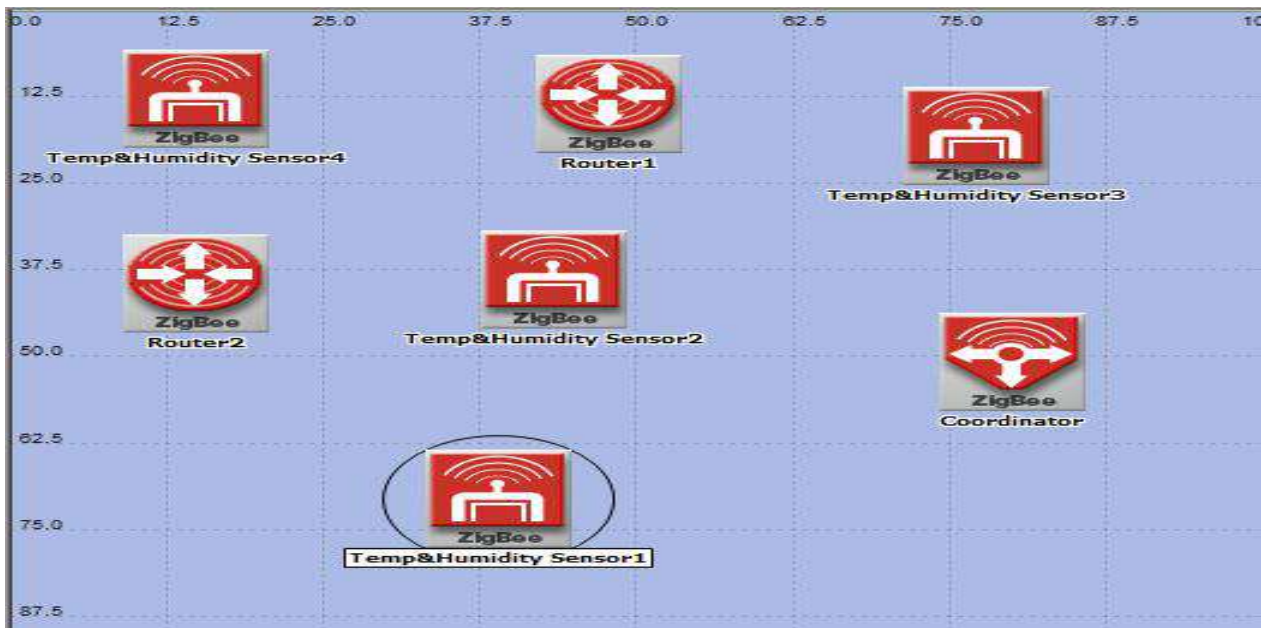


Fig. 4: Simulation Setup of Scenario 1

Scenario 2: consists of 8 Sensor nodes, 4 Routers, and 2 Coordinators. The second Coordinator is for the new set of sensor types; representing data sensing of soil nutrients,

it is configured to route its traffic to the central Coordinator.



Fig. 5: Simulation Setup of Scenario 2

Scenario 3: consists of 12 Sensor nodes, 6 Routers, and 3 Coordinators. Again, the third Coordinator is for the next new set of sensor types; representing data sensing of

motion variable, while the first Coordinator remains the central Coordinator while traffic from Nut_Coordinator is equally configured to be routed to it.

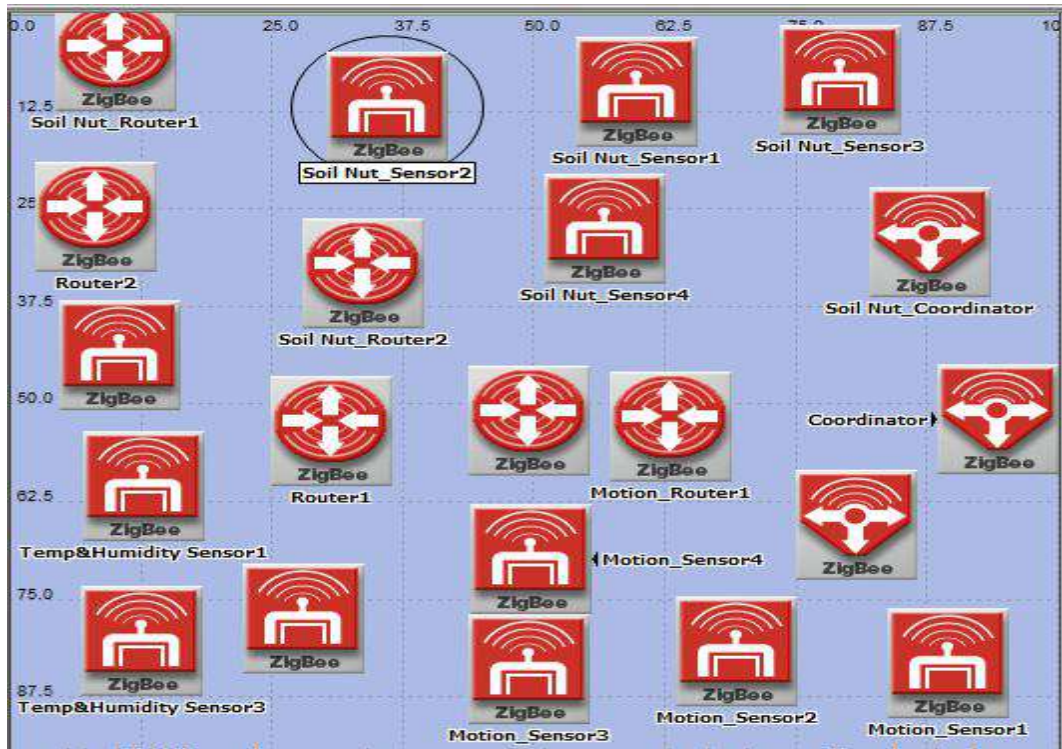


Fig. 6: Simulation Setup of Scenario 3

3.3 Design Process for Multi-input Power System

To mitigate the problem of limited power capability associated with WSN, a multi-input power model was designed to supplement the power of the coordinator (sink node) and the actuator systems while the end devices would utilize battery energy since more processing occur at the coordinator level.

To achieve this, solar energy is coupled and delivered to the power circuitry of the coordinator through a charging circuit and can also be powered by the wireless powered (Wp) source wirelessly in the event that the solar energy is not available. Figure 7 shows the block diagram of the multi-input power model of the network.

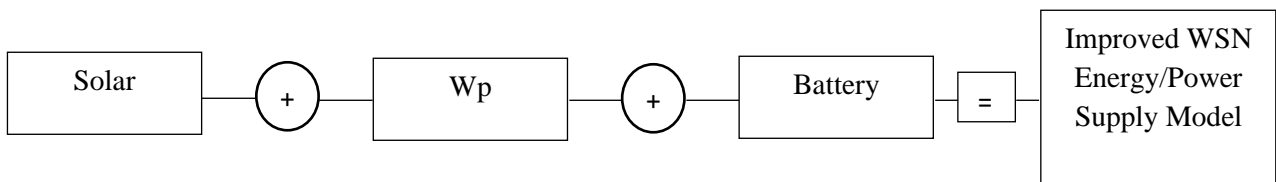


Fig. 7: A simple block diagram of the WSN power supply system.

From Fig. 7;

Let S = solar energy from the sun.

Wp = Energy obtained from the wireless power system.

B+ = Energy stored in the battery backup system.

The power supply model can be represented as: [13]

$$\sum_n [(S + Wp + B^+) - \phi] = P_{supply} (j/s) \tag{1}$$

Where ϕ is an error factor (0.1 – 0.01), assumed of the circuit which represents power loss due to circuit imperfection.

3.4 Power Model Schematic Diagram and Operation

The system is configured such that energy from the solar system is used for charging the battery and/or powering the coordinator (sink) and the actuator systems. The wireless power system is activated by a dark sensor switch when solar energy is unavailable and it transmits energy to the coordinator if there is a potential/energy difference between the battery terminal and the wireless

power sensor terminal coordinated by the relay coil as shown in figure 8.

It can be seen from figure 9 that the solar panel power is fed to a charging circuit, and also to a Single Pole Double Throw (SPDT) relay coil (via a 78L12 voltage regulator). This relay remains activated as long as the solar panel voltage is persistent, and as soon as the voltage falls below threshold, the relay contacts automatically switch the mains Switching Mode Power Supply (SMPS) adapter voltage through the wireless power receiver to the

charging circuit which then stores some energy and powers the coordinator electronics through the regulated adjustable 5-volt circuit model of figure 8 designed using electronic circuit wizard. The output voltage can be fine-tuned to the desired value (usually 4.5-5.5V) with the help of potentiometer (variable resistor (VR1)) connected just behind the 5-volt regulator. The regulated 5-volt circuit is to be built into the coordinator power system and the actuator system.

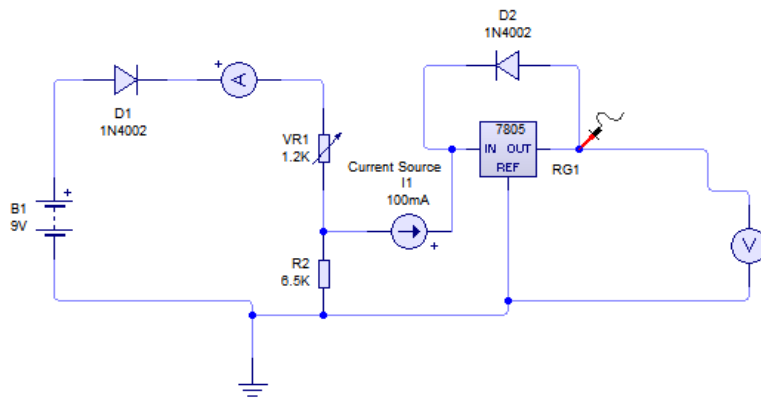


Fig. 8: Volt regulated power supply model.

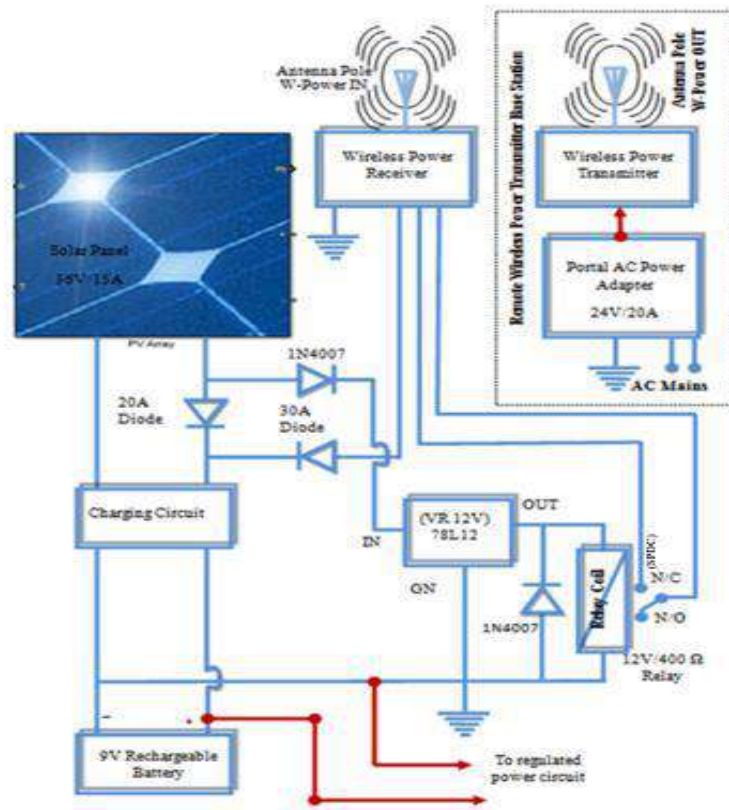


Fig. 9: Schematic diagram of the WSN power system

In order to ensure the system performs as expected, it is important to evaluate what the right energy requirement would be.

The energy model of the network is developed based on the following design assumptions:

1. Assume that it takes 1 joule/sec (1 watt) of energy to move one unit charge of electric current containing one packet of sensed data from one sensor node to the router node;
2. Same quantity of energy is expended by the router node to move the data to the coordinator;
3. 1 joule/sec (1 watt) of energy is needed to power ON and activate a sensor node. At standby mode, power consumption is equal to zero; for simplicity's sake;
4. It takes 1 joule/sec (1 watt) of energy for a node to sense and gather measurement signals such as temperature, distance etc.;
5. The water pump is fractional horse power (1/3hp, 250Watt) liquid pump, which does not operate all the time except when actuation signal is received.

Also,

Let x = ON-OFF mode energy in joules (Activation energy);

y = energy required to gather measurement data (temperature, proximity, etc.), that is, Sensing Energy

t = Operation time (1 sec)

k = Gain constant (1-1.5; assumed)

m = pump/actuator energy consumption.

λ = Coordinator node energy consumption.

β = energy consumption of Router node (Transmit and Reception)

α = energy required to transmit sensed data (propagation energy).

Then;

Energy consumed by a node during active state

$$(x + y + \alpha)kt - \psi = P_{Tx} = P_{Rx} \text{ (j/s)} \quad (2)$$

Energy consumed by a node during inactive state

$$\sum(x + y + \alpha)kt - \Psi = 0 \text{ (j/s)} \quad (3)$$

Energy consumed by the router node during active state

$$n(\beta + x)kt - \psi \text{ (j/s)} \quad (4)$$

Where n is the number of simultaneous operations/quantity of packets arriving at the router at any given time, t .

Total Node Energy consumption at any point in time

$$\sum_{i,j}^i n(x + y + \alpha)kt - \Psi \text{ (j/s)} \quad (5)$$

Coordinator Energy Consumption

$$n(\lambda)kt - \psi \text{ (j/s)} \quad (6)$$

Gross Farm Field Energy Consumption

Sensor node energy + Router node energy + Coordinator energy + Pump/Actuator energy, that is;

$$\sum_{j,j \rightarrow 0}^i [(x + y + \alpha)kt - \psi] + [n(\beta + x)kt - \psi] + [n(\lambda)kt - \psi] + (m) = P_{consumed} \text{ (j/s)} \quad (7)$$

3.5 Parameter Computation

From the power consumption model and basic assumptions presented in section 3.4, the average energy requirement of each unit and the entire network can be estimated as follows:

(i) Energy Consumption at the Node level

Citing from equations 2 and 3;

From our design assumptions we have;

$$x = y = \alpha = 1 \quad (8)$$

With $k = 1.3$ (mid-range value considered optimal), and $t(s) = 1$;

Eqn. 5 now becomes

$$(1 + 1 + 1) * 1.3(1) - \psi = P_{Tx/Rx} \text{ (j/s)} \quad (9)$$

Applying mid-range value of energy loss, ψ of 0.055;

$$P_{Tx/Rx} = 3.845 \text{ (j/s)} \quad (10)$$

For n number of nodes, total average energy is

$$n(P_{Tx/Rx}) = n(3.845) \text{ (j/s)} \quad (11)$$

(ii) Energy Consumption at the Router/Repeater level

$$n(\beta + x)kt - \psi \text{ (j/s)} \quad (12)$$

Where n is the number of packets from end devices arriving at the router at a given time, t .

$$n(2)1.3(1) - 0.055 = 2.6n - 0.055 \text{ (j/s)} \quad (13)$$

(iii) Energy Consumption at the Coordinator level

$$n(\lambda)kt - \psi \text{ (j/s)} \quad (14)$$

Where n is the number of packets arriving at the coordinator at a given time, t .

The n factor at the coordinator expectedly should be higher than at router since packets from various routers arrive at the coordinator for processing.

Following from eqn. 14;

$$n(1)1.3(1) - 0.055 \text{ (j/s)}$$

$$\therefore P_{Coordinator} = 1.3n - 0.055 \text{ (j/s)} \tag{15}$$

Gross/average power consumption of the farm field

$$\sum_{j,j=0}^i (P_{node} + P_{router} + P_{Coordinator} + P_{Actuators/pump} + P_{others}) = P_{gross} \text{ (j/s)} \tag{16}$$

Where P_{others} are powers consumed by lighting system, etc. Assuming $P_{others} = 10\%$ of Coordinator Power = $0.13n - 0.0055$ and

$$P_{pump/actuator} = \frac{1}{3} \text{ of } 1hp = \frac{1}{3} * 750 = 250 \text{ j/s}$$

then,

$$P_{av} = (3.84 + 2.6n - 0.055 + 1.3n - 0.055 + 0.13n - 0.0055 + 250) \text{ (j/s)} \tag{17}$$

$$= 4.03n + 253.73 \text{ (j/s)} \tag{18}$$

The proposed power model for enhanced WSN is expected to supply this amount of power to the farm, with expansion factor taken into consideration. This means that the computed power can be varied either upward or downward to meet the energy requirement of the proposed farm.

IV. RESULTS AND DISCUSSION

The 3-power sources designed for the farm were modeled and represented mathematically as a combination of the various sources as represented in equation 1. Expectedly, the equation of the power combination is suggestive of the fact that the system will be sustained for a longer period of time than it would have been for a single source of power. This is true since any of the sources, say, the battery can independently power the system but can get drained up much faster.

4.1. Result of Power System Evaluation for the WSN and the Actuator System

The energy requirement for each component unit of the WSN and actuator system was evaluated and presented. For Zigbee end devices (ZEDs), the amount of energy required to sense its data and transmit same is given by

$$(x + y + \alpha)kt - \psi = P_{Tx} = P_{Rx} \text{ (j/s)}.$$

While the amount of energy required by Zigbee Router (ZR) during active state is given by $n(\beta + x)kt - \psi \text{ (j/s)}$.

And the amount of energy required by a Zigbee Coordinator (ZC) during active state is given by

$$n(\lambda)kt - \psi \text{ (j/s)}.$$

The result of the computation indicated that about 3.845 (j/s) will be required by a Zigbee end device for its operation during active state.

For Zigbee router, the computed energy is $2.6n - 0.055 \text{ (j/s)}$ while for Zigbee coordinator, the value is $1.3n - 0.055 \text{ (j/s)}$. The n factor is the amount of data packets arriving from Zigbee end devices for the router, and from Zigbee routers for the coordinator. It is expected that the value of n is higher at the coordinator than at the router. This is so since all the routers route their data to the coordinator.

Energy requirement of the pump/actuator is a fractional horse power (1/3hp), i.e., $1/3*750 = 250 \text{ (j/s)}$.

Although the computed energy values for Zigbee end device, Zigbee router and the coordinator are low, they can be seen to be high in comparison with standard energy definition for Zigbee devices. This is understandable since parametric values were assumed for simplicity of computation.

Since energy is a scarce commodity in most rural areas in Nigeria and to ensure network longevity, an improved multi-input power system comprising an integration of solar energy, wireless power and battery source could serve as an enhanced energy power supply for improved rice production.

V. CONCLUSION

Adoption of new and modern agricultural practices is said to be driven by access to affordable and uninterrupted sources of energy. The implementation of a dynamic multi-input power system for enhanced rice production is proposed in the study to address the predominant issue affecting modern farming especially in rice production in Nigeria. Energy-harvesting deployment was introduced which converts ambient energy from solar and wireless energy from wireless transmitted network to electrical

energy with the aim to revolutionize the power supply on sensor nodes. The study was able to actualize an effective and coordinated power system configuration for improved rice production to address the classical limitation of inadequate energy supply and distribution on the deployed WSN. The amount of power required for effective energy distribution in a specified rice farmland was evaluated in the study. The study context could be implemented in other farm sectors as an enhanced approach for efficient energy supply.

[13] Gatheridge B. (2014), "Electric Motor Power Measurement and Analysis", *Yokogawa Corporation of America*.

REFERENCES

- [1] Chanchangi, Y.N., Adu, F., Ghosh, A.(2022), "Nigeria's energy review: Focusing on solar energy potential and penetration", *Environ Dev Sustain*. <https://doi.org/10.1007/s10668-022-02308-4>.
- [2] Food and Agricultural Organization of the United Nations, "production year Book" *FAO*, 2006.
- [3] Oyibo U, Nosiri O.C. (2022), "KPI Deployment for Enhanced Rice Production in a Geo-location Environment using a Wireless Sensor Network", *International Journal of Wireless and Mobile networks (IJWMN)*, Vol 14, No. 3, pp 35-54.
- [4] George L., (2020), "A growing problem: Nigerian rice farmers fall short after borders close" <https://www.reuters.com/article/us-nigeria-economy-rice-idUSKBN1ZM109>.
- [5] The "Guardian Newspaper", 23 April 2021. <https://guardian.ng/business-services/businesses-lose-29-billion-yearly-to-poor-electricity-says-world-bank>.
- [6] Nigeria to Improve Electricity Access and Services to Citizens "World Bank, Press Release No.:2021/88/AFR. <http://www.worldbank.org/en/news/press-release/2021/02/05/>
- [7] Manoj A. (2013), "Wireless Sensor Network-A Theoretical Review", *International Journal of Wired and Wireless Communications* Vol.1, Issue 2.
- [8] Qinghua W. and Ilanko B. (2010), "Wireless Sensor Networks - An Introduction, Wireless Sensor Networks: Application-Centric Design", *Yen Kheng Tan (Ed.)*, ISBN: 978-953-307-321-7, InTech,
- [9] Shah N. (2015), "Performance Study of ZigBee-based Green House Monitoring System".
- [10] Petr J. Anis K. (2007), "Technical Report (The IEEE 802.15.4 OPNET Simulation Model: ReferenceGuidev2.0)", http://www.openzb.net/downloads/HURRAY_TR_070509.pdf
- [11] Mohammad R. S. (2009), "Communication Networks: Implementation of an IEEE 802.15.4 and ZigBee Protocol using the OPNET simulator", <http://www.openzb.net/downloads>. Published spring.
- [12] Boris M. and Mitko B. (2011) "Overview and Analysis of the Performances of ZigBee-based Wireless Sensor Networks", *International Journal of Computer Applications (0975 – 8887) Volume 29– No.12*.

Home Service Information System Design for Health Workers

Andi Hutami Endang¹, Mirandha Ariesca Riana², Mardiatul Jannah³, Kamil Malik⁴

¹Department of Information System, Institute Technology & Business Kalla, Indonesia

Email: hutamiendang@kallabs.ac.id

²Department Retail Management, Institute Technology & Business Kalla, Indonesia

Email : mirandhaariesca@kallabs.ac.id

Received: 22 Jun 2022,

Received in revised form: 18 Jul 2022,

Accepted: 22 July 2022,

Available online: 28 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Home Service, Information System, SDLC, Health Works

Abstract— Home Service is a set of health care systems that includes patient care and consultation, baby spa, and many other health services. Home Service adopts the same system flow as Start Up in general. With the limitation of the problem only on health workers, nurses and midwives only. The method used in this research is SDLC. The purpose of developing this research framework is iterative development, based on the User engineering approach. SDLC has stages starting from the planning, analysis, design, implementation, and maintenance stages. The home service application has a flow starting from the registration made by the patient, through their account, the patient will be able to order the services they need. The application will automatically match their orders with nurses or midwives as service providers who have registered as partners. Partners can then confirm the services they can provide as well as the service schedule and fees.

I. INTRODUCTION

The development of the world of technology today is getting faster, technology has penetrated various sectors ranging from the public, agriculture, service sectors to the health sector. The presence of technological innovations, especially in the health sector, is growing, this is certainly very much needed by the country of Indonesia, which has a very wide geographical condition that is needed especially by health facilities. One of the main challenges in healthcare industry is providing for large geographic distances. Issues like uneven distribution of clinical workforce and more costly resources for rural patients can not be avoided. Information technology (IT) can address these challenges and enhance healthcare services. For the last decade, the development of healthcare information system has been accelerated. There are quite a lot of tools to potentially support healthcare delivery such as telecommunications, web solutions, and social networking.

Studies show that increased adoption of information system in healthcare leads to innovations that improve healthcare quality [1]. One of the said innovation is home service information system. This system facilitates the delivery of services at many levels. It supports activities such as planning and managing the performance of processes, also enabling the recording of information [2].

Home service information system enable patients more control of the service. It leads to a role transition from being passive (as the recipient of health services), to being more active, meaning patients would have choices and would be more involved in the decision-making process. Such a transition is triggered by the increasing usage of home service devices and software, access to healthcare information and online communities, as well as the use of personal health records maintained by patients themselves [3].

II. STUDY LITERATURE

2.1 Information System

Informatization has been the way to go in this era. With the rapid evolvement of technologies and scientific theories, traditional health care has gradually begun to digitize and to informationize. Through the development of IT-based technologies, low-cost health services, efficient supervision of the centralized management, and monitoring of public health can be realized [4]. It is not only a simple technological advancement, it is an all-round, multi-level change. These changes can be seen from various point of views such as information construction, service model, prevention and treatment process, and business management.

In terms of the information construction, the process shifts from clinical to regional medical. Shifting also occurs to the service model. It goes from disease-centered service to patient-centered service, which effects the prevention and treatment concept. It was widely assumed that health services are carried out as treatments that patients undergo after the fact. Now, the concept focuses on prevention. At last, all of the changes lead to a complete business transformation from general management to be more personalized [5]. This evolution aims to meet the individual needs of service users and enhancing their experience. Therefore, the quality of healthcare can be improved to represent the future development direction of modern health care [6].

2.2 Home Service

One of many ways the health care service industry holds the welfares of information systems for its personnel and patients is by offering a home service information system. It has manifested extensive practicality and application in healthcare services, reducing the cost of medical expenses, better operational proficiency and patient's safety, expanding functional capability in the healthcare sector [7]. This technology helps to spread medical knowledge to the isolated and secluded places. Home service enables the amalgamation and fruitful interchange of data between the utilizer and provider with a fully equipped IoT system containing operator devices, network components, electronics, and data storage and analyzers [8]. This approach has shown effectiveness especially in the COVID-19 pandemic. In addition, it helps to address significant health issues and better managing the health workers' work situation [9].

In parallel to the increasing implementation of home service, all over the world, follows various interests of healthcare system namely dehospitalization process, usage of hospital beds rationalization, cost reduction, and related organization (especially those of patient-centered care)

[10]. As a contribution to the shifting of both the focus and the environment of healthcare system, the demand of home service is yet another challenge to be faced [11]. To give some contexts, there are a few driving factors concerning the new healthcare system; the aging process of the population, pregnant women and infant care, children with chronic diseases, adults who has degenerative conditions, and patients require palliative care, rehabilitation, or life support [12]. These needs explain the highly-anticipated innovation in healthcare system. It is natural that home service being the said innovation continues to increase in demand. Thus, the relevance of improving the home service implementation is highlighted in the current and future healthcare systems which goal is to contribute on the configuration of substitute healthcare networks and health services transformation [13].

From the service model perspective, the real need behind home service approach has been arguably questioned. It has been concluded that some reasons for inpatients due to specific health problems are consider expandable and unnecessary prolonged. In that case, home service is the more reasonable option. Beside the cost-efficient reason, it also represents the connotation of providing service quality, well-being, and comfort by allowing patients to remain in their places of choice [14].

The whole process of home service information system is navigated by the interaction between users (patients) and providers (health workers). The implementation of home service relies on the integration between the healthcare system and the user, in which is configured by the service provider. This role in particular is performed by a multidisciplinary team, who has the capability to provide the necessary service [15]. Considering all of the interactions between patients and health workers take place in patients' home, there would be a need for some adjustment and adaptation from both parties. In this case, patients play a much more active role from the jump. Starting with planning the service, choosing the provider, setting the time and location, and confirming to a specific service. Health workers, on the other hand, have more limited responsibilities [16].

III. METHODS

The development method used in this study is the System Development Life Cycle (SDLC). The selection of SDLC as a method in developing information systems in this study because SDLC is able to produce high-quality systems that are tailored to user needs [17]. The types of development models from the SDLC methodology vary such as prototype models, RAD models, agile models,

fountain models, v-models, RUD models, waterfall models, scrum models, iterative models, spiral models, big bang models, UP models, extreme programming.

After knowing the types of models that exist in the SDLC methodology. The researcher decided to use an iterative model because Iterative model is the model provides a new method of developing systems which could provide faster results, require less up-front information, and offer greater flexibility. With Iterative Development, the project is divided into small parts. This allows the development team to demonstrate results earlier on in the process and obtain valuable feedback from system users.

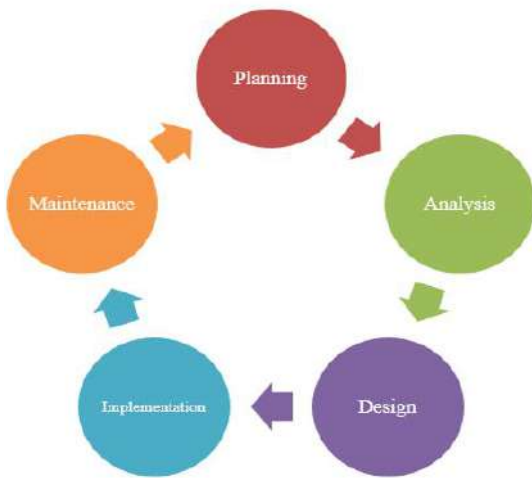


Fig. 1: The phases of Iterative Model

IV. RESULTS

This research, result obtained in the form of an information system for nurses and midwives medical personnel in the form of a mobile application “Siap Rawat”. This application is based on android that can be operated on android smartphone. This application can be used in various service including baby spa, home care, exercises for pregnant women, and wound care.

4.1 Design Algorithm

The design algorithm used in this study is as follows:



Fig. 2: Figure Title below the figure

Figure 1, starting with registration as member, when registration has been carried out, an email will be sent to activate the account, but if it is not successful, will receive an email confirmation of account activation. Furthermore, if the email confirmation stage is successful, go directly to the main page. On the menus in the application will be shown. The is willing or not. The final stage will be agreed upon by the health service provider and consumer who will use the type of service.

4.2 Design User Interface

a. Member Register

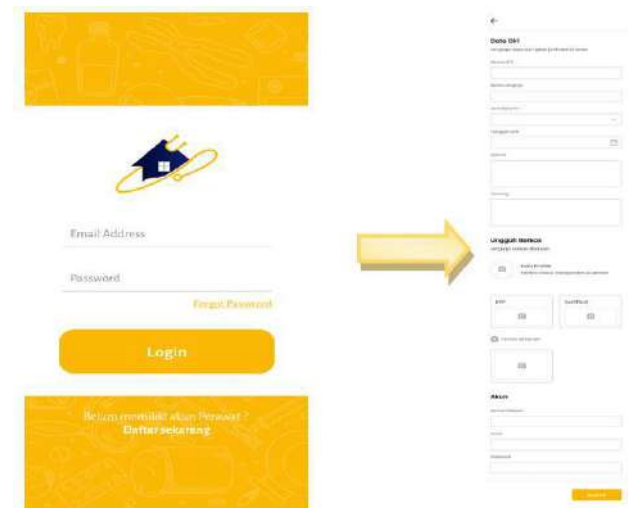


Fig. 3: Member Registration

b. Confirmation Email



Fig. 4: Member Registration

c. Dashboard



Fig. 5: Member Registration

d. Service



Fig. 6: Service

e. Patient Address



Fig. 7: Patient Address

V. CONCLUSION

Technological innovation, especially in the health sector, is currently needed not only for the general public but also for those who work as health workers. Indonesia's geographical conditions are one of the factors that hinder the maximum role of health workers for the general public who act as patients. The absence of an information system that has developed as a forum for bringing them together and also a conventional health care system is quite time-consuming for patients or the general public who need services from health workers, therefore the development of the "Siap Rawat" application is expected to be one of the alternative to answer this problem. This system was developed not only for health workers but also ready to be used by the general public, the working system of this application is the same as start-ups in general which offer special services for health workers on an application and the general public can make reservations for health services from home through the application. It is hoped that in the future this system will continue to be developed according to user needs and can run well so that it will become easier for health workers and the general public to meet their needs.

REFERENCES

- [1] Y. K. Alotaibi and F. Federico, "The Impact of Health Information Technology on Patient Safety," *Saudi Med J.*, vol. 38, no. 12, 2017.
- [2] H. Thimbleby, "Technology and The Future of Healthcare," *J. Public Health Res.*, vol. 2, no. 28, 2013.
- [3] S. Olson, *The Role of Human Factors in Home Health Care*. Washington D.C: National Academies Press, 2010.
- [4] M. Usak, M. Kubiato, M. S. Shabbir, O. V. Dudnik, K. Jermstittiparsert, and L. Rajabion, "Health Care Service Delivery Based on The Internet of Things: A Systematic and Comprehensive Study," *Int. J. Commun. Syst.*, vol. 33, no. 2, 2019.
- [5] F. L. Rajão and M. Martins, "Home Care in Brazil: An

- Exploratory Study on The Construction Process and Service Use in The Brazilian Health System,” *Cien. Saude Colet.*, vol. 25, no. 5, 2020.
- [6] N. Rapport, *Transforming Healthcare with Qualitative Research*, 1st editio. 2021.
- [7] G. Lee, S. Yang, and E. Woo, “Past, Present, and Future of Home Visiting Healthcare Services based on Public Health Centers in Korea,” *J. Korean Public Heal. Nurs.*, vol. 32, no. 1, 2018.
- [8] V. Jagadeeswari, V. Subramaniaswamy, R. Logesh, and V. Vijayakumar, “A study on Medical Internet of Things and Big Data in Personalized Healthcare System,” *Heal. Inf. Sci. Syst.*, 2018.
- [9] S. Tian, W. Yang, J. M. Le Grange, P. Wang, W. Huang, and Z. Yei, “Smart Healthcare: Making Medical Care More Intelligent,” *Glob. Heal. J.*, vol. 3, no. 3, 2019.
- [10] K. S. Kadar, F. Ardilla, A. Puspitha, and Erfina, “Implementation of Home Care Services by Community Health Centers (Puskesmas) in Makassar City, Indonesia,” *J. Keperawatan Indones.*, vol. 25, no. 1, 2022.
- [11] M. Mitchell and L. Kan, “Digital Technology and The Future of Health Systems,” *Heal. Syst. Reform*, vol. 5, no. 2, 2019.
- [12] R. Chunara et al., “Telemedicine and Healthcare Disparities: A Cohort StudH in A Large Healthcare System in New York City During COVID-19,” *J. Am. Med. Informatics Assoc.*, vol. 28, no. 1, 2021.
- [13] A.-M. Rosland et al., “Patient-Centered Medical Home Implementation and Improved Chronic Disease Quality: A Longitudinal Observational Study,” *Health Serv. Res.*, vol. 53, no. 4, 2017.
- [14] P. Worley, “Why We Need Better Rural and Remote Health, Now More Than Ever,” *Rural Remote Health*, vol. 20, no. 1, 2020.
- [15] M. H. Türkkani, T. Özdemir, F. Göksel, and Ç. Özdilekcan, “Configuration of Palliative Care Clinics and Integration with Home Health Care Services: Current Practice in Turkey,” *Cyprus J. Med. Sci.*, vol. 5, no. 3, 2020.
- [16] C. C. Foster, R. K. Agrawal, and M. M. Davis, “Home Health Care For Children With Medical Complexity: Workforce Gaps, Policy, And Future Directions,” *Health Aff.*, vol. 38, no. 6, 2019.
- [17] M. Ardiansyah and Jukenly, “Design And Development Point Of Sale System With DSS (Decision Support System) Using SDLC Research Method,” *2nd Conf. Manag. Business, Innov. Educ. Soc. Sci.*, pp. 164–177, 2022.

Use of the Endogenous Resources of the Palestine Settlement, Cravolândia-BA: The Potentials of Quixabeira (*Sideroxylon obtusifolium* [Humb. ex Roem. & Schult.] T.D. Penn.)

James Lima Chaves¹, Suyare Araújo Ramalho², José Raimundo Oliveira Lima³, Jéssica do Nascimento Pereira Lima⁴, Jacqueline Araújo Castro⁵

¹Discente do Programa de Pós-Graduação em Planejamento Territorial da Universidade Estadual de Feira de Santana, UEFS, Brasil
Email : jamesufrb@gmail.com

²Doutora em Biotecnologia, UFS; Professora do Instituto Federal de Educação, Ciência e Tecnologia de Sergipe, IFS, Brasil
Email : suyare.ramalho@ifs.edu.br

³Doutor em Educação e Contemporaneidade, UNEB; Professor da Universidade Estadual de Feira de Santana, UEFS, Brasil
Email : zeraimundo@uefs.br

⁴Estudante de Iniciação Científica Junior, Instituto Federal de Educação, Ciência e Tecnologia Baiana, IF BAIANO, Brasil
Email : suyare.ramalho@ifs.edu.br

⁵Doutora em Genética e Biologia Molecular, UESC; Professora do Instituto Federal de Educação, Ciência e Tecnologia Baiano, IF BAIANO, Brasil
Email : jacque.rgv@gmail.com

Received: 21 Jun 2022,

Received in revised form: 16 Jul 2022,

Accepted: 22 July 2022,

Available online: 28 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *Endogenous local development, fruit waste, chemical composition, phenolic compounds, quixaba.*

Abstract— *The persistence of poverty in semiarid regions resides, among other difficulties and limitations, in the inability to use its endogenous elements in a rational way. Thus, this article aimed to investigate the content of total phenolic compounds in the pulp and residues of quixaba fruits (*Sideroxylon obtusifolium*) in ethanol extracts and evaluate properties (pH, acidity and soluble solids) essential to the fermentation process with a view to developing products for school meals and also low-alcohol beverages capable of generating income for the local population from the use of an endogenous resource available in the legal reserve areas of the Palestine Settlement located in the municipality of Cravolândia, Bahia. In addition to documentary studies, the chemical characterization of quixaba fruits was carried out. An analysis of all parts of the quixaba fruit, in terms of total soluble solids content, pH and acidity, indicates potential for its agro-industrial processing. In addition, the high ° Brix indicates that the pulp has sugar levels that make it ideal for flavoring yogurts that can be offered at school lunches. The phenolic compounds present in different parts of the quixaba indicated a possible antioxidant potential. Even though the use of quixaba is currently neglected, it is possible to use it agro-industrially.*

I. INTRODUCTION

Of the 9,428 rural settlers managed by National Institute for Colonization and Agrarian Reform (INCRA), 2,246 are located in the northeastern semi-arid region, totaling an area of 4,665,101.25 hectares serving 116,976 families [1]. It is a territory where a high rate of insolation, high temperatures and low thermal amplitudes predominate, marked by low rainfall, irregular distribution of rain in time and space, low humidity, high evapotranspiration rate and predominance of xerophilous vegetation [2].

The Brazilian semiarid has most of its territory occupied by vegetation adapted to drought and extremely important from a biological point of view, called Caatinga [3]. According to [4], in addition to having endemic species, this biome is the center of diversification of several rare biological interactions, it has a relevant biodiversity, represented by animal, plant and microorganism species that cannot be found in other places elsewhere on the planet.

According to [5], the Caatinga biota is currently composed of 3,150 vascular plants, 276 ants, 386 fish, 98 amphibians, 191 reptiles, 548 birds and 183 mammals. These endogenous resources constitute the greatest wealth of this biome, awaiting public policies and institutional arrangements aimed at sustainable development, compatible with the rational use of territorial elements [6].

According to the Ministry of the Environment, the biodiversity of the Caatinga supports several economic activities [7]. Despite this, it is the scene of a complex reality of exploitation and inadequate use of natural resources, being often destroyed to make way for pastures, supply bakery ovens, produce charcoal and for the implementation of various crops. In fact, this devaluation and human action has already resulted in the deforestation of 46% of its area [7] and about 500 thousand hectares of this biome are deforested per year [8].

As an aggravating factor and also a challenge, the implementation of rural settlements in semi-arid regions intensifies the exploratory pressure on the Caatinga, promoting greater use of water resources, soil and animal and plant biodiversity. The settlers, in turn, face great difficulty in structuring productive and sustainable systems in the face of social, economic and environmental conditions in the new agricultural units.

According to [9], the persistence of poverty in semi-arid regions lies in the inability to use their endogenous elements in a rational way. Thus, considering that the Caatinga bears the title of one of the richest dry forests in the world [5], the sustainable use of its biodiversity presents itself as a viable economic alternative [3].

Regarding plants with food potential, the amount of these resources in the Caatinga is much greater than, at first glance, one could imagine [10]. Despite this, several native species, especially fruit, have neglected use and are still poorly studied, even though they are known and used by local communities, they do not participate in a family chain of agro-industrialization, nor are they present in school meals and in the set of commercialized products. or produced, in order to contribute to the composition of the income of local families. An example of this is the quixabeira (*Sideroxylon obtusifolium* [Humb. ex Roem. & Schult.] T.D. Penn.), a species that grows and produces abundantly in the Caatinga region of northeastern Brazil [11] but which, despite this, has its neglected use.

Some studies have proven the anti-inflammatory, hypoglycemic and antioxidant activity in the leaves, stem and ribs of quixaba [12]; [13]; [14]. However, studies are still needed on the antioxidant activity and the content of total phenolic compounds in the pulp, peel and seed of the quixaba fruit. Dedicating attention to the study of native fruits such as quixabeira is extremely important, as it can result in the offer of new alternatives of fresh fruits for fresh consumption and also of raw material for agroindustry, constituting a precious source of food and wealth [15]; [16]; [17].

In this sense, agricultural policy for the semi-arid region, especially in agrarian reform settlements, needs to be associated with endogenous local development (DLE). This process involves the proper use and valorization of available endogenous territorial elements, and can also be understood as a means capable of promoting transformations in a community [18].

In view of the above, the present article aimed to investigate the content of total phenolic compounds in the pulp and residues of quixaba in ethanolic extracts, as well as to evaluate chemical characteristics (pH, acidity and soluble solids) essential to the fermentation process with a view to the development of products for food. school and also low-alcohol beverages capable of generating income for the local population from the use of an endogenous resource available in the legal reserve areas, collective areas and lots of the Palestine Settlement

II. MATERIALS AND METHODS

The research used documentary studies as well as theoretical support in references in the area. Documentary research was carried out mainly on the website of the Electronic System of the Citizen Information Service (e-SIC) to obtain ordinances, reports, statistical and descriptive reports from federal agencies, such as the National Institute of Colonization and Agrarian Reform (INCRA) and the portal of the Brazilian Institute of

Geography and Statistics (IBGE) will be used as a source of statistical information.

At state level, the Access to Information Law (LAI) and at the level of scope of documents with the Superintendence of Economic and Social Studies of the State of Bahia (SEI) Company for Regional Development and Action (CAR). The files of the Association of Agricultural Workers of Cravolândia (ATAC) also provide a document for analysis: the location map of the Settlement, including the lots and legal reserve areas. For [19], the main characteristic of documentary research is restricted to the source of data collection, which is restricted to written or unwritten documents, and can be collected at the time it occurs or fact or later.

Characterization of the Study Site

The study site covers the Palestine Rural Settlement, originated through an expropriation action (for social interest) of the set of lands of the former Palestine/Timbó/Salobro farms with an area of 4,327.45 hectares initially occupied by 180 families. The settlement is located in Cravolândia-BA, belongs to the Vale do Jiquiriçá Identity Territory, located mainly in the South Center of Bahia, has an area of 12,233km², with an estimated population of 313,678 inhabitants, representing 2.24% of the Bahian population. , with 134,176 individuals located in rural areas and 179,502 in urban areas [20]. Another predominant characteristic in that territory is the high level of land concentration and low indicators of economic and social development, aspects that interfere in the socio-spatial dynamics.

Among the 20 municipalities that make up the territory of identity, Cravolândia was the first in the region to host actions to promote access to land when the National Institute for Colonization and Agrarian Reform (INCRA) transformed a camp for landless rural workers into a rural settlement. of agrarian reform in 1999.

The city of Cravolândia borders the municipalities of Santa Inês, Itaquara and Ubaíra, has the Caatinga as the predominant biome in most of its territory, has an area of 160 km², a population of 5,145 inhabitants, distributed in urban and rural areas [21]. Of this total, 1,148 individuals are in extreme poverty and 1,072 in total poverty. It is one of the 20 municipalities in Bahia with the lowest tax collection. It has a low human development index (HDI), of 0.599, occupying the 155th position in the HDI ranking of the state of Bahia and the 4,167th position in Brazil [20].

Chemical Characterization

The fruits of the quixabeira (*S. obtusifolium*) were collected in the legal reserve areas of the Palestine Rural

Settlement (13°24'39.2"S 39°48'47.6"W), in accordance with the Regulatory Framework for Biodiversity, with registration with the SISGEN (A2085D3), in Cravolândia, a municipality belonging to the Vale do Jiquiriçá Identity Territory, in the State of Bahia.

The analyzes of total phenolic compounds and chemical characteristics of the fruits were carried out at the Microbiology Laboratory of the Instituto Federal Baiano campus Governador Mangabeira. The whole process started with the washing of the fruits in running water and sanitization using mixkill organic chlorine at 200 ppm for 15 min and rinsing at 3 ppm. The quixabas were stored at -18°C, in a freezer, and then they were manually pulped and the seeds, husks and pulp were separated.

Acidity

The determination of acidity was carried out by weighing the samples (5g) and homogenizing them in 50 mL of distilled water. 2 to 4 drops of the phenolphthalein solution were added. Then, the samples were titrated with 0.1 N sodium hydroxide solution until the pink color changed [22].

Total Soluble Solids (°BRIX)

In order to determine the content of soluble solids existing in the pulp and residues of quixaba, direct reading was used in a model refractometer (BRASEQ) in which the samples were inserted on the surface of the prism. The procedure was as follows: With the aid of a pipette, drops of water were added over the lower prism, taking care to avoid the presence of air bubbles in the liquid, so as not to reduce the contrast of the limit line. It was waited a few minutes for the liquid to come into thermal equilibrium with the prisms. With the separation line very clear, the division between the two regions was positioned exactly at the center of the reticle and the refractive index of the sample was read [22].

Hydrogenionic Potential (PH)

In order to determine the pH of each sample studied, a pH meter (model PH21 mv meter, Hanna brand) was used under direct reading. Initially, the pH meter was calibrated with buffer solutions of 4.0 and 7.0. Then, 5 g of each sample was weighed and these were diluted in distilled water, after homogenization, a direct reading was performed [22].

Determination of the Content of Bioactive Compounds

Obtaining Ethanol Extracts

The samples of pulp, peel and seed of the quixaba in natura were initially ground in an industrial mixer until it became powder, then 5g of each sample was weighed,

which were homogenized in 50mL of ethanol at 12% and 70%, stirred for 30 min on a shaker plate and protected from light. In the second step, the extracts were centrifuged at 12000 rpm for 15 min in 30 mL centrifuge tubes. The supernatant was reserved and subjected to a new centrifugation (1200 rpm for 15 min), this time using 2.0 mL eppendorfs in order to remove small particles still present in the extracts. Final extracts were used immediately. Figure 3 shows the extraction scheme.

Determination of Total Phenolic Compounds

The quantification of phenolic compounds was determined according to [23] adapted by [24]. 1mL aliquots of aqueous or ethanolic extracts were transferred to test tubes, to which were added in this sequence: 1mL of 95% ethanol solution, 5mL of distilled water and 0.5mL of 1N Folin-Ciocalteu reagent. Homogenization was carried out immediately. Then, 1mL of 5% (w/v) sodium carbonate solution was added, followed by a new homogenization. The test tubes were kept in a darkroom for 60 min, at the end of which they were once again homogenized. The samples had their absorbances measured at a wavelength of 725nm against a blank, consisting of 95% ethanol solution. For the quantification of these extracts, a calibration curve was constructed based on different concentrations of gallic acid (0.035-2.82 mg/mL), in order to convert the absorbances and express the results in terms of micrograms of gallic acid equivalent. (GAE) per gram of sample weight ($\mu\text{g GAE eq/g sample}$).

In the present study, all analyzes were performed in triplicate and the results were presented as mean \pm standard deviation.

III. RESULTS AND DISCUSSION

The Palestine settlement has 07 legal reserve areas in which the vegetation is preserved (Fig. 1). The largest of them has 313,802 hectares, and the smallest 27,028 hectares, totaling 908.37 hectares. In these areas, quixabeiras occur spontaneously and abundantly, the fresh consumption of the fruit is practiced by the local population, however, no type of processing is carried out to originate drinks, flour or any other product.

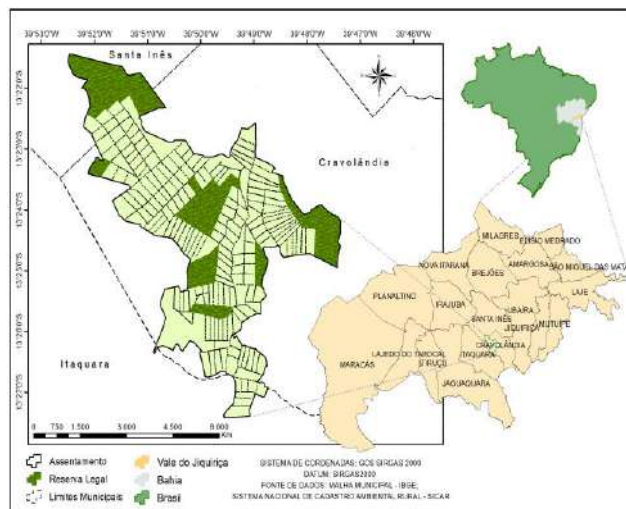


Fig.1 Cravolândia (BA): Legal reserve area in the Palestine Settlement, 2021.

The devaluation of local products was exacerbated by the Green Revolution, which encouraged the adoption of plants and seeds said to be superior and improved to the detriment of local and adapted species and cultivars, which may also explain the community's estrangement from the great value and richness of its natural environment. It has. Contradictorily, the idea still prevails that the Caatinga biome is dry, poor in diversity and with few possibilities, the opportunity to value its resources and even obtain income from their sustainable management is lost.

Studies carried out by [25] states that all territorial communities have a set of resources (economic, human, institutional and cultural) that constitute their potential for endogenous development. Therefore, it is possible to implement a public policy aimed at a form of development that bets on the existing potential in the territory, on the use of plant species from the Caatinga biome, on the rational use of land and water, on the valorization of the rural man and on the dissemination of social technology for coexistence with the semiarid region. In this sense, it is understood that Social Technologies are “a set of transforming techniques and methodologies, developed and/or applied in the interaction with the population and appropriated by it, which represent solutions for social inclusion and improvement of living conditions” [26].

Chemical Characteristics of Quixaba

The quixaba fruits present a globular shape with a dark purple color when ripe, similar to the jabuticabeira fruits (Fig. 2). In addition, they present little variation in length, diameter and weight.



Fig. 2 – Quixaba (*S.obtusifolium*): Fruits

The results of the composition of the pulp and the residues (peel and seed) of the quixaba are described in Table 01. The pH is established as a quality attribute by the legislation, as it favors the conservation of the pulp, preventing microbial growth, although there is no index used as a standard for the quixaba fruit. In this study, the average pH for quixaba pulp (5.28) was similar to that found by [27] who found a pH value of around 5.4 in quixabas from Mossoró-RN and by [28], in fruits from the Barrocas site in the semiarid region of Paraíba, a value of 4.8. In residues, the values were similar to those found by [28] who showed a titratable acidity of 1.01 (% citric acid).

Table 1- Quixaba (*S. obtusifolium*): Results of pulp composition and bark and seed residues

AMOSTRAS	PH	AT(%)	°BRIX
Resíduo (casca+semente)	4,32±0,15	1,20±0,02	22,01±0,02
Polpa	5,28±0,01	4,13±0,11	25,02±0,01

In the evaluation of total soluble solids, mean values of 22.01 were obtained for the skin and seeds and an average of 25.02 °Brix only in quixaba pulps. In a fermentation process, the contents of soluble solids, expressed in °Brix, are 18 °Brix and 18 °Brix, consequently, implying in this smaller addition of study, the potential of verification for this purpose. Similar results were found by [29] that the Brix value for quixa pulp was 24.23°.

An analysis of all parts as parts (peel, pulp and seed), in terms of soluble solid fruit content at such, pH and agro-industrial calculations, indicates potential for its agro-industrial processing, as the high content of soluble solids (22–25 %) and pH conducive to the degradation of the substrate (4.32 – 5.28), make it suitable for application in fermentation processes. In addition, the high sugar indicates that the pulp has sugar contents that make it ideal for flavoring yogurts that naturally have a slightly sour taste. These, in turn, can be offered in school lunches via the National School Feeding Program (PNAE).

The Food Acquisition Program (PAA) and the National School Feeding Program (PNAE) are public policies that can significantly stimulate the local market, including introducing typical fruits and products from the region in school meals. In this way, the use of native plants (fruit and roots) would contribute to income generation, in addition to strengthening the local culture, which is also related to food customs.

According to [30], the mentality that favors the acquisition of local products will enable the introduction of exotic genres from the perspective of a locality. In this way, the strengthening of local markets is one of the ways to face the oligopolistic control of food [31], as well as a way to build production chains of species that, despite their great nutritional and economic potential, are neglected by the big industry.

The production and consumption of native fruits is also a strategic issue for the health and well-being of the population, as it is linked to the access and maintenance of diversity, being a form of resistance to an agri-food system lacking nutrients, controlled by powerful corporations. [32]. In addition, the conservation of the local biodiversity of the Caatinga can be encouraged from a design of production, processing and distribution of food based on the production chain of native fruits, as well as support for solidarity economy initiatives.

Among the guidelines defined by the National Education Development Fund (FNDE) for the PNAE, the first says that the agricultural vocation of the region must be respected, prioritizing raw materials and food produced and marketed in the region as a way of encouraging production place, giving preference to products of traditional consumption. The twelfth guideline mentions that the selection of foods that make up the program's menu must be consistent with the agricultural and agro-industrial vocation of the locality, with the purpose of encouraging Local Development, supporting food acquisition projects from family farming and cooperatives. of small producers [33].

The Production Cooperative of the Piemonte da Diamantina Region (COOPES), located in Capim Grosso-Ba, a semi-arid region, has been inserting products from licuri and native fruits into the PNAE. The Agricultural Production Cooperative of Giló and Region (COOPAG), from the cities of Várzea Nova and Miguel Calmon, in Bahia, also offers PNAE flavored yogurts with fruits from the Caatinga, such as licuri and umbu [34]. The Delícias do Jacuípe fruit pulp factory, located in the city of Pintadas in Bahia, is also supplied with fruits from agroforestry systems or from extractivism from the Caatinga itself, from small peasant farmers. It currently produces various

pulps and meets the PNAE and PAA with the offer of its products [35]. These initiatives first show that the non-timber territorial resources of the Caatinga have the potential to be used as instruments to promote DLE.

Another initiative is that of the Cooperativa Agropecuária Familiar de Canudos, Uauá and Curaçá (COOPERCUC) which benefits native fruits of the Caatinga with strong socioeconomic potential, but until then, little valued, such as umbu (*Spondias tuberosa*) and passion fruit (*Passiflora cincinnata*). This self-managed cooperative encourages members to feel a sense of belonging, uses social technologies to harmoniously develop strategies that make it possible to face difficulties related to water deficit, as well as link economic performance to environmental preservation. As a result, there is an endogenous local development model (DLE), in which the resources of the Caatinga, in this case the fruits, instead of being placed in the hands of middlemen, are benefited or even in natura placed in school meals via PNAE and PAA.

Bioactive Compounds

Fig. 3 shows the steps in the process of extracting phenolic compounds from quixaba fruits using 12% and 70% ethanolic solvents, under agitation for 30 minutes in the dark and subsequent centrifugation at 1,200 rpm for 15 minutes.

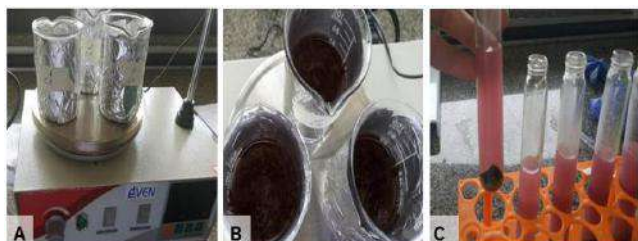


Fig. 3 – Stages of the phenolic compounds extraction process.

Table 2 indicates the content of total phenolics present in the pulp and residues (peel and seed) of quixaba in its in natura form, higher averages were obtained in residues in ethanolic extract at 70% (1222.36 ± 0.06) and % (929.83 ± 0.01), compared to pulps in ethanolic extract at 70% (949.67 ± 0.02) and 12% (646.49 ± 0.01). It was also found that lower ethanol content (12%) was efficient in the extraction process, requiring further studies on this.

Table 2 – Content of total phenolics present in the pulp and residues (peel and seed) of quixaba in its in natura form.

AMOSTRAS	EXTRATO	EXTRATO
	ETANÓLICO A 12% (µG GAE* EQ/G)	ETANÓLICO A 70% (µG GAE* EQ/G)
Resíduo	929,83±0,01	1222,36±0,06
Polpa	646,49±0,01	949,67±0,02

Phenolic compounds, which include anthocyanins, flavonols, catechins and tannins [36] are present mainly in red to purple fruits. According to [37], the antioxidant activity of phenolic compounds is mainly due to their redox properties, so they can play an important role in the absorption and neutralization of free radicals, in addition to exhibiting a wide range of biological effects, including antioxidant, antimicrobial, anti-inflammatory and vasodilatory actions.

In non-astringent fruits, the concentration of tannins is poor, in this case, its antioxidant capacity is determined not only by tannins, but mainly by other phenolic compounds. The concentrations of other phenolic compounds are, in this sense, higher in the skin than in the pulp [38]. This corroborates the values obtained in this study for quixaba as well.

Phytochemical analysis of quixaba bark was performed by Araújo Neto (2009) [39] using the following extracts: a) crude ethanol extract; b) crude ethanol extract diluted in a methanol/water solution (2:3); c) crude ethanol extract subjected to liquid-liquid extraction with hexane (hexane fraction), chloroform (chloroform fraction) and ethyl acetate. After the study, it evidenced the presence of total phenols, tannins, flavonols, flavononols, flavonones, xanthonnes, catechins, steroids, triterpenoids and saponin heterosides. However, his work did not present quantifications of these compounds in the rind and/or in the quixaba fruit itself as a means of comparison for the present study.

In view of the fact that quixaba is rich in phenolic compounds, an important class of antioxidants of interest to the food industry, it is evident the need to deepen studies capable of identifying and quantifying individually the phenolic compounds with antioxidant potential, as well as applications of the referred to fruit in the preparation of dairy and fermented beverages, jellies, peel flour intended for bakery products, product flavoring, extraction of food pigments, among others. Such studies must take place in order to be supported by the social, economic and environmental tripod, valuing popular knowledge and

territorial elements and using them as allies to achieve social well-being, environmental sustainability and local endogenous development.

IV. CONCLUSION

Even though the use of quixaba is currently neglected in the Palestine Settlement in Cravolândia-Bahia, the present research demonstrates that the fruit has agro-industrial potential. Quixaba can be applied in fermentation processes, flavoring of dairy drinks and has antioxidant potential even at low ethanol concentration. The recognition and use of endogenous elements, such as the quixaba species, is a fundamental step in the search for strategies that enable local development. Faced with the process of globalization of markets, the valorization of local products, giving them a territorial identity, can guarantee the success of the family farmer. As well as the quixaba, the Palestine Settlement has, in its 908.37 hectares of legal reserve, several species that can also be used to generate and supplement income, which requires, above all, works of an extensionist nature built together with the members community, valuing their knowledge. In addition, technological practices are needed that allow the use of endogenous resources for the development of new products.

Therefore, we consider that we have achieved the objective of investigating the content of total phenolic compounds in the pulp and residues of quixaba in ethanolic extracts, as well as evaluating chemical characteristics (pH, acidity and soluble solids) essential to the fermentation process, with a view to the development of products for school meals and low-alcohol beverages, capable of generating income for the local population from the use of an endogenous resource available in the legal reserve areas, collective areas and lots of the Palestine Settlement in Cravolândia, Bahia.

ACKNOWLEDGEMENTS

We thank the Association of Agricultural Workers of Cravolândia (ATAC).

REFERENCES

- [1] INCRA. (2021). Instituto Nacional De Colonização E Reforma Agrária. Assentamentos: relação de projetos. Brasília
- [2] ZANELLA, M. E. (2014). Considerações sobre o clima e os recursos hídricos do semiárido nordestino. Caderno Prudentino de Geografia, Presidente Prudente, (36), 126-142.
- [3] KIILL, L. H. P.; ARAÚJO, F. P.; ANJOS, J. B.; FERNANDES JUNIOR, P. I.; AIDAR, S. T.; SOUZA, A. V. (2019). Biodiversidade da Caatinga como potencialidade para a agricultura familiar. In: MELO, R. F.; VOLTOLINI, T. V. (Org.). Agricultura familiar dependente de chuva no Semiárido. Brasília: Embrapa, 15-45.
- [4] LEAL, I. R.; LOPES, A. V.; MACHADO, I. C.; TABERELLI, M. (2017) Plant-animal interactions in the Caatinga: overview and perspectives. In: SILVA, J. M. C.; LEAL, I. R.; TABERELLI, M. (Eds.) Caatinga. the largest tropical dry forest region in South America. Cham: Springer International Publishing, 255-278.
- [5] SILVA, J. M. C.; LEAL, I. R.; TABARELLI, M. (2017). Caatinga. the largest tropical dry forest region in South America. Cahm: Springer International Publishing, 3-475.
- [6] DANTAS, J. P. (2007). Recursos florísticos: módulo VI Curso DSSB. Capina Grande: Abeas/UFCEG-PB.
- [7] BRASIL. (2021). Bioma Caatinga. Brasília, MMA.
- [8] VIEIRA, G. G. (2009). Desertificação e convivência com o semiárido brasileiro: da casa de adobe e do mocó à agroecologia e permacultura na região de Gilbués, Piauí. Okora: Geografia em debate, João Pessoa, (3), 23-53.
- [9] PEREIRA, J. P. G. (2007). Fundamentos da Agroecologia. Módulo XIII. Curso DSSB. Campina Grande: ABEAS/UFCEG-PB.
- [10] ALBUQUERQUE, U. P. (2010). Caatinga: biodiversidade e qualidade de vida. Bauru: NUPEEA.
- [11] LORENZI, H. (1998). Árvores brasileiras: Manual de identificação e cultivo de plantas arbóreas nativos do Brasil. Nova Odessa: Plantarum.
- [12] FALCÃO S. H.; LIMA, I. O.; SANTOS L.V.; DANTAS F.H.; DINIZ M.F.F.M.; BARBOSA-FILHO M.J.; BATISTA M. L. (2005). Review of the plants with anti-inflammatory activity studied in Brazil. Brazilian Journal of Pharmacognosy. Curitiba, (15), 381-391. <https://doi.org/10.1590/S0102-695X2005000400020>
- [13] FERREIRA, C. P. (2008). Plantas medicinais empregadas no tratamento do Diabetes mellitus: padronização e controle de qualidade. Dissertação (Mestrado em Botânica) – Recife, UFRPE.
- [14] SILVA, M. D. (2008). Estudo farmacobotânico de três espécies medicinais da Caatinga em Pernambuco. Dissertação (Mestrado em Botânica) – Recife: UFRPE.
- [15] GIACOMETTI, D. C. (1992). Recursos genéticos de frutíferas nativas do Brasil. In: Simpósio Nacional de Recursos Genéticos de Frutíferas Nativas, 1992. Anais do 1º Simpósio Nacional de Recursos Genéticos de Fruteiras Nativas. Cruz das Almas.
- [16] MORAES, V. H. F.; MULLER, C. H.; SOUZA, A. G. C.; ANTÔNIO, I. C. (1994). Native fruit species of economic potential from the Brazilian Amazon. Journal Angewandte Botanik. Germany, (68), 47-52.
- [17] LIRA JUNIOR, J. S.; MUSSER, R. S.; MELO, E. A.; MACIEL, M. I. S.; LEDERMAN, I. E.; SANTOS, V. F. (2005). Caracterização física e físico-química de frutos de cajá-umbu (*Spodias spp.*). Ciência e Tecnologia de Alimentos, Campinas, (25), 753-761.

- [18] COSTA, L. F.; ÍTAVO, L. C. V.; SOARES, C. M.; CEREDA, M. P.; MACIE, J. C.; ÍTALO, C. C. B. F. (2010). Democracia e desenvolvimento local em assentamentos rurais. *Interações*, Campo Grande, (11), 161-169.
- [19] LAKATOS, E. M.; MARCONI, M. A. (2003). *Fundamentos de metodologia científica*. São Paulo.
- [20] BAHIA (2015). *Perfil dos territórios de identidade da Bahia*. Salvador: SEI.
- [21] BRASIL (2010). Banco de Dados. Rio de Janeiro: IBGE. <https://cidades.ibge.gov.br/brasil/ba/cravolandia/pesquisa/23/27652?detalhes=true>.
- [22] INSTITUTO ADOLFO LUTZ (2008). *Métodos físico-químicos para análises de alimentos*. São Paulo: IAL.
- [23] SHETTY, K.; CURTIR, O. F.; LEVIN, R. E.; WITKOWSKY, R.; ANG, W. (1995). Prevention of vitrification associated with in vitro shoot culture of oregano (*Origanum vulgare*) by *Pseudomonas* ssp. *Journal of Plant Physiology*. Goytacazes, (147), 447-451.
- [24] CORREIA, R. T. P.; MCCUE, P.; MAGALHÃES, M. M. A.; MACEDO, G. R.; SHETTY, K. (2004). Phenolic antioxidant enrichment of soy flour-supplemented guava waste by *Rhizopus oligopus*-mediated solid state bioprocessing. *Journal of Food Biochemistry*, United States, (28), 408-418. <https://doi.org/10.1111/j.1745-4514.2004.05703.x>
- [25] BARQUERO, V. A. (1998). *Desarrollo local: una estrategia de creación de empleo*. Ramón de la Cruz: Pirámide.
- [26] ITS (2004). Instituto de Tecnologia Social. *Tecnologia social no Brasil: direito à ciência e ciência para cidadania*. São Paulo: Caderno de Debate, 9-37.
- [27] AROUCHA, E. M. M.; LINHARES, P. C. F.; RODRIGUES, G. S. O.; SOUZA, A. E.; QUEIROZ, R. F. (2010). Características químicas de frutos da quixabeira. *Revista Verde*, Pombal, (5), 05-08.
- [28] FIGUEIREDO, F. J. (2013). *Caracterização Físico-Química e Potencial Antioxidante do Fruto de Quixabeira (Sideroxylon obtusifolium Penn) Nativa de Soledade-PB*. Dissertação (Mestrado em Botânica) – Recife: UFRPE.
- [29] GARRIDO, M. S.; SOARES F. C. A.; SOUZA S C.; CALAFANTE P. L. P. (2007). Características física e química dos frutos de quixaba. *Revista Caatinga*. Mossoró, (20), 34-37.
- [30] MANCÉ, E. A. (1999). *A revolução das redes: a colaboração solidária como uma alternativa pós-capitalista à globalização atual*. Petrópolis: Vozes.
- [31] ROSA, P. R.; FELÍCIO, M, J. (2019). Reforma agrária como estratégia para o desenvolvimento com soberania alimentar. In: Pereira, D. M. B. et al. (Eds.). *A reforma agrária e o sistema de justiça*. Brasília: Ministério Público Federal, 150 - 167.
- [32] CETAP. (2015). Centro Ecológico, Rede Ecovida de Agroecologia e Terra do Futuro. *Frutas Nativas: alimentos locais, sabores e ingredientes especiais*. Passo Fundo, Caderno de Debate, 1-22, 2015.
- [33] BRASIL. (2004). Diretrizes Operacionais para o Planejamento de Atividades do Programa Nacional de Alimentação Escolar (PNAE): programação e controle de qualidade. FNDE.
- [34] ARAÚJO, A. M. (2017). Cooperativa de Várzea Nova lança iogurte de licuri na FENAGRO. Salvador, *Jornal A Tarde*.
- [35] PADOVEZI, A. OLIVEIRA, M.; JACOB, L. B. (2018). *Conhecimento agroecológico local: caminhos para a adaptação às mudanças climáticas e restauração da Caatinga*. Working Paper, São Paulo, 1- 3.
- [36] ANGELO, P. M.; JORGE, N. (2007). Compostos fenólicos em alimentos – uma breve revisão. *Rev. Inst. Adolfo Lutz*, São Paulo, (66), 1-9.
- [37] DEGÁSPARI, C. H.; WASZCZYNSKYJ, N. (2004). Propriedades antioxidantes de compostos fenólicos. *Visão Acadêmica*, Curitiba, (5), 33-40.
- [38] GU, H. F.; LI, C. M.; XU, Y. J.; HU, W. F.; CHEN, M. H. Wan, Q. H. (2008). Structural features and antioxidant activity of tannin from persimmon pulp. *Food Research International*, Essex, (41). 208-217. <https://doi.org/10.1016/j.foodres.2007.11.011>
- [39] ARAÚJO NETO, V. (2009). *Estudo das atividades antinociceptiva, antiinflamatória e antioxidante da Sideroxylon obtusifolium (SAPOTACEAE)*. Dissertação (Mestrado em Biotecnologia) – São Cristóvão: UFSE.

Therapeutic Approaches to Molar-Incisor Hypomineralization: An Integrative Review

Lucas Emmanuel Rodrigues Lima¹, Marcela Bezerra de Menezes Ponte¹, Lara Alves Meneses⁴, Luana Beatriz Ribeiro Lima¹, Raissa Cardoso dos Santos¹, Alice Freire dos Santos¹, Vitória Alexandre de Moraes¹, José Evando da Silva Filho¹, Ana Catarina Tomaz Soares¹, Gabriel Gouveia Frota¹, Jose Ariston Raulino Neto¹, Paulo Leonardo Ponte Marques³, Grace Sampaio Teles da Rocha², Anastácia Leite Jucá Ramalho², Ticiania Medeiros de Saboia Arnez²

¹Curso de Odontologia da Universidade de Fortaleza, Fortaleza (CE), Brasil

²Departamento de Odontopediatria, Universidade de Fortaleza, Fortaleza (CE), Brasil

³Departamento de Saúde Coletiva, Universidade de Fortaleza, Fortaleza (CE), Brasil

⁴Cirurgiã-Dentista pela Universidade de Fortaleza, Fortaleza (CE), Brasil

Received: 22 Jun 2022,

Received in revised form: 15 Jul 2022,

Accepted: 21 July 2022,

Available online: 28 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *Tooth Demineralization; Dental Enamel; Dental Care.*

Abstract— *Molar Incisor Hypomineralization (MIH) is a systemic disease that affects one to four permanent first molars, often associated with affected incisors. The treatments for this pathology vary according to the degree and location, and can be aimed at prevention, repair, and even extirpation of the dental element. This study aims to describe the therapeutic approach for people with Molar-Incisor Hypomineralization. Based on an integrative literature review, this study discusses therapeutic approaches in patients with MIH. The period from 2016 to 2022 was taken as a reference. Using the descriptors: "Molar-Incisor Hypomineralization"; "Dental Enamel"; "; "Pediatric Dentistry"; "Treatment" in the listed databases, 77 articles were identified. After applying the inclusion and exclusion criteria, nine articles were selected for this review. There are many recommended clinical therapies in recent literature including laser therapies alone or associated with other modalities with resin infiltration seem to be effective in treating dentin hypersensitivity. However, until now, there is no homogeneity in the existing protocols.*

I. INTRODUCTION

During the development of the dental enamel, it might occur disturbs called Defects in Enamel Development (DED) that cause defects in translucency and/or enamel color (Bezamat et al., 2021). These impacts on enamel development are critical since this tissue doesn't have the capacity for cellular repair (Lacruz et al., 2017; Smith et al., 2017; Alves et al., 2021).

There are 2 groups: quantitative defects, such as enamel hypoplasia, and qualitative defects, such as enamel hypomineralization (Folayan et al., 2018). Among these last developmental changes, the Molar-Incisor Hypomineralization (MIH) stands out, in which only after the year 2001, when received this name at the Congress of the European Academy of Pediatric Dentistry (EAPD), in Bergen.(Farias et al., 2018).

MIHMIH is a systemic disease that affects one to four permanent first molars, often associated with affected

incisors (Shrestha; Upadhaya; Bajracharya, 2014; Kirthiga et al., 2015; Yannam et al., 2016). It's also called hypomineralized First Permanent Molars (FPM), idiopathic enamel hypomineralization, non-fluoridated hypomineralization, and demineralized FPM. Koch et al. called them cheese molars after conducting the first epidemiological study on permanent teeth of Swedish children (Krishnan; Ramesh, 2014).

The teeth affected by this lesion has lower mechanical properties, such as reduced elastic modulus, when compared with healthy enamel. This is because, molecularly, they have a large number of proteins, which inhibit the growth of hydroxyapatite crystals during enamel maturation (Bezamat et al., 2021; Alves et al., 2021).

The macrostructural characteristics of enamel increase the risk of rapid progression of caries disease, which can lead to tooth loss at very early ages. The frequency of restorative interventions and the need for retreatment are significantly higher when compared to groups of patients who do not have this pathology, so early diagnosis is essential to avoid further consequences. (Lopez Jordi et al., 2014).

The wide range of prevalence rates may be due to differences in population age, testing patterns, chosen index, or calibration. In two recent meta-analyses, the average global prevalence of MIH was estimated at 13.1% (Schwendicke et al., 2018) with significant differences between regions and countries and 14.2% (Dave; Taylor, 2018) with no significant difference. between boys and girls. Densely populated countries significantly contribute to high prevalence, while growing countries rank first in terms of prevalence (Schwendicke et al., 2018).

In Brazil, studies were made in the Southern, Northeast, and Midwest regions. In Southern, four studies reported rates of prevalence of 12.3%; 19.8%; 20.4%; and, 40.2%. The values found for the Northeast and Center-West regions were 18.4% and 14.69%, respectively. This variation is partly explained by the use of non-standardized methods of diagnosis and sample selection (LEITE, 2020).

Regarding treatment and the therapeutic decision, the choice depends on: the disease, the patient's age, cooperative capacity, socioeconomic status, the orthodontic importance of the affected tooth, the presence of other minor anomalies, and the patient's expectation (Ochoa et al. 2017).

The treatments proposed for teeth with MIH vary and go according to the degree and location, and can be aimed at prevention, repair, and even extirpation of the dental element. Fluorides, varnishes, and topical fluoride use, for example, are widely used in the management of sensitivity

and prevention of dental caries, due to the fragility of the enamel, as in the aesthetic and functional treatment, the most used materials are composite resins and Glass Ionomer Cement (GIC). At the appropriate time, restoration with composites is considered a more feasible alternative to promote longevity (Domingos et al., 2019). This study aims to describe the therapeutic approach for people with Molar-Incisor Hypomineralization.

II. METHODOLOGY

This study is an integrative review of the literature on therapeutic approaches in patients with Molar-Incisor Hypomineralization (MIH). The period from 2016 to 2022 was taken as a reference.

Data collection was carried out in the Virtual Health Library (VHL) in Portuguese called by "Biblioteca Virtual de Saúde" (BVS) (<https://bvsa.org/>) and PubMed (<https://pubmed.ncbi.nlm.nih.gov/>) databases in June 2022. The aim of the research was "What is the therapeutic approach in patients affected by Molar-Incisor Hypomineralization?".

Six steps were taken to design the review: 1) identification of the theme, 2) selection of the aim of the research; 3) establishment of inclusion and exclusion criteria for studies; 4) categorization of studies; 5) evaluation of studies; 6) interpretation of results and synthesis of knowledge.

The descriptors used for the selection of articles in Portuguese in the BVS were: "Hipomineralização Molar-Incisivo, Esmalte Dentário, Odontopediatria, Tratamento", linked together by the Boolean operator "AND" and grouped to ensure greater specificity to the research. The descriptors used in English in the BVS comprised the following: "Molar-Incisor Hypomineralization"; "Dental enamel"; "Pediatric Dentistry"; "Treatment" also linked together by the Boolean operator "AND". For the selection of articles in PUBMED we used the descriptors related to each other by the Boolean operator "AND", which were: "Molar-Incisor Hypomineralization"; "Dental enamel"; "Pediatric Dentistry"; "Treatment".

The formulation of the central question of the integrative review used the PVO technique, where P refers to the Problem situation, participants or context; V comprises the study Variables, and O applies to the Outcome or expected result. Using the BVS technique the study population was defined as "Children with Molar-Incisor Hypomineralization", the variable of interest was "Molar-Incisor Hypomineralization" and the outcome/Outcome "Treatment".

Studies available in the BVS and PubMed databases that dealt with MIH and its therapeutic management in English and Portuguese from 2016 to 2022 were included.

The exclusion criteria were studies by year of publication and careful reading of abstracts; duplicate articles; laboratory studies; and those without full text available,

articles outside the period from 2016 to 2022, as well as articles in languages other than Portuguese and English.

The survey of the main publications related to the therapeutic management of MIH was tabulated in a text editor. The subjects with titles of the publications and their respective authors are represented in table 1, in the results section.

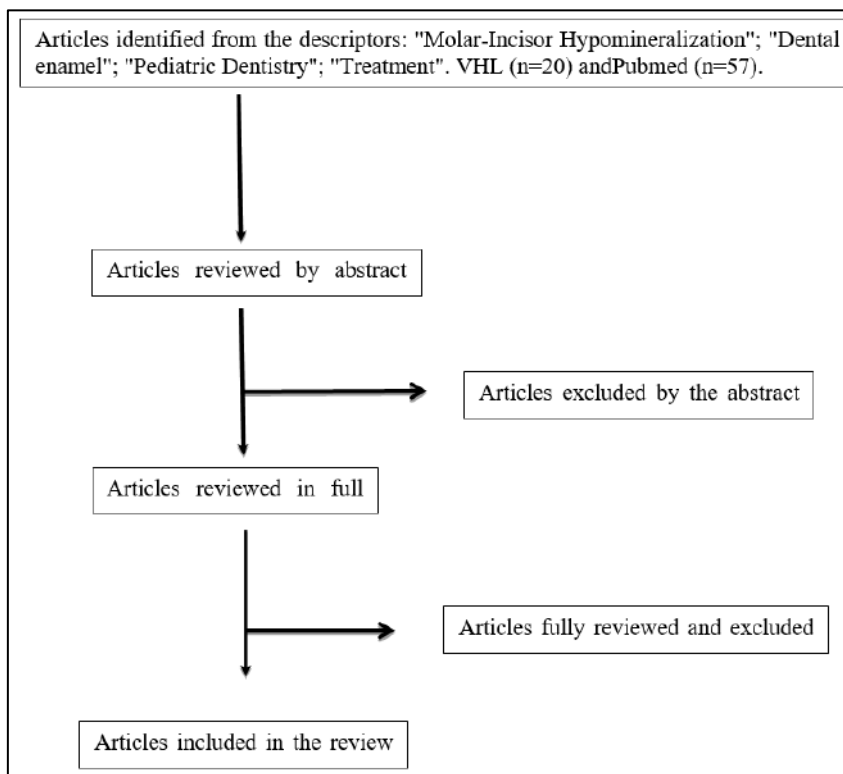


Fig.1 - Diagram of the study selection process

Source: Authors

III. RESULTS AND DISCUSSION

Using the descriptors: "Molar-Incisor Hypomineralization"; "Dental enamel"; "Dental enamel"; "Pediatric Dentistry"; "Treatment" in the listed databases, 77 articles were identified. After applying the inclusion and exclusion criteria, nine articles were selected for this review (Figure 1).

Chart 1 details the articles included in the review, according to criteria of authorship, publication period, type of study, objectives, and results.

Author/Year	Journal	Type of study	Objectives	Results
Bekeset al., 2021	Clin Oral Investig	Prospective multicenter study	To investigate the changes in QVRSO before and at different times after treatment of hypersensitive molars affected by MIH using the CPQ questionnaire.	Sealing hypersensitive molars affected by MIH with a composite material or a glass ionomer cement revealed a significant improvement in QVRSO immediately and over 12 weeks of follow-up.
Durmuset al., 2021	Clínica MedPrinc	Prospective intervention study	To evaluate the clinical survival of a high-viscosity glass ionomer (HVGI) at 2-year	Restoration using HVGI after SCR was observed to be an effective approach to maintain

			follow-up to restore molar incisors severely affected by hypomineralization post selective removal of decayed tissue (SCR).	the integrity of the tooth structure.
Vieira et al., 2019	Medicine (Baltimore)	Controlled clinical trial	To evaluate the clinical effect of antimicrobial photodynamic therapy (aPDT) on permanent teeth with severe MIH and painful sensitivity, associated with the presence of caries lesion.	In situations of deep lesions associated with MIH (mainly with risk of pulpal exposure) selective soft dentin removal should be applied, i.e. removal of this soft tissue only from the surrounding walls, keeping the soft dentin from the pulpal wall
Somaniet al., 2022	EurArchPaediatrDent	Systematic review	Systematically review the success of treatment modalities for molars and incisors affected by MIH.	Resin-based fissure sealants, preformed metal crowns, direct and indirect composite resin restorations for molars affected by MIH in specific clinical settings.
Weber et al., 2021	Reserchandscience	Systematic review	Systematically search the literature for treatment options (i.e. preparation and pretreatment of the substance tooth as well as the choice of material) to restore teeth affected by different severities of MIH.	Resin-modified glass ionomer cements appear to be superior to conventional glass ionomer cements; resin composites are expected to be suitable for restoring all severities of MIH and indirect restorations (i.e. onlays or partial crowns) show a good long-term clinical success, but should be restricted mainly to severe cases of MIH.
Muñozet al., 2020	BMC Oral Health.	Cross-sectional study	To evaluate and compare the perceptions, knowledge and clinical experiences of MIH in general dentists (GDPs) and pediatric dentists (PDs) in Spain.	They use GICs more often, taking advantage of their remineralizing potential, except in incisors, where they use composites.
Lygidakiset al., 2022	EurArchPaediatrDent.	Updated policy paper from the European Academy of Pediatric Dentistry	Evaluate etiological factors involved in MIH and treatment options for clinical management.	Despite an increase in the number of studies addressing the management of teeth affected by MIH, evidence is still limited, with conventional restorative options being the most common approach.
Farias et al., 2018	Journal of Medical and Biological Sciences	Integrative review	To review the literature on MIH in order to provide the dental surgeon who treats children with information about the diagnosis, clinical features, and treatment.	Tooth whitening, deep infill technique, sealant application, use of desensitizing pastes, restorations with GIC, resin and use of steel crowns.

Dullaet al., 2021	SwissDent J	Narrativerewiew	The purpose of this review is to summarize current knowledge on the etiology, prevalence and diagnosis of IMH, as well as to provide guidance on treatment decision as well as to discuss evidence for non- and micro-invasive interventions.	Use of glass ionomer cement as intermediate coverage, but mainly composite resins are materials of choice, use of steel crown.
-------------------	-------------	-----------------	---	--

Source: Authors

The study by Bekes et al. (2021), showed that sealing hypersensitive molars affected by MIH with composite resin or a GIC revealed significant improvement immediately and over 12 weeks of follow-up, showing that treating hypersensitive molars with a sealing technique leads to positive changes in the child's quality of life. According to Fragelli et al. (2017) the application of resin sealants can be useful in the treatment of mild MIH to prevent the progression of carious lesions.

Schraverus et al. (2021), showed that molars that were not sealed were 77% more likely to develop dental caries lesions compared to molars that received a Glass Ionomer Sealant application. This protective effect is due to the sealant acts as a mechanical barrier, physically isolating the pits and fissures from the oral environment. In addition, one of the main advantages of GIC is the release of fluoride, which is associated with the prevention of caries. Another positive feature offered is the reduction of hypersensitivity, allowing better oral hygiene for the patient and therefore contributing to the prevention of caries (Alves et al., 2021).

Vieira et al. (2019) state that when teeth are already affected by caries lesions, treatment should respect the principles of minimal intervention. The removal of infected dentin from the surrounding walls only should be performed, keeping this tissue in the pulp wall. Immediately after this selective removal, antimicrobial photodynamic therapy is performed, using the PapacárieMblue gel, modified with the addition of methylene blue as a photosensitizer for desensitization and decontamination in conjunction with the low-power laser.

Rolin et al. (2021) reported the challenge of adhesion to hypomineralized enamel, being difficult in performing direct restorations because hypomineralized enamel has less mineral content, high protein content, and lower resistance related to microhardness with masticatory forces. Previous studies recommend the total removal of hypomineralized enamel until a solid enamel is obtained,

improving the bond strength of restorative materials to the tooth surface.

Durmus et al (2020) stated that restoration using high viscosity glass ionomer (HVGI) after selective removal of carious tissue (SCR) was observed as an effective approach to maintain the integrity of tooth structure. Teeth severely affected by MIH are more susceptible to restoration failure and repeated treatments (Jalevic, Klingberg, 2002; Kotsanos et al., 2005). The benefits of SCR-HVGI in clinical practice (especially in public dental clinics) are its simplicity, shorter operation time, and better treatment of behavioral problems in MIH compared to conventional caries removal (Franzon et al., 2014; Maltz et al., 2013).

A systematic review by Somani et al. (2022) states that fissure sealants are predominantly used for fully erupted molars that have mild MIH. In this review, only three studies were included with a low total number of sealants placed (184). One of them did not report which material was used (Kotsanos et al.2005a,b), while all three studies used different primary outcome measures. A significant difference in retention rate was observed in one study when an adhesive was applied before the placement of a resin-based fissure sealant (Lygidakiset al.2009). This has been reported in teeth not affected by MIH (McCafferty; O'Connell, 2016).

Studies advise that amalgam restorations on teeth affected by MIH should be avoided due to the lack of adhesion and need for physical retention, which in conjunction with atypically shaped cavities can further increase margin breakage (Ghanim et al., 2017). Furthermore, a European directive (Article 10 (2) of the Mercury Regulation (EU) 2017/852) has advised against the use of amalgam in children under 15 years of age unless strictly necessary which is likely to lead to a decline in its use in research and clinical practice.

In contrast, eight studies in this systematic review used direct composite resin restorations in 793 molars, most of which were severely affected by MIH. Overall, the

reported success rates suggest that this is an effective option for the management of molars affected by MIH, where the rupture or carious lesions do not extend to the pulp or do not present with irreversible pulpitis, even in the most severe cases. Total or partial removal of hypomineralized enamel before restoration with composite resin under rubber dam isolation remains a reliable technique in terms of restoration success rates.

Lab-made indirect restorations may be considered a better option in the long term, especially in older children; however, the included studies followed participants for no more than 43 months, highlighting the need for longer studies. (Zagdwon et al., 2003; Gaardmand et al., 2013; Dhareula et al., 2019)

An alternative approach for severely affected molars is to use Preformed Metal Crowns (PMC). Although only three studies included in this review using PMC for molars affected by MIH, they outperformed all other restorative materials with one study reporting 86% success rate (Oh et al., 2020) and others reporting a 100% success rate (Kotsanos et al., 2005a,b; Koleventi et al., 2018).

In a systematic review by Weber et al (2021) the mechanical properties of resin-modified glass ionomer cement are superior to those of conventional glass ionomer cements. When indirectly comparing the 12-month success rates of conventional glass ionomer cement with that of resin-modified glass ionomer cements, a clinical study investigating a resin-modified glass ionomer cement showed a success rate of 98.3% (Grossi et al., 2018), whereas a clinical study investigating a conventional glass ionomer cement showed a survival rate of 78.7% (Fragelli et al., 2015). However, it should be noted that the two studies were designed and conducted differently concerning the severity of hypomineralization and pretreatment of the teeth.

Studies investigating composite resins for the restoration of teeth affected by MIH suggest that these materials can be used to restore all severities of MIH. (Lygidakis et al., 2009; de Souza et al., 2017; Fragelli et al., 2017; Sonmez&Saat 2017; Gatón-Hernandéz et al. 2020; Linner et al., 2020; Rolim et al., 2021). However, the use of composite resins requires good patient compliance during treatment, at best with rubber dam application. Regarding the preparation of the tooth substance, a higher survival rate of composites has been demonstrated after the complete removal of the MIH-affected enamel (Sönmez&Saat 2017; Linner et al., 2020).

In the study by Munõz et al., (2020) As for the material of choice in cases of post-eruptive fractures, resin-modified glass ionomer (RMGIC) was the most commonly used by both groups. However, there were significant differences in

the use of glass ionomer cement (GIC) between PIBs (12.21%) and odontopediatricians (18.40%). No significant differences were found in the materials used to restore opacity, with RMGIC again being the first choice in both groups. However, in the case of treating incisor lesions, the composite resin was the material of choice in both groups, with significant differences in the use of RMGIC between general dentists and odontopediatricians.

Studies are showing that GIC (81%) was more used than resin-modified GIC (44.3%), which is justified by the higher fluoride release. (Crombie et al., 2008). However, a recent systematic review showed that the failure rate of restorative materials in the treatment of MIH is higher with the use of amalgam and glass ionomers, and the highest success rate is achieved with indirect restorations, preformed stainless steel crowns (SSC), and composite resin restoration (Elhennawy; Schwendicke, 2016). In other studies, the composite was the material of choice. (Gamboa et al., 2018; Alanzi et al., 2018; Silva et al., 2016; Crombie et al., 2008), and was recommended by Lygidakis et al., 2010, in moderate lesions.

Farias et al., (2018), The treatment of demarcated opacities can be performed by different conducts among which tooth whitening (Harika et al., 2016) and more recently the deep infiltration technique (Giannetti et al., 2018), aiming at aesthetic improvement (Giannetti et al., 2018; Harika et al., 2016). In hypomineralized molars, the direct application of sealants shows an adequate survival rate, suggesting that they can be used to prevent carious lesions (Fragelli et al., 2017).

The use of desensitizing materials is also reported in the literature. The study developed by Bekes et al., (2017) exposed that the use of desensitizing pastes containing 8% arginine and calcium carbonate associated with a brushing program with the toothpaste of the same composition with additional 1450 ppm fluoride and mouthwash for 8 weeks, demonstrated a reduction of hypersensitivity in molars affected by MIH. Positive sensitivity reduction results were reported immediately and after completion of the study (Bekes et al., 2017).

Some studies indicate the performance of temporary restorations with restorative Glass Ionomer Cement and its clinical and radiographic follow-up, for teeth affected by MIH and cavitated (Fragelli et al., 2015; Grossi et al., 2018; Oliveira; Favretto; Cunha, 2015; Orellana; Pérez, 2017). In the works of Grossi et al., (2018). Direct restorations have their indication the more conservative the preparation of the tooth (Souza et al., 2017). Already indirect restorations such as onlays and steel crowns, are indicated in teeth with large extensions of coronary destruction, in the last case it is advisable that exodontia is

indicated along with orthodontic treatment for rehabilitation of the functional arc (Mathu-Muju; Kennedy, 2016).

Dulla et al., (2021) stated that for treatment of MIH the application of a flowable Glass Ionomer Cement is recommended as an intermediate protection. To stabilize the porosity of the structures of hypomineralized molars, resin infiltration appears to prevent enamel breakage to a greater extent when compared to fluoride varnish (Nogueira et al., 2020). If hypersensitivity persists after the application of a sealant, a direct or indirect restoration should be chosen.

The extent of it will determine whether the tooth is restorable or not, and the treatment of a molar affected by MIH with post-eruptive enamel fracture but no hypersensitivity is determined by the location and size of the defect. If the loss of substance does not occur in the fissure and includes less than 1/3 of the tooth surface, a sealant is recommended. However, if there is a localized loss of substance in the fissure or the size of the defect is greater than 1/3 of the tooth or the defect is close to the pulp, then short-term temporary restoration using GIC with or without orthodontic banding should be the therapy of choice. After the tooth has matured, the temporary filling can be replaced with a permanent restoration. Alternatively, a long-term temporary restoration in the form of a steel crown may also be an option.

IV. CONCLUSION

There are many recommended clinical therapies in recent literature to reduce the difficulties caused by MIH, which are hypersensitivity, post-eruptive fractures, and adhesion difficulty. Laser therapies alone or associated with other modalities with resin infiltration seem to be effective in treating dentin hypersensitivity. Sealants seem to be an alternative to avoid fractures, also the development of dental caries lesions and finally, adhesive materials can be used, although physical and chemical alterations in dental tissues interfere in their efficacy and sometimes indirect restorations can be used with good clinical results. However, further studies are still needed to determine homogeneous and effective clinical protocols for the treatment of molar-incisor hypomineralization.

REFERENCES

[1] Alanzi A., Faridoun A., Kavvadia K., Ghanim A. (2018) Dentists' perception, knowledge, and clinical management of molar-incisor-hypomineralisation in Kuwait: a cross-sectional study. *BMC Oral Health*. 18:34.
 [2] Alves, M.C.O; Camargos, B.S.F; Carvalho, T.A; Machado, F.C. (2021). Clinical protocols in Molar-Incisor

Hypomineralization (MIH): an integrative literature review. *Protocolos Clínicos en la Hipomineralización Molar-Incisivo (MIH): una revisión bibliográfica integradora*. Research, Society and Development, v. 10, n. 13, 1-9. <http://dx.doi.org/10.33448/rsd-v10i13.21605>

- [3] Bekes, K. et al. (2017) Efficacy of desensitizing products containing 8% arginine and calcium carbonate for hypersensitivity relief in MIH-affected molars: an 8-week clinical study. *Clin.Oral Investig.*, Berlin, v. 21, n. 7, p. 2311-2317, Sept.
- [4] Bekes, K; Amend, S; Priller, J; Zamek, C; Tanja, S; Kramer, N. (2021). Changes in oral health-related quality of life after treatment of hypersensitive molar incisor hypomineralization-affected molars with a sealing. *Clinical Oral Investigations*, 25:6449-6454. <https://doi.org/10.1007/s00784-021-03947-z>
- [5] Bezamat, M., Souza, J. F., Silva, F., Corrêa, E. G., Fatturi, A. L., Brancher, J. A., Carvalho, F. M., Cavallari, T., Bertolazo, L., Machado-Souza, C., Koruyucu, M., Bayram, M., Racic, A., Harrison, B. M., Sweat, Y. Y., Letra, A., Studen-Pavlovich, D., Seymen, F., Amendt, B., Werneck, R. I., ... Vieira, A. R. (2021). Gene-environment interaction in molar-incisor hypomineralization. *PloS one*, 16(1), e0241898. <https://doi.org/10.1371/journal.pone.0241898>.
- [6] Crombie FA, Manton DJ, Weerheijm KL, Kilpatrick NM (2008) Molar incisor hypomineralization: a survey of members of the Australian and New Zealand Society of Paediatric Dentistry. *Aust Dent J*.53:160-6
- [7] Dave M, Taylor G. Global prevalence of molar incisor hypomineralisation. *Evid Based Dent*. 2018;19(3):78-9. <https://doi.org/10.1038/sj.ebd.6401324>.
- [8] De Souza J F, Fragelli C B, Jeremias F, Paschoal M A B, Santos-Pinto L, de Cassia Loiola Cordeiro R (2017) Eighteen-month clinical performance of composite resin restorations with two different adhesive systems for molars affected by molar incisor hypomineralization. *Clin Oral Investig* 21: 1725-1733.
- [9] Dhareula A, Goyal A, Gauba K, Bhatia S, Kapur A, Bhandari S. (2019) A clinical and radiographic investigation comparing the efficacy of cast metal and indirect resin onlays in rehabilitation of permanent first molars affected with severe molar incisor hypomineralisation (MIH): a 36-month randomized controlled clinical trial. *EurArchPaediatrDent*. 20; 489-500.
- [10] Domingos PAS, Donato HAR, Nonato CN, Souza EO, Silva VJ. (2019) Molar Incisor Hypomineralization: literature review. *Journal of Research in Dentistry*. 7(1):8-12.
- [11] Dulla J A, Meyer-Lueckel H; (2021) Molar-incisor hypomineralisation: narrative review on aetiology, epidemiology, diagnostics and treatment decision. *Swiss Dent J* 131: 886-895
- [12] Durmus, B; Sezer, B; Tugcu, N; Caliskan, C; Bekiroglu, N; Kargul, B. (2020). Two-Year Survival of High-Viscosity Glass Ionomer in Children with Molar Incisor

- Hypomineralization. *Med Princ Prac.*;30:73–79, 10.1159/000508676.
- [13] Elhennawy K, Schwendicke F. (2016) Managing molar-incisor hypomineralization: a systematic review. *J Dent.* 55:16–24 *European Archives of Paediatric Dentistry.* 23:39–64 <https://doi.org/10.1007/s40368-021-00635-0>
- [14] Farias, L., Laureano, I. C. C., Alencar, C. R. B. de, & Cavalcanti, A. L. (2018). Hipomineralização molar-incisivo: etiologia, características clínicas e tratamento. *Revista De Ciências Médicas E Biológicas*, 17(2), 211–219. <https://doi.org/10.9771/cmbio.v17i2.27435>
- [15] Folyan, M. O., Chukwumah, N. M., Popoola, B. O., Temilola, D.O., Onyejaka, N.K., Oyedele, T.A., Lawal, F.B. (2018). Developmental defects of the enamel and its impact on the oral health quality of life of children resident in Southwest Nigeria. *BMC Oral Health* 18, 160. <https://doi.org/10.1186/s12903-018-0622-3>
- [16] Fragelli C M B, Souza J F, Bussaneli D G, Jeremias F, Santos-Pinto L D, Cordeiro R C L (2017) Survival of sealants in molars affected by molar-incisor hypomineralization: 18-month follow-up. *Braz Oral Res* 31; 30
- [17] Fragelli C M, Souza J F, Jeremias F, Cordeiro R de C, Santos-Pinto L (2015) Molar incisor hypomineralization (MIH): conservative treatment management to restore affected teeth. *Braz Oral Res* 29: S1806-83242015000100271
- [18] Fragelli C. M. B., Souza, J.F., Bussaneli, D.G., Jeremias, F., Santos-Pinto, L., Cordeiro, R.S.L. (2017) Survival of sealants in molars affected by molar-incisor hypomineralization: 18-month follow-up. *Braz. Oral Res.*, São Paulo, v. 31, n. 1, p. 1-9, Apr.
- [19] Fragelli, C., Souza, J. F., Bussaneli, D. G., Jeremias, F., Santos-Pinto, L. D., & Cordeiro, R. (2017). Survival of sealants in molars affected by molar-incisor hypomineralization: 18-month follow-up. *Brazilian oral research*, 31, e30. <https://doi.org/10.1590/1807-3107BOR-2017.vol31.0030>
- [20] Fragelli C.M., Sousa, J.F., Jeremias, F., Cordeiro, R.C.L., Santos-Pinto, L. (2015) Molar incisor hypomineralization (MIH): conservative treatment management to restore affected teeth. *Braz. Oral Res.*, São Paulo, v. 29, n. 1, p. 1-7, June.
- [21] Franzon R, Guimarães LF, Magalhães CE, Haas AN, Araujo FB. (2014) Outcomes of one-step incomplete and complete excavation in primary teeth: a 24-month randomized controlled trial. *Caries Res.* 48; 376–383.
- [22] Gaardmand E, Poulsen S, Haubek D. (2013) Pilot study of minimally invasive cast adhesive copings for early restoration of hypomineralised first permanent molars with post-eruptive breakdown. *Eur Arch Paediatr Dent.* 14:35–39.
- [23] Gamboa GCS, Lee GHM, Ekambaram M, Yiu CKY. (2018) Knowledge perceptions, and clinical experiences on molar incisor hypomineralization among dental care providers in Hong Kong. *BMC Oral Health.* 2018; 217-219
- [24] Gatón-Hernández P, Serrano C R, da Silva L A B, de Castañeda E R, da Silva R A B, Pucinelli C M, Manton M, Ustrell-Torent J M, Nelson-Filho P (2020) Minimally interventive restorative care of teeth with molar incisor hypomineralization and open apex – A 24-month longitudinal study. *Int J Paediatr Dent* 30: 4–10
- [25] Ghanim A, Silva MJ, Elfrink MEC, Lygidakis NA, Mariño RJ, Weerheijm KL, Manton DJ (2017) Molar incisor hypomineralisation (MIH) training manual for clinical field surveys and practice. *Eur Arch Paediatr Dent.* 18:225–242.
- [26] GIANNETTI, L. et al. (2018) Deep infiltration for the treatment of hypomineralized enamel lesions in a patient with molar incisor hypomineralization: a clinical case. *J. Biol. Regul. Homeost. Agents.*, Milano, v. 32, n. 3, p. 751–754, May/June
- [27] Grossi J A, Cabral R N, Ribeiro A P D, Leal S C (2018) Glass hybrid restorations as an alternative for restoring hypomineralized molars in the ART model. *BMC Oral Health* 18: 65
- [28] HARIKA, R. et al. (2016) A novel clinical approach for long-term retention and durability of resin restorations bonded to multiple developmental defects of enamel. *J. Int. Soc. Prev. Community Dent.*, Mumbai, v. 6, n. 6, p. 597–601, Nov./Dec.
- [29] Jälevik B, Klingberg GA. (2002) Dental treatment, dental fear and behaviour management problems in children with severe enamel hypomineralization of their permanent first molars. *Int J Paediatr Dent.* 12; 24– 32.
- [30] Koch M J, García-Godoy F. (2000) The clinical performance of laboratory-fabricated crowns placed on first permanent molars with developmental defects. *J Am Dent Assoc* 131: 1285–1290.
- [31] Koleventi A, Sakellari D, Arapostathis KN, Kotsanos N. (2018) periodontal impact of preformed metal crowns on permanent molars of children and adolescents: a pilot study. *Pediatr Dent.* 40; 117–121.
- [32] Kotsanos N, Kaklamanos EG, Arapostathis K. (2005 a) Treatment management of first permanent molars in children with Molar-Incisor Hypomineralisation. *Eur Arch Paediatr Dent.* 4:179–184.
- [33] Kotsanos N, Kaklamanos EG, Arapostathis K. (2005 b) Treatment management of first permanent molars in children with Molar-Incisor Hypomineralisation. *Eur J Paediatr Dent.* 6; 179–184.
- [34] Krishnan R, Ramesh M. (2014) Molar incisor hypomineralisation: A review of its current concepts and management. *SRM J Res Dent Sci.* 5:248-52.
- [35] Lacruz, R. S., Habelitz, S., Wright, J. T., & Paine, M. L. (2017). Dental enamel formation and implications for oral health and disease. *Physiological reviews*, 97(3), 939–993. <https://doi.org/10.1152/physrev.00030.2016>
- [36] Leite, L.C. Prevalence of Incisor Molar Hypomineralization in Bragantine children from 6 to 8 years old. (2020). 16 f. TCC (Graduation) - Dentistry Course, Universidade São Francisco, Bragança Paulista, 2020.

- [37] Linner T, Khazaei Y, Bücher K, Pfisterer J, Hickel R, Kühnisch J (2020) Comparison of four different treatment strategies in teeth with molar-incisor hypomineralization-related enamel breakdown – A retrospective cohort study. *Int J Paediatr Dent* 30: 597–606
- [38] López Jordi, M. D. C., Cortese, S. G., Álvarez, L., Salveraglio, I., Ortolani, A. M., & Biondi, A. M. (2014). Comparison of the prevalence of incisor molar hypomineralization in children with different health care coverage in the cities of Buenos Aires (Argentina) and Montevideo (Uruguay). *Saúde Coletiva Lanús*, 10 (2), 243-251.
- [39] Lygidakis NA, Dimou G, Stamataki E. (2009) Retention of fissure sealants using two different methods of application in teeth with hypomineralised molars (MIH): a 4-year clinical study. *Eur Arch Paediatr Dent*. 10; 223–226.
- [40] Lygidakis NA, Wong F, Jälevik B, Vierrou A-M, Alaluusua S, Espelid I. (2010) Best clinical practice guidance for clinicians dealing with children presenting with molar-incisor-hypomineralisation (MIH): an EAPD policy document. *Eur Arch Paediatr Dent*; 11:75–81.
- [41] Maltz, M., Jardim J.J., Mestrinho H.D., Yamaguti P.M., Podestá K., Moura M.S., Paula, L.M. (2013) Partial removal of carious dentine: a multicenter randomized controlled trial and 18-month follow-up results. *Caries Res*. 47; 103–109.
- [42] Mathu-Muju, k. R.; Kennedy, D.B. (2016) Loss of permanent first molars in the mixed dentition: Circumstances resulting in extraction and requiring orthodontic management. *Pediatr Dent.*, Chicago, v. 38, n. 5, p. 46-53, Oct.
- [43] McCaferty J, O'Connell AC. (2016) A randomized clinical trial on the use of intermediate bonding on the retention of fissure sealants in children. *Int J Pediatr Dent*. 26:110–115.
- [44] Muñoz, C.S; Beneyto, Y.M; Silva, A.P; Pascual, A.P; López, F.J.I; Ruiz, A.J.O. (2020). Perception, knowledge, and attitudes towards molar incisor hypomineralization among Spanish dentists: a cross-sectional study. *BMC Oral Health*. 20, 2-10. <https://doi.org/10.1186/s12903-020-01249-6>
- [45] Nogueira, V.K.C., Mendes Soares, I.P., Fragelli, C.M.B., Boldieri, T., Manton, D.J., Bussaneli, D.G., Cordeiro, R.C.L. (2020) Structural integrity of MIH-affected teeth after treatment with fluoride varnish or resin infiltration: An 18-Month randomized clinical trial. *J Dent* 29: 105: 103570
- [46] Ochoa, D.A., Contreras, I.R., Melendez, J.D., & Vidal, P.S. (2017). Abordaje Terapéutico de la Hipomineralización Molar - Incisal. *Revisión Narrativa. International journal of odontostomatology*, 11, 247-251. DOI:10.4067/S0718-381X2017000300247
- [47] Oh N, Nam S, Lee J, Kim H. (2020) Retrospective study on the survival rate of preformed metal crowns in permanent first molars. *Journal of the Korean Academy of Pediatric Dentistry*. 47; 140–147.
- [48] Oliveira, D.C.; Favretto, C.O.; Cunha, R.F. (2015) Molar incisor hypomineralization: Considerations about treatment in a controlled longitudinal case. *J. Indian Soc. Pedod. Prev Dent.*, Chandigarh, v. 33, n. 2, p. 152- 155, Apr./June
- [49] Orelanna, C.; Pérez, V. (2017) Modified glass ionomer and orthodontic band: an interim alternative for the treatment of molar incisor hypomineralization. A case report. *J. Oral Res.*, Concepción, v. 6, n. 3, p. 70-74, Mar.
- [50] Rolim, T., da Costa, T., Wambier, L. M., Chibinski, A. C., Wambier, D. S., da Silva Assunção, L. R., de Menezes, J., & Feltrin-Souza, J. (2021). Adhesive restoration of molars affected by molar incisor hypomineralization: a randomized clinical trial. *Clinical oral investigations*, 25(3), 1513–1524. <https://doi.org/10.1007/s00784-020-03459-2>
- [51] Schraverus, M. S., Olegário, I. C., Bonifácio, C. C., González, A., Pedroza, M., & Hesse, D. (2021). Glass Ionomer Sealants Can Prevent Dental Caries but Cannot Prevent Post-eruptive Breakdown on Molars Affected by Molar Incisor Hypomineralization: One-Year Results of a Randomized Clinical Trial. *Caries research*, 55(4), 301–309. <https://doi.org/10.1159/000516266>
- [52] Schwendicke F, Elhennawy K, Reda S, Bekes K, Manton DJ, Krois J. (2018) Global burden of molar incisor hypomineralization. *J Dent*. 68:10–8. <https://doi.org/10.1016/j.jdent.2017.12.002>. Erratum. In: *J Dent*. 2019 Jan; 80:89-92.
- [53] Schwendicke, F., Elhennawy, K., Reda, S., Bekes, K., Manton, D. J., & Krois, J. (2018). Global burden of molar incisor hypomineralization. *Journal of dentistry*, 68, 10–18. <https://doi.org/10.1016/j.jdent.2017.12.002>
- [54] Shrestha R, Upadhaya S, Bajracharya M. (2014) Prevalence of molar incisor hypomineralisation among school children in Kavre. *Kathmandu Univ Med J (KUMJ)*. 12:38-42.
- [55] Silva MJ, Alhwaish L, Ghanim A, Manton DJ. (2016) Knowledge and attitudes regarding molar incisor hypomineralisation amongst Saudi Arabian dental practitioners and dental students. *Eur Arch Paediatr Dent*. 17:215–22
- [56] Smith, C.E.L., Poulter, J.A., Antanaviciute, A., Kirkham, J., Brookes, S.J., Inglehearn CF and Mighell AJ (2017) Amelogenesis Imperfecta; Genes, Proteins, and Pathways. *Front. Physiol*. 8:435. DOI: 10.3389/fphys.2017.00435.
- [57] Somani, C; Taylor, G.D; Garot, E; Rouas, P; Lygidakis, N.A; Wong, F.S.L. (2022). An update of treatment modalities in children and adolescents with teeth affected by molar incisor hypomineralisation (MIH): a systematic review.
- [58] Sönmez H, Saat S (2017) A Clinical Evaluation of Deproteinization and Different Cavity Designs on Resin Restoration Performance in MIH-Affected Molars: Two-Year Results. *J Clin Pediatr Dent* 41: 336–342.
- [59] Souza, J. F., Fragelli, C.B., Jeremias, F., Paschoal, M.A.B., Sousa-Pinto, L., Coderio, R.C.L. (2017) Eighteen-month clinical performance of composite resin restorations with two different adhesive systems for molars affected by molar incisor hypomineralization. *Clin Oral Investig.*, Berlin, v. 21, n. 5, p. 1725-1733, June
- [60] Vieira, L., Paschoal, M., de Barros Motta, P., Ferri, E. P., Ribeiro, C., Dos Santos-Pinto, L., Motta, L. J., Gonçalves,

M., Horliana, A., Fernandes, K., Ferrari, R., Deana, A. M., & Bussadori, S. K. (2019). Antimicrobial photodynamic therapy on teeth with molar incisor hypomineralization-controlled clinical trial. *Medicine*, 98(39), e17355. <https://doi.org/10.1097/MD.00000000000017355>

- [61] Weber, K.R; Wierichs, R.J; Luckel, H.M; Flury, S. (2021). Restoration of teeth affected by molar-incisor hypomineralisation A systematic review. *SWISS DENTAL JOURNAL SSO*, 131, 988-997.
- [62] Zagdwon AM, Fayle SA, Pollard MA. (2003) A prospective clinical trial comparing preformed metal

Reliability analysis of reinforced concrete slabs designed according to NBR 6118

Carlos Henrique Hernandorena Viegas¹, Mauro de Vasconcellos Real²

¹Engineering School, Federal University of Rio Grande - FURG, Brazil

Email: chviegas@furg.br

²Engineering School, Federal University of Rio Grande- FURG, Brazil

Email: mauroreal@furg.br

Received: 20 Jun 2022,

Received in revised form: 15 Jul 2022,

Accepted: 21 July 2022,

Available online: 27 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *non-linear analysis, slabs,
reinforced concrete, finite element
method, ANSYS.*

Abstract— *NBR 6118 (2014) is the Brazilian standard that guides the design of reinforced concrete structures and adopts semi-probabilistic methods as a reference. These establish safety criteria that confront internal forces resulting from actions, increased by majoring coefficients, with the characteristic strengths of steel and concrete materials also reduced by minoring coefficients so that the former is equal to or less than the latter ($S_d \leq R_d$). However, unlike the Brazilian standard, the international standards determine the calibration of these coefficients through probabilistic methods. This calibration is a factor of paramount importance concerning the measurement of the risk of the structure. It is known that the material's properties present a certain level of dispersion. Depending on the workmanship quality, there are also uncertainties regarding the geometry of the structural parts. Furthermore, the actions in the structure show considerable variation throughout its useful life. In this context, one of the objectives of this work was to determine the reliability of reinforced concrete slabs designed according to NBR 6118 (2014), with loads determined by the recently updated standard NBR 6120 (2019), through a probabilistic analysis using a Finite Element numerical model and through a non-linear analysis. For this, the proposed study addresses the determination of resistance, represented by a theoretical distribution adjusted from simulations generated by the Monte Carlo Method using the ANSYS software. The reliability indices were obtained using the FORM method. As a result, it was possible to verify that most slabs are above the reliability indices indicated as acceptable by the American standard ACI 318 (2014). In addition, the significant influence of the variable loading on the results was confirmed due to its great variability.*

I. INTRODUCTION

It is necessary that Brazilian standards, like European and American standards, can be calibrated in the light of the Reliability Theory. However, it is known that there is a lack of studies that make this feasible.

Some studies point out that the behavior of reinforced concrete structures is complex due to its non-linearity, generating uncertainties in its approach in studies and designs. Thus, the probabilistic analysis presents an excellent way to investigate the safety margin of structures as a function of their failure probability [1].

Santiago (2019) presented a reliability-based calibration of the partial safety factors of Brazilian standards used in the design of steel and concrete structures. About reinforced concrete structures, the study addressed reinforced concrete beams subjected to bending, reinforced concrete beams subjected to shear, reinforced concrete columns subjected to normal bending-compression, and reinforced concrete slabs subjected to bending. The work contributed to statistically adjusting the main random variables of resistance and load associated with both metallic and reinforced concrete structures in Brazil. However, the authors emphasize the need for more work to support reviewing the safety coefficients in force [2].

The safety of a structure must be linked to the reliability that indicates its probability of failure - preferably low - taking into account the ultimate and service limit states. It can be said, then, that the Reliability Theory considers it essential to assess the uncertainty linked to all the variables involved in the safety and performance of the structure to obtain knowledge of the probability of failure corresponding to its limit states. [3].

Among the methods used for this type of study, the most accurate is the Finite Element Method (FEM), which presents the best prediction of behavior and failure for a reinforced concrete structure [4]. The FEM is the most used tool for engineering modeling and analyzing structures with non-linear behavior. The use of this type of analysis results, in contrast to experimental models, in the possibility of not having to use a large number of physical models, saving considerable financial and material resources [5].

The loading variables (actions) are divided into permanent and variable, and it is assumed that they must be present during all or part of the service life of the structures. It is important to predict the loads acting on a structure precisely. The loads' characteristics and variability are fundamental parameters in reliability analysis. That is, a reliable database conducts a good statistical analysis. [6]. In this sense, it is worth noting that the Brazilian standard NBR 6120 - Actions for the Calculation of Building Structures had its last revision in 2019 [7], so its evaluation from the perspective of the Reliability Theory should be desirable and necessary.

The purpose of this research is the numerical study of the reliability of reinforced concrete slabs subjected to bending designed according to the NBR 6118 [8], using a non-linear analysis employing the Finite Element Method and taking into account loadings recommended by NBR 6120, updated in 2019. The numerical model used was

validated, and more information can be found in Viegas et al. [9].

II. METHODOLOGICAL STRATEGY

With the proper performance of this model, it is possible to obtain the resistant capacity of slabs designed according to the NBR 6118 (2014) standard. ANSYS has a handy platform called APDL (Ansys Parametric Design Language) so that the user can add routines - in a programming language similar to Fortran 77 - together with pre-existing computational models of the software. The used model was validated by comparing the model's rupture load with data from experimental slab tests.

The model was developed and used for rectangular slabs simply supported on the four edges. The slab strength statistics and distributions were determined by the Monte Carlo method, which is available in the ANSYS software through the Probabilistic Design System (PDS) tool. The main random variables related to geometry and material properties are considered in the process and represented by probability distributions [8].

For the reliability study, the FORM transformation method (First-Order Reliability Method) and the Monte Carlo simulation method were used, with the algorithms implemented in Python software. The resistance obtained as a function of the Ultimate Bending Limit State determines the model's safety margin. This analysis is accomplished using the numerical model, and the actions composed in each combination are determined through the Brazilian norms [7] and [10]. Finally, the reliability indices obtained in this work were analyzed with the target reliability indices indicated by international standards, in addition to a parametric study that stated the main design parameters which influenced the variation of reliability indices. The rupture model implemented was the one present in recent versions of ANSYS called Drucker Prager Rankine (DP-Rankine). For the reliability analysis, slabs with dimensions of 400x400cm, 500x500cm, 600x600cm, a minimum thickness of 10 cm and increased accordingly to design were used; and, for f_{ck} of 25, 50, and 70 MPa. The loading variation, $q_k/(g_k+q_k)$, will be 0.25, 0.5, and 0.75, where: q_k is the characteristic variable loading, and g_k is the characteristic permanent loading.

III. STRUCTURAL RELIABILITY

Structural reliability deals with the ability of a structure to fulfill the structural function for which it was designed, associated with a certain risk. For this, the so-called degree of confidence is used, measured through the probability of non-failure ($1-P_f$), where P_f is the failure probability.

Thus, each model developed to analyze structures must consider the structural behavior as accurately as possible through a specified set of basic variables. Among them, we can mention the weight of materials, dimensions, influences of loads, and environmental actions, as well as parameters of the model itself and other structural requirements. The fact is that most of these variables are more or less random depending on their nature, and thus it is almost impossible to create an exact model for them. This way, simplifications are used through probability distributions of some parameters, transforming the analysis result into a random variable [11].

This way, for structures to be designed to fulfill their predetermined functions throughout their useful life, they must meet safety requirements. At the same time, they must be economically viable. One of the ways used to achieve these requirements of a technical nature is the so-called Limit States method.

In this direction, for reinforced concrete elements, the design and analysis must be based on: Ultimate Limit States - which deal with the collapse conditions of the structure - and Service Limit States - which deal with their conditions of use involving durability, functionality, comfort, among others. Any of these limit states make the use of the structure unfeasible. [12].

In this way, the degree of confidence is measured considering the physical and design uncertainties, and, for this purpose, it uses, among others, physical, mathematical, and statistical models. Thus, the uncertainties in engineering projects can be classified as intrinsic when related to physical, chemical, and biological phenomena of nature; epistemic, when associated with the knowledge of system variables as well as situational processes; and human error, which, through training, can be avoided or reduced considerably. In the study of structure reliability, several efficient techniques exist to estimate these uncertainties [12].

In addition, it is necessary to specify the performance function for the safety and failure regions in the design variable space. Then, the probability distributions are integrated using numerical integration or simulation techniques. One of the possible methods for this calculation is the Monte Carlo method [13].

The Monte Carlo method was presented in 1949 through the article "The Monte Carlo Method," developed by mathematicians John Von Neumann and Stanislaw Ulam. The technique aims to simulate the response of functions of random variables through deterministic values of these variables in each simulation cycle [14].

IV. BASIC RELIABILITY PROBLEM

The reliability study combines all load and resistance distribution functions and a performance function that will characterize the safety and failure region. In this way, this is accomplished through the integration of the probability density function over the failure region.

According to [13], reliability considers a load effect, S , resisted by a resistance, R , where a probability distribution represents each, namely: f_S and f_R . This way, S can be determined from the applied load or set of resulting internal forces of structural analysis. A structural element fails when its strength R is less than the stress resulting from load S . So, the probability of failure is given by:

$$pf = P\{S \geq R\} \quad (1)$$

V. LIMIT STATE FUNCTIONS

According to [12], limit state functions, also called performance functions, constitute one of the first situations to be established in the scope of structural reliability and follow a "margin of safety" style approach involving two statically independent random variables of normal distribution. If (R) represents the resisting capacity and (S) represents the load, the performance function is a failure condition. Thus, the limit state function can be defined by Equation 2 and presented in Fig. 1.

$$G(R, S) = R - S \quad (2)$$

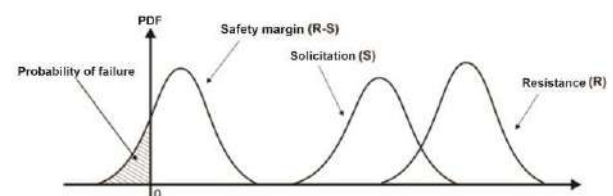


Fig.1: Function of request probability density, resistance, and safety margin. Adapted from [15]

The safety parameters related to the failure of the structure are directly linked to the Ultimate Limit State, where the load intensity (S) must always be below the resistance intensity (R). The probability of failure is equal to the likelihood of non-compliance with the analyzed Limit State and is given by Equation 3:

$$P[G(R, S) \leq 0] \quad (3)$$

Thus, if R and S are configured as random variables, each one has a probability function, all of which are configured as random variables. In Fig. 2, the equations are represented by the failure domain (hatched region) $G < 0 = D$, so that the failure probability can be described

as

$$P_f = P(g(x) \leq 0) = P(R - S \leq 0) = \int_D \int f_{RS}(r,s) dr ds \tag{4}$$

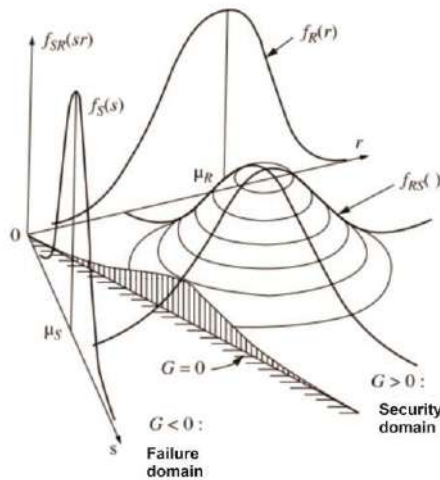


Fig.2: Space of two random variables (r,s) and the joint density function $f_{RS}(r,s)$, of the density functions f_R and f_S and a failure domain D given by $G < 0$. Adapted from [16]

Target reliability index β_0

The target reliability index, β_0 , is the reference index suggested in several standards to compare the index obtained in the reliability analysis. Thus, the target reliability index is the value indicated by different codes for each type of element and internal forces or simply for the Limit State.

Since NBR 6118 [8] does not present reliability studies or references for such, international codes must be adopted to be used as a reference to obtain a target reliability index. There are at least three critical standards that address the subject, namely: ACI 318 (2014), EUROCODE, and CEB-FIP/MC (2010) [16].

In this study, the reference value stipulated by the American standard ACI 318 [17] will be used as it is the only one to present values referring to the type of structural element analyzed, in this case, reinforced concrete slabs subjected to bending (Tab. 1).

Table 1: Acceptable values for the parameter (β). Adapted from [17]

Element	Acceptable β parameter
Pillars	3.8
Beams	3.3
Slabs subject to bending	2.5
Slabs subjected to punching	2.5 a 3.0

VI. FORM TRANSFORMATION METHOD

The first order analytical method FORM (First Order Reliability Method) is proposed as an evolution of the FOSM method (First Order Second Moment), where the restriction to the second moment of the variables is removed. The technique employs an idealization of a joint probability distribution function, transforming this distribution into a multivariate reduced normal [13]. One of the changes regarding the FOSM occurs due to the restriction of the second-moment method to only the normal probability distribution for the random variables. At the same time, the FORM can be integrated with other probability distribution analyses, as well as the linear correlation between the variables of the problem. The method approximates the failure surface in a reduced space at the design point as a truncated linear failure surface in the first order of the Taylor series [15].

The use and acceptance of the FORM as an efficient and effective method has been widely reported in the literature in general and recommended by the JCSS (Joint Committee on Structural Safety) [19].

The method is based on transforming a vector of random variables of a group $X = (X_1, X_2, \dots, X_n)$, of a real space in a group of statistically independent, normalized, and standardized random variables represented by X' . And, still, they can be constituted by any probability functions, with or without correlation between them, and the accumulated probability function $F_{X_i}(x_i)$, para $i=1,2,\dots,n$,

Thus, it is shown that the minimum distance between the origin of the standardized coordinate system and the point with the highest failure probability on the tangent plane to the surface $g(X')=0$ corresponds to the reliability index. β (Fig. 3) [20].

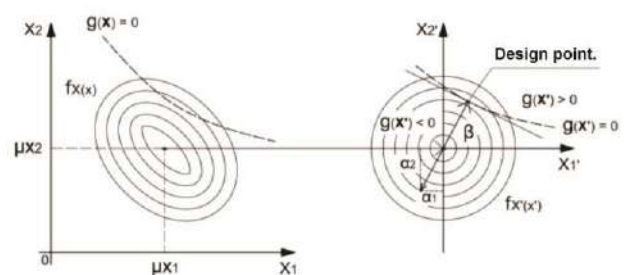


Fig.3: The reliability index and the uncorrelated standardized normal system transformation. Source: [16] adapted from [19]

VII. PDS AND THE MONTE CARLO METHOD

Ansys contains a module called PDS (Probabilistic Design System) for probabilistic studies. The Monte Carlo Simulation Method or the Response Surface can be

chosen, where a parameterized model can be determined by defining a group of input variables with their probability distributions. [21].

The Monte Carlo method is defined by randomly generating a number N of values for input variables of the model from their respective theoretical probability distributions. Several distributions can be pre-established for variables such as Beta, Exponential, Gamma, Lognormal, Normal, Triangular, Uniform, and Weibull [21].

In addition, it is possible to work with the techniques of direct sampling, Latin-Hypercube sampling, and custom sampling. In direct sampling, it imitates natural processes given by the random generation of values according to their probability distributions. In this case, there is no control over the proximity of values. For Latin-Hypercube sampling, domains of variables are segmented into equiprobable intervals. Only one sample is generated for these intervals, not repeating the interval for the subsequent simulations. The statistical convergence of the results is accelerated using a "memory" of the generation of sample points, guaranteeing the non-generation of nearby points and covering the probability domain of the variable as a whole [22].

VIII. ALGORITHM FOR DETERMINING RELIABILITY

One of this work's objectives is to determine the reliability of the slabs studied; then, a parametric study was carried out. Thus, the FORM transformation method determined the reliability indices and the corresponding failure probability.

For implementing these methods, Python software was used through a computational routine to determine the reliability developed by [23] in open source, based on the model presented by [12]. The routine for use in Python is available for download in the domain <https://github.com/mvreal/Reliability>.

This routine is adapted from the algorithms of Hasofer and Lind, Rackwitz, and Fissler (HLRF), developed exclusively for solutions of optimization problems in structural reliability based on the approximation of a limit state by a hyperplane.

According to [12], solutions to non-linear reliability problems involving limit state equations converge to determine a design point. For this, any possibility can have the ability to find the design point. Concisely, a joint probability distribution function must be developed and perform the transformation to a multivariate normal distribution.

Basically, within the GitHub domain, it is possible to download the routines and some examples of application tests. The essential files for the routine execution consist of the *realpy.py* Python class and one of the *example.py* files containing the input routine.

The algorithm considers the possibility of random variables following the normal, uniform, lognormal, Gumbel, Fréchet, and Weibull distributions. This way, the routine was implemented using the Nataf transformation model because it is a practical method.

The model aims to transform the workspace from the design space (Fig. 4a) in three steps: Transforming distributions into equivalent normal probability distributions; introducing the equivalent normal correlation coefficients in a reduced correlated space (Fig. 4b), and finally, eliminating the correction between the variables, resulting in a reduced uncorrelated space (Fig. 4c) [24].

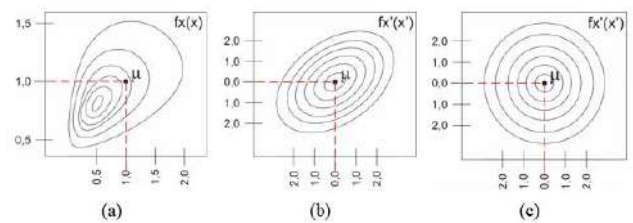


Fig.4: Space transformation by the Nataf model. Adapted from [24]

The principle of normal approximation for probability distributions was based on [25], which aims to find an equivalent normal distribution for the point x_i^* , conserving the probability characteristics of the original distribution considering parameters of the equivalent mean (μ_{xeq}) and equivalent standard deviation (σ_{xeq}). To determine these equivalent parameters, it is necessary to solve a system of two equations for two unknowns (Equation 5 and 6), where [26] suggest that for the point x^* , the probability function (FDP) and the accumulated probability function (FDPA) must have the same value.

$$\Phi\left(\frac{x^* - \mu_{xi}^{eq}}{\sigma_{xi}^{eq}}\right) = F_X(x^*) \tag{5}$$

$$\frac{1}{\sigma_{xi}^{eq}} \phi\left(\frac{x^* - \mu_{xi}^{eq}}{\sigma_{xi}^{eq}}\right) = f_X(x^*) \tag{6}$$

From this, these equations in analytical format for the average and standard deviation of the equivalent normal distribution can be represented by:

$$\mu_X^{eq} = x^* - \Phi^{-1}[F_X(x^*)]\sigma_X^{eq} \tag{7}$$

$$\sigma_x^{eq} = \frac{\phi\{\Phi^{-1}[F_X(x^*)]\}}{f_X(x^*)} \tag{8}$$

One of the difficulties in implementing the algorithm is that the transformation procedure has to be performed individually for each of the marginal distributions, valid for a point x^* . From this, it is necessary to verify the correlation coefficients between pairs of variables since, from the development of the normal approximation, random variables of normal joint distribution with original correlations are produced [24].

Thus, to correct the correlations of the variables, the model of Liu e Der Kiureghian [25], where, through the implementation of the Nataf model to determine correlation adjustment factors (r) from non-normal to normal distributions (ρ to ρ_{eq}) [12] The transformation equation is:

$$r_{X,Y} = \frac{\rho_{X,Y}^{eq}}{\rho_{X,Y}} \tag{9}$$

To reach the uncorrelated reduced space, there are two ways: using the eigenvectors of the covariance matrix or Cholesky decomposition. In the algorithm in question, the second option was used.

Also, the transformation method uses an iterative process, where at each cycle, it is necessary to restructure the covariance matrix through the equation:

$$COV = \sigma^{eq} \cdot \rho^{eq} \sigma^{eq} \tag{10}$$

By applying the Cholesky decomposition, the matrix is rewritten according to equation 11:

$$COV = L \cdot L^T \tag{11}$$

Where L is a lower triangular matrix.

Then, through Equation 12, there is the vector of uncorrelated reduced variables.

$$x' = L^{-1} \cdot (x - \mu^{eq}) \tag{12}$$

Subsequently, through the results found for the mean and equivalent standard deviation, the procedures of the FOSM method (first order and second-moment method) are used. And, getting the new design point in the reduced space, it transforms from the reducing space to the design space through the equation:

$$x = \mu^{eq} + L \cdot x' \tag{13}$$

Determining reliability (Hasofer, Lind, Rackwitz, and Fissler Algorithm)

The improved Hasofer, Lind, Rackwitz, and Fissler algorithm (iHLRF) was used to calculate the reliability index in the FORM method. Solutions of reliability

problems can be developed through an optimization problem to determine the design point by approximating the limit state equation by a tangent hyperplane. (Fig. 5).

According to [12], HLRF presents some convergence problems in cases that are too non-linear. However, it is widely used due to its simplicity, although it does not obtain a guarantee of convergence.

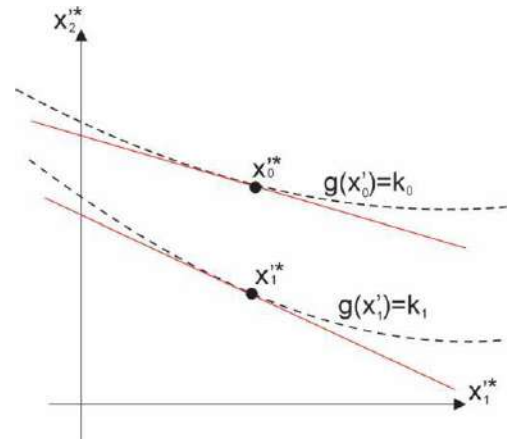


Fig.5: Iteration process that determines the design point. Adapted from [27]

For HLRF to be implemented, it is necessary to execute the recursive equation through x'_{k+1} by Equation 14. Where x'_k is the vector destined for iteration by checking in the reduced space where the iterative process presents convergence (without guarantees) at the point of $g(x'_k) \cong 0$ e $x'_{k+1} \cong x'_k$.

$$x'_{k+1} = \frac{\nabla g(xk')}{\|\nabla g(x_k)\|^2} [\nabla g(x'_k)^T \cdot x'_k - g(x'_k)] \tag{14}$$

An improvement was suggested based on the HLRF algorithm by adding the letter "i" to the name "improved" (iHLRF). The central idea is to use the original algorithm to find an optimal step (λ_k), which minimizes a previously defined merit function in the direction indicated by the HLRF in Equation (15). and getting a new point by Equation (16) [28].

$$d_k = x'_{k+1} - x'_k = \frac{\nabla g(xk')}{\|\nabla g(x_k)\|^2} [\nabla g(x'_k)^T \cdot x'_k - g(x'_k)] - x'_k \tag{15}$$

$$x'_{k+1} = x'_k + \lambda_k d_k \tag{16}$$

This function guarantees convergence by determining the value of penalties (c) of the merit function through the condition presented in Equation (17) and adopting $\gamma = 2$ (serves to meet the penalty condition) and δ the tolerance

for $\mathbf{g}(x'_k) = \mathbf{0}$, being x'_k the design point. The direction of d_k is the descent direction of the merit function [12; 28].

$$m(x'_k) = \frac{1}{2} \|x'_k\|^2 + c|g(x'_k)| \tag{17}$$

$$c = \gamma \max \left[\frac{\|y_k\|}{\|\nabla g(x'_k)\|'^2}, \frac{1}{2} \frac{\|y_k + d_k\|}{|g(x'_k)|} \right] \tag{18}$$

$$c = \gamma \left[\frac{\|y_k\|}{\|\nabla g(x'_k)\|} \right]$$

Armijo's rule [29] is then used for the linear search of the optimal step (λ_k) through Equation (19). Typical values for these parameters are $a=0.1$; $b=0.5$ in addition to the already mentioned $\gamma=2$ [12].

$$\lambda_k = \max_{n \in \mathbb{N}} [b^n |m(x'_k + b^n \cdot d_k) - m(x'_k)| \leq -a \cdot b^n \cdot \nabla m(x'_k)^T \cdot d_k] \tag{19}$$

The reliability index is obtained at the design point when $\beta = \|x^*\|$ in the moment that $x' = x'_{k+1}$.

Table 2: Summary of slab design result.

SLAB	fck(MPa)	Lx(m)	Ly(m)	h(m)	Direction X		Direction Y	
					ϕ(mm)	S(cm)	ϕ(mm)	S(cm)
L1	25	4	4	0.1	6.3	10	6.3	10
L2	25	5	5	0.12	6.3	7	6.3	7
L3	25	6	6	0.15	6.3	6	6.3	6
L4	50	4	4	0.1	6.3	10	6.3	10
L5	50	5	5	0.1	6.3	6	6.3	6
L6	50	6	6	0.13	6.3	6	6.3	6
L7	70	4	4	0.1	6.3	10	6.3	10
L8	70	5	5	0.1	6.3	6	6.3	6
L9	70	6	6	0.13	6.3	6	6.3	6

From this, five random variables were previously determined, namely the compressive strength of the concrete (fc), the yield strength of the steel (fy), the spacing between bars (esp), the slab thickness (h), and the covering of the reinforcing bars (cobr).

With the code calibrated with the ANSYS PDS tool, the Monte Carlo simulation method was used for the slabs from L1 to L9.

IX. RESULTS AND PROBABILISTIC STUDY OF REINFORCED CONCRETE SLABS

Simulations were performed with nine (9) slabs, designed according to NBR 6118 (2014). For loading, the element's self-weight was adopted as a permanent load, in addition to a floor load of 1 kN/m² traditionally used in projects. As the variable loading, a fixed load of 6 kN/m² was used, stipulated by the NBR 6120 (2019) standard as the minimum for a room used as a library. This load was chosen because it is one of the largest of the standard in question. With the proper sizing of all slabs, it was possible, through the ANSYS software, to determine the rupture loads for each slab using the Monte Carlo simulation method divided into eight cycles of 50 simulations.

The nine slabs chosen for the analysis were named from L1 to L9 with variations of spans of 4x4, 5x5, and 6x6 meters. The diameter of the steel bars was fixed at 6.3mm. The spacing of the bars (esp) and thickness (h) of the slab varies according to the design according to NBR 6118 (2014). A summary of the design of these slabs is presented in Tab 2.

Monte Carlo simulation

The Monte Carlo Method was limited to 400 simulations per slab divided into eight cycles of 50 simulations each. Still, as a result, it was possible to request the "print" of a vector referring to the rupture load of the structural element for each simulation, as well as the values used in the random variables in each simulation (Fig. 6)

ANALISEPROBLAJE						
ITER	CYCL	LOOP	ERR	FC	FY	ESP
1	1	1	0	5.504749554e+00	4.336034481e+01	6.093570681e+00
1	1	2	0	6.029637797e+00	4.718144176e+01	6.052757049e+00
1	1	3	0	6.743018692e+00	4.678735236e+01	6.825335005e+00
1	1	4	0	7.217305913e+00	5.135050769e+01	6.457376383e+00
1	1	5	0	6.104241360e+00	5.157433117e+01	5.596489922e+00
1	1	6	0	8.939901106e+00	5.049440866e+01	5.923964609e+00
.
.

H	COBR	PR
1.238720882e+01	1.782014847e+00	8.341514772e+02
1.258883066e+01	1.936276412e+00	7.995624691e+02
1.365046157e+01	1.733019024e+00	8.259686553e+02
1.289826629e+01	2.064282981e+00	9.651382588e+02
1.269469113e+01	2.281103626e+00	9.572603914e+02
1.299880918e+01	2.024159698e+00	8.217206520e+02
.	.	.
.	.	.

Fig.6: PDS tool printing the results for the Monte Carlo Method.

Through this set of rupture load values, it is then possible to obtain a normal probability distribution adjustment, determining the mean, the standard deviation, and the coefficient of variation, transforming the resistance function into a random variable. From this, one can then determine the performance function as being

$$g(R, g, q) = R - g - q = 0 \tag{20}$$

Where R is the slab-resistance function, g is the permanent load, and q is the variable load.

Model error estimation

The random variables chosen are intrinsic to the strength of the materials and the loads imposed on the slabs. However, it is essential to analyze the inherent uncertainties of the resistance and loading model attributed in this work, named eM and eS. The main objective of these variables is to assess uncertainties related to any randomness or numerical simplification present in the model[18]. Thus, eS is assigned a unit mean with a standard deviation of 0.05; that is, the coefficient of variation is also 0.05. The eM can be calculated according to some works in the literature. In this sense, the model error estimation was verified following the guidelines presented in [30].

There are distortions in the experimental and theoretical results due to situations that can be influenced by the computational numerical model, by the variability of the random variables of the system, or even by the variability associated with the experimental activity. Thus, to estimate the model error, it is used the following equation:

$$\left(\frac{V_\epsilon}{m} \right)^2 = V_m^2 + V_{batch}^2 + V_{test}^2 \tag{21}$$

Where $V_{e/m}$ is the coefficient of variation of the ratio between the experimental results and the numerical model; V_m is the coefficient of variation of the model error; V_{batch} is the coefficient of variation of the laboratory tests of the system variables represented by the dimensions and strengths and V_{test} the coefficient of variation of the slab experiments.

Through the results obtained in the validation of the model, the value of $V_{e/m} = 0.0886$ was obtained. As for the V_{test} , it is defined that $V_{test} = 0.02$ should be used for elements subjected to bending. Finally, 400 Monte Carlo simulations were performed for one of the slabs used in the model validation to determine the lot variation coefficient. For this simulation, a coefficient of variation of the concrete compressive strength of 0.05 was adopted, and for the steel yield strength, a value of 0.02 was considered. As a result, $V_{batch} = 0.0404$ was obtained. These considerations resulted in a value of $V_m = 0.0763$.

It is then possible to consider these results for the reliability analysis, updating Equation (20) to:

$$g(R, g, q) = R * (eM) - (g - q) * (eS) = 0 \tag{22}$$

Furthermore, the model error is identified by a normal distribution of the unitary mean value. Using the result of the model error calculation, $V_m = 0.0763$, and the mean $\mu M = 1.00$, an error estimate can be calculated by Equation (23) [31]:

$$eM(z) = \mu M(1 + zVm) \tag{23}$$

where z is a Gaussian random variable with zero mean and unit standard deviation. Fig. 7 shows the histogram for the error estimate, and in Fig. 8, the normal probability plot verifies that the data converges to a normal distribution curve.

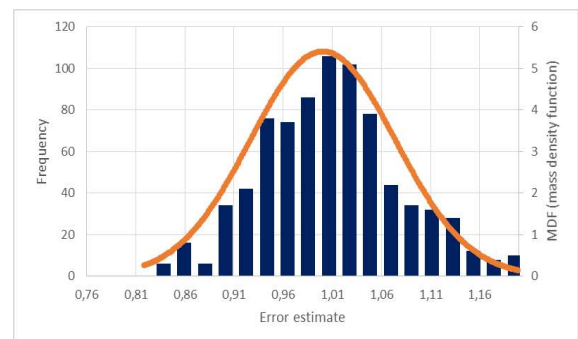


Fig.7: Histogram of model error estimation.

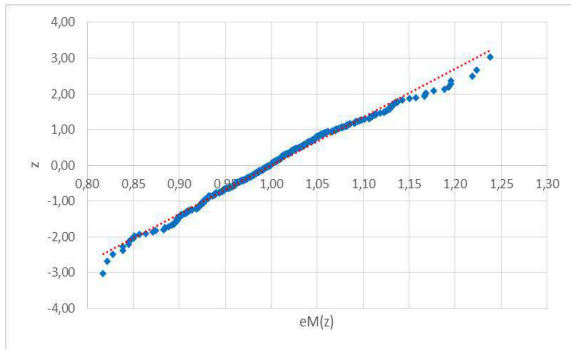


Fig.8: Normal probability graph.

Random variables considered

Some minimum conditions must be considered so that the structures perform their functions satisfactorily. For this, fundamental variables were used to parameterize the element with the limit state function. The variables that most influence the behavior of the structure must be selected. Generally, they are related to geometric properties, materials, and loads. The variabilities of these variables happen in the production, manufacturing control, and loading, among others. Thus, the random variables chosen were the concrete's compressive strength, the steel's yield strength, the slab's thickness, the cover (which measures the variation of the effective depth), and the spacing between bars (which measures the rate of reinforcement). For f_c , f_y , h , $cobr$, g and q , were employed the statistical parameters indicated by [32]. For eM and eS , the parameters suggested by [30] were used.

The parameters for the random variables are shown in the Table.

Table 3: Random variables considered.

Variable	μ	C.V.	Distribution
f_c	$\frac{f_{ck}}{1 - 1,645V_{f_c}}$	0.15	Normal
f_y	$\frac{f_{yk}}{1 - 1,645V_{f_y}}$	0.05	Normal
esp	esp	0.05	Normal
h	h	0.04	Normal
cobr	cobr	0.125	Normal
g	g_k	0.1	Normal
q	q_k	0.25	Gumbel
eM	1	0.0763	Normal
esp	1	0.05	Normal

Evaluation of the structural reliability of the slabs

Tab. 5 presents the loading parameters for each slab used in its design, where g_k is the characteristic permanent

loading and q_k is the characteristic variable loading. The loading variation was due to the alternation of slab thickness, necessary for all standard checks to be met.

Fig. 9 shows the normal distribution graph of slab L1 for the 400 simulations. The results showed an average rupture load (μ_{CR}) of 16.92 kN/m², deviation (σ) of 1.51 kN/m² with a coefficient of variation (CV) of 8.91% (Tab. 4).

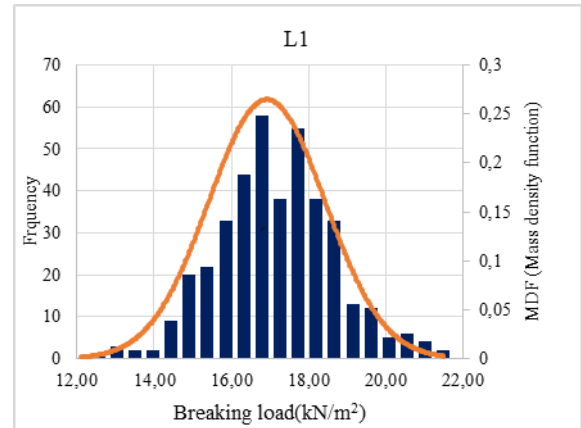


Table 4: Parametric results of the Monte Carlo simulations of the slabs.

LAJE	μ_{CR} (kN/m ²)	σ (kN/m ²)	CV
L1	16.92	1.51	0.089052
L2	18.93	1.00	0.052965
L3	19.11	0.82	0.043078
L4	17.20	1.48	0.086152
L5	17.91	1.08	0.060523
L6	18.05	1.39	0.077116
L7	17.28	1.23	0.071332
L8	18.22	0.88	0.048379
L9	18.59	1.44	0.077706

Table 5: Loading distribution parameters according to sizing by NBR 6118 and NBR 6120.

Sla b	g_k (kN/m ²)	q_k (kN/m ²)	g_k+q_k (kN/m ²)	$q_k/(g_k+q_k)$
L1	3.5	6	9.5	0.37
L2	4	6	10	0.40
L3	4.75	6	10.75	0.44
L4	3.5	6	9.5	0.37
L5	3.5	6	9.5	0.37
L6	4.25	6	10.25	0.41

L7	3.5	6	9.5	0.37
L8	3.75	6	9.75	0.38
L9	4.25	6	10.25	0.41

Regarding the results (Tab. 6), it can be observed that all the results were above the target reliability index $\beta_0=2.5$, indicated as acceptable by the American standard ACI 318 for slabs subjected to bending. This code is the only standard that presents the indicative parameters of β_0 by type of structural element and the internal forces to which it is subjected.

Table 6: Slab reliability results according to design load distribution.

FORM		
Slab	β	Fp
L1	2.65	3.9684E-03
L2	2.84	2.1954E-03
L3	2.96	1.5218E-03
L4	2.73	3.1816E-03
L5	2.75	2.9815E-03
L6	2.76	2.8596E-03
L7	2.81	2.4218E-03
L8	3.03	1.2208E-03
L9	2.88	1.9684E-03

Considering $qk/(gk+qk)=0.25$

In this item, the reliability results will be presented considering the variable loading of the slabs, totaling 25%. It is possible to consider this relationship as the closest to reality since the variable loads of a residential building made of reinforced concrete generally do not exceed 25% of the total, justified by the considerable self-weight of the reinforced concrete. According to that, Araújo[33] describes that in the absence of knowledge of the variation between the two types of loading, a relationship of $qk \cong 0.15gk$ can be estimated, which results in a proportion of 13% of variable load only.

Therefore, analyzing the results of Tab. 7, none of the slabs indicated a reliability index lower than the target index of ACI 318 (2014).

Table 7: Slab reliability results according to load distribution $qk/(qk+gk)=0.25$.

FORM		
Slab	β	Fp
L1	3.50	2.3548E-04
L2	3.83	6.4562E-05
L3	3.99	3.3692E-05
L4	3.63	1.4209E-04
L5	4.18	1.4406E-05
L6	3.60	1.6204E-04
L7	4.40	5.4933E-06
L8	4.24	1.0981E-05
L9	3.76	8.6678E-05

Considering $qk/(gk+qk)=0.50$

When the results are observed in an analysis submitted to loading divided into 50% variable and 50% permanent (Tab. 8), it is possible to verify a reduction in the reliability indexes. This reduction happens with the increase in the variable loading portion. It is also noted that the minimum reliability is met in all slabs according to the ACI 318 (2014) standard for slabs subjected to bending stresses.

Table 8: Slab reliability results according to load distribution $qk/(qk+gk)=0.50$.

FORM		
Slab	β	Pf
L1	2.94	1.6629E-03
L2	3.19	7.0101E-04
L3	3.13	8.6506E-04
L4	3.02	1.2475E-03
L5	3.33	4.3376E-04
L6	2.95	1.5636E-03
L7	3.45	2.7851E-04
L8	3.34	4.2208E-04
L9	3.08	1.0373E-03

Considering $qk/(gk+qk)=0.75$

When the variable load presents 75% of the total, it results in the lowest values of reliability indices (Tab. 9). Exclusively in this analysis, slab L1 and L6 did not present the minimum results suggested by ACI 318 (2014), but

they are close to the target. For all other slabs, β is greater than 2.5.

Table 9: Slab reliability results according to load distribution $qk/(qk+gk)=0.75$.

Slab	FORM	
	β	Pf
L1	2.46	6.9539E-03
L2	2.78	2.7197E-03
L3	2.58	5.0007E-03
L4	2.53	5.7281E-03
L5	2.75	2.9980E-03
L6	2.46	7.0287E-03
L7	2.84	2.2776E-03
L8	2.67	3.7707E-03
L9	2.56	5.2175E-03

Analysis of director cosines

Tab. 10 below represents the director cosines found in the L1 reliability analysis for each load proportion. This result is indispensable for analyzing the influence of each random variable considered in the Ultimate Limit State function.

It is observed that the random variable of slab strength (R) has a more significant influence on the result, reducing with the increase of the variable loading portion (Q). As for the variable Q, it already becomes considerably preponderant from the equal division of loads.

Table 10: Cosine directors generated by FORM method for L1.

L1 Random variable	Director Cosine α_{xi}^2		
	qk/(gk+qk)		
	0.25	0.5	0.75
R	0.363	0.185	0.121
G	0.117	0.023	0.003
Q	0.219	0.623	0.760
eM	0.023	0.126	0.084
eS	0.069	0.043	0.031

X. CONCLUSION

This work simulated nine different models of reinforced concrete slabs for reliability analysis. Also, the model error was analyzed for its insertion as a random variable to obtain more accurate reliability results. Posteriorly, through the results of probability distributions

and using a computational routine developed by Real (2022) for Python language, the structural reliability of 36 models of reinforced concrete slabs was determined through the FORM first-order transformation method. The proportions between variable and permanent loads were varied to verify the influence of the failure probability and structural reliability index between the parameters. Among the 36 slab reliability index results presented, only two were below the one indicated by the American standard ACI 318 (2014). This American code is the only one to suggest a target index related to the type of element and the internal forces to which it is subjected. With this, the satisfactory safety of the reinforced concrete slabs designed following NBR 6118 (2014) stands out.

The director-cosines of FORM for slab L1 were presented to show the significant parameters that influenced the reliability of the slabs. It was verified that the influence of the random variable resistance of the slab is inversely proportional to that of the random parameter of variable loading. The preponderance of the variable load increases in the proportion of the variable loading applied to the slab. It is justified that the random variable loading presents predominance due to its high degree of variability.

Finally, there is a great variation in the reliability indices between the different cases studied here, which, for the most part, are considerably higher than necessary. Thus, the need to calibrate the partial safety factors adopted by the NBR 6118 (2014) is evidenced.

REFERENCES

- [1] NASSIM, K.; KHALIL, B.r; BEKADDOUR, B. A.. Non-linear finite element analysis of reinforced concrete members and punching shear strength of HSC slabs. Matec Web Of Conferences, [s.l.], v. 149, p.02056-02062, 2018. EDP Sciences. <http://dx.doi.org/10.1051/mateconf/201814902056>
- [2] SANTIAGO, W. C. Calibração Baseada em Confiabilidade dos Coeficientes Parciais de Segurança das Principais Normas Brasileiras de Projeto Estrutural. 2019. 181 f. Doctoral dissertation, São Carlos, SP, Brazil: Universidade Federal de São Carlos.
- [3] CARVALHO, M. L.; SILVA, C. R.; STUCCHI, F. R.. Study on reliability of punching shear of flat slabs without shear reinforcement according to NBR6118. Revista Ibracon de Estruturas e Materiais, [s.l.], v. 10, n. 2, p.276-297, abr. 2017. FapUNIFESP (SciELO). <http://dx.doi.org/10.1590/s1983-41952017000200002>
- [4] BERMEJO, M.; S., ANASTASIO P.; GOICOLEA, J. M.. Development of Practical Finite Element Models for Collapse of Reinforced Concrete Structures and Experimental Validation. Shock And Vibration, Madrid, v. 2017, p. 1-9, 2017. Hindawi Limited.

- <http://dx.doi.org/10.1155/2017/4636381>FANNING, P. Nonlinear Models of Reinforced and Post-tensioned Concrete Beams. Electronic Journal of Structural Engineering, Dublin, Ireland, 2001.
- [5] SILVA, E. M. L. Ajuste com Quantificação de Incertezas de Modelos em Elementos Finitos Através de Função Objetivo Baseada na Energia de Deformação Modal. 2019. 174 f. Doctoral dissertation, Rio de Janeiro, RJ, Brazil: Universidade Federal do Rio de Janeiro.
- [6] EL-REEDY, M. A.. Reinforced Concrete Structural Reliability. U. S: Taylor & Francis Group, Llc, 2013.
- [7] ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 6120: Ações para o cálculo de estruturas de edificações. Rio de Janeiro: 2019.
- [8] ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 6118: Projeto de estruturas de concreto — Procedimento. Rio de Janeiro: 2014
- [9] VIEGAS, Carlos Henrique Hernandorena; REAL, Mauro de Vasconcelos; TITELLO, Eduardo Pagnussat. Non-linear analysis of reinforced concrete slabs through the finite element method. International Journal Of Advanced Engineering Research And Science, [S.L.], v. 9, n. 4, p. 310-318, 2022. AI Publications. <http://dx.doi.org/10.22161/ijaers.94.36>
- [10] ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 8681: Ações e segurança nas estruturas – Procedimento. Rio de Janeiro: 2003.
- [11] ANDERSEN, V. J.. Effects of load histories on reliability analyses based on non-linear finite element analyses of reinforced concrete structures. 2017. 94 f. Master thesis , Department Of Structural Engineering, Ntnu- Norwegian University Of Science And Technology, Noruega, 2017.
- [12] BECK, A.T. Confiabilidade e Segurança das Estruturas. Rio de Janeiro: Elsevier, 2019.
- [13] MELCHERS, R.; BECK, A. T.. Structural Reliability Analysis and Prediction. 3. ed. Usa: John Wiley & Sons Ltd, 2018.
- [14] SILVA, G. R. Análise da Confiabilidade da Ligação Laje-Pilar Interno sob Punção de Acordo com a NBR-6118:2014. 2017. 173 f. Master thesis Porto Alegre, RS, Brazil: Universidade Federal do Rio Grande do Sul.
- [15] NOWAK, A.S.; COLLINS, K.R. Reliability of Structures. McGraw-Hill Companies, Inc., 2000.
- [16] SCHERER, M. Avaliação da Confiabilidade de Vigas de Concreto Armado pelo Método dos Elementos Finitos. 2018. 180 f. Master thesis, Porto Alegre, RS, Brazil: Universidade Federal do Rio Grande do Sul.
- [17] ACI COMMITTEE 318 – American Concrete Institute. ACI 318-11: Building Code Requirements for Reinforced Concrete and Commentary. Farmington Hills, 2014
- [18] JOINT COMMITTEE ON STRUCTURAL SAFETY. JCSS Probabilistic Model Code. Lyngby, 2001.
- [19] PALIGA, C. M. Análise probabilística de vigas de concreto armado recuperadas à flexão, através do método de Monte Carlo utilizando um modelo de Elementos Finitos. 2008. 249 f. Doctoral dissertation, Porto Alegre, RS, Brazil: Universidade Federal do Rio Grande do Sul, Porto Alegre. 2008.
- [20] VERMA, A. K.; SRIVIDYA A.; DURGA R. K.. Reliability and Safety Engineering. 2. ed. Hoang Pham: Springer, 2016. (Hoang Pham, Piscataway, USA).
- [21] ANSYS. Help. 2020. Available at: https://ansyshelp.ansys.com/account/secured?returnurl=/Views/Secured/main_page.html. Accessed in: Jun. 2020
- [22] KAPETANOVIC, Esad. Probabilistic based topology optimization in ANSYS. Tu Wien, [S.L.], p. 1-87, 2019. TU Wien. <http://dx.doi.org/10.34726/HSS.2019.72882>
- [23] REAL, M. V. A Python class for Reliability analysis including Monte Carlo and FORM methods. 2022. Available at: <https://github.com/mvreal/Reliability..> Accessed: 10 Oct. 2021
- [24] TITELLO, E. P.. Análise da Confiabilidade de Vigas em Concreto Armado Reforçado com Fibras de Aço em Relação aos Esforços Transversais. 2020. 161 f. Master thesis, Porto Alegre, RS, Brazil: Universidade Federal do Rio Grande do Sul, Porto Alegre, 2020.
- [25] LIU, P.-L.; DER KIUREGHIAN, A. Multivariate distribution models with prescribed marginals and covariances. Probabilistic Engineering Mechanics, v. 1, n. 2, p. 105-112, 1986
- [26] RACKWITZ, R; FIESSLER, B. Note on discrete safety checking when using non-normal stochastic models for basic variables. Cambridge: MIT, 1976.
- [27] HALDAR, A.; MAHADEVAN, S.. Probability, Reliability, and Statistical Methods in Engineering Design. New York / Chichester / Brisbane / Weinheim / Singapore / Toronto: John Wiley & Sons, Inc., 2000.
- [28] ZHANG, Y.; DER KIUREGHIAN, A. Two improved algorithms for reliability analysis. In: Reliability and optimization of structural systems. Boston, Springer: 1995. p. 297-304.
- [29] LUENBERGER, D.; YE, Y. Linear and non-linear programming. Fourth Edition. 4rd ed. New York: Springer, 2016
- [30] MIRZA, S. A.; SKRABEK, B. W. Reliability of Short Composite Beam-Column Strength Interaction. Journal of the Structural Division, v. 117, p. 2320-2339, 1991.
- [31] MAGALHÃES, F. C. A problemática dos concretos não conformes e sua influência na confiabilidade de pilares de concreto armado. 2014. 292 f. Doctoral dissertation - Curso de Programa de Pós-Graduação em Engenharia Civil, Universidade Federal do Rio Grande do Sul - Ufrgs, Porto Alegre, 2014.
- [32] GALAMBOS, T. V.; ELLINGWOOD, B.; MACGREGOR, J. G.; CORNELL, C. A. Probability based load criteria: Assessment of current design practice. Journal of the Structural Division, v. 108, p. 959-977. 1982
- [33] ARAÚJO, J. M. Projeto Estrutural de Edifícios de Concreto Armado. 4. ed. Rio Grande: Dunas, 2021. 302 p

Application of Analytical Hierarchy Process for site selection for container leasing and selling company

Muriel Rios Thomas¹, Alessandro Roberto Rocha², Fernando Nascimento Zatta³, Diego Vieira dos Santos⁴, Wellington Gonçalves⁵

¹Engineering and Technology Department, Federal University of Espírito Santo, Brazil.

Email: muriel.borini@edu.ufes.br

²Institute of Life Sciences, Federal University of Juiz de Fora, Brazil.

Email: alessandro.rocha@ufjf.edu.br

³Center for social and Applied Sciences, Mackenzie Presbyterian University, Brazil.

Email: zatta@hmzconsulting.com.br

⁴Federal Institute of Espírito Santo, Brazil.

Email: diego.santos@ifes.edu.br

⁵Engineering and Technology Department, Federal University of Espírito Santo, Brazil.

Email: wellington.goncalves@ufes.br

Received: 22 Jun 2022,

Received in revised form: 15 Jul 2022,

Accepted: 21 July 2022,

Available online: 29 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *Multi-criteria decision making, AHP, Optimal location selection, Competitive advantage.*

Abstract— *Obtaining a competitive advantage in the fierce globalized market has been the objective of several organizations. And, within this context, location can be identified as one of the important elements of differentiation. At the same time, the selection of an ideal location for setting up a company is a strategic challenge to be overcome by decision makers, and this is explained by the high number of attributes involved in this selection. Something that not only demands an expanded reflection on this topic, but also encompasses different opinions from different stakeholders that need to be brought together. Thus, considering the multiplicity of factors and sub-factors present in this context, in addition to the need to gather opinions, in this work a survey was used to support the operationalization of the Analytic Hierarchy Process (AHP) multi-criteria method, in order to contribute to the decision-making process. selection of a location for the installation of a container leasing and sales company. The results indicated that the main factor in decision making, according to the respondents, is regional development.*

I. INTRODUCTION

Facility location decisions are currently a critical element in strategic logistics planning for companies and regional development. The definition of this location impacts numerous operational, logistical and social decisions (Badri, 1999; Şahin, 2019). Most of the time, according to Heitz et al. (2019) the high costs associated with the acquisition of properties and construction of facilities make projects for the location or relocation of facilities a long-term investment.

But, although important, cost optimization is not the only preponderant element in decision making about the ideal location (He et al., 2018). For these authors, in addition to costs, it is necessary to understand and have knowledge of regional needs, forecasts and potentialities, something that can directly impact future operationalization.

Extending this perspective, Onstein et al. (2019) highlight that distribution structures are embedded in the spatial layout of the goods transport and storage system

used to move goods between the various places of production and consumption. According to Wang et al. (2020) this perspective should also observe the need for routing optimization, which will also be associated with the location of logistics, which, among other urban situations, will have collection and delivery with time windows – for example.

According to Faugère et al. (2020) “last mile” logistics, the final part of product delivery, is an essential but eminently expensive component of logistics in cities, being responsible for numerous annoyances in urban areas. These authors assert that the location of a facility in an urban environment must, among other functions, serve as a mobile access (hub), as flexible points of consolidation and transshipment, dynamically using the urban space.

Holl and Mariotti (2018) emphasize that the organization of modern economies is based on regional economic particularities and the available transport system, something that plays a growing role in the logistics sector to help overcome time and distance restrictions in modern times. urban supply chains. The view of this challenge is supported by Stević et al. (2018) defend the need to listen to different stakeholders and gather opinions as a way of expanding discussions and possibilities for solutions.

In addition, several researchers have highlighted the efficiency in the use of multicriteria methods to aid decision making and also as a way of grouping opinions (Ho & Ma, 2018; Santos et al., 2019; Sá et al., 2020; Ruiz Bargeño et al., 2021). Therefore, as in the operationalization of the process of selecting the ideal location, several attributes must be considered (Şahin, 2019) and, as a result, the involvement of different stakeholders, for the forwarding of possible solutions, an objective method is necessary in which all impressive factors are studied together and not randomly or subjectively (Sá et al., 2020; Ruiz Bargeño et al., 2021).

For these reasons, this work aimed to develop an approach to support the company’s location decision using the Analytic Hierarchy Process (AHP). This method was chosen because its application allows associating a real-world study with the decision to locate an installation, combining different opinions, in addition to allowing adaptations to different circumstances and scenarios. The general framework of analysis consists of a hierarchy of criteria that includes attributes related to traditional and logistical services and products.

II. URBAN MOBILITY AND LOCATION

Over the years, accelerated urbanization has led more than half of the world's population to live in cities, with 68% of the world's population expected to live in urban areas by 2050 (UN, 2019). Due to the proportions that this acceleration has demanded, it is crucial to understand land use, in addition to urban features such as infrastructure, facilities, population distribution, jobs and services, which play a fundamental role in health, urban livability and sustainability (Wojtyra et al., 2020).

On the other hand, Heitz et al. (2020) emphasize that it is essential to know the factors involved in the intended location, especially when the facility is to operate in an urban environment. These factors, according to Rodrigue (2020) depend on the nature of the activity for which the locational behavior is being investigated. Extending this view, for Zhang et al. (2020) this explains the highly diversified locational behavior of companies in the face of the global economy, considering, in addition to locational factors, the opinions of various actors that make up their ecosystem.

Different logistical solutions that are incorporated into consolidation plant and deconsolidation can help reduce negative impacts from urban cargo movements (Crainic et al., 2004; Browne et al., 2005; Tian et al., 2021). For this reason, according to Simoni et al. (2018) in recent years, several municipalities have promoted different measures to encourage the implementation of logistics centers in urban areas.

From another perspective, Lauer mann (2018) understands that the increase in urbanization in large centers has directly influenced cities with lower status than the main city. This mega-urbanization, in addition to penetrating the soil of cities, also participates in the increase in the fulfillment of housing and infrastructure needs, becoming a determinant of the increasing lack of accessibility, change of land use and, in some cases, reaching the conversion of land. productive farms – complements this author.

Within this context, even with diversified academic advances, some theories on location have their origins attributed to the works of Weber (1929) - especially in his proposal to use a locational triangle to define the positioning and installation of facilities and, of Lösch (1954) who proposed a theory based on a central place and, based on that, considers a maximum number of points of spatial offer, implying an economic system dominated by a “primal city”. Aldrich (1999), Gordon and McCann (2000) and Zhang and Guhathakurta (2021) when analyzing such works realized that, in general, location theory has as its main framework the hypothesis that every

enterprise determines its location in a way that can make as much profit as possible.

The contemporary market scenario, which imposes a global stance and scope on organizations, is highly competitive, and among other reasons, transversally, the choice of location must be preceded by a broad discussion and technical, literary and operational observation (Wojtyra et al., 2020; Tian et al., 2021). Based on this thought, a literature review was carried out to support the operationalization of the methodological approach of this work (Table 1).

Table 1: Influences on the location of facilities

Factor	Subfactors	Authors
Costs	Transport, land acquisition and maintenance	Guha and Khuller (1999), Snyder and Daskin (2005), Chen et al. (2014), Govindan et al. (2016), Temur (2016), Wang et al. (2016) and, Emeç and Akkaya (2018)
Demography	Demographic density and urban growth	Farahani et al. (2015), Esmailian et al. (2016), Ghadge et al. (2016), Temur (2016), Anvari and Turkey (2017), Ketokivi et al. (2017) and, Sakai et al. (2020)
Coverage	Proximity to suppliers, proximity to highways, proximity to customers and proximity to competitors	Guha and Khuller (1999), Jain et al. (2003), Snyder and Daskin (2005), Farahani et al. (2015), Govindan et al. (2016), Wang et al. (2016), Emeç and Akkaya (2018) and, Sakai et al. (2020)
Regional development	Land availability, skilled labor and industrial trend	Jain et al. (2003), Chen et al. (2014), Esmailian et al. (2016), Ghadge et al. (2016), Govindan et al. (2016), Wang et al. (2016) and, Anvari and Turkey (2017)
Government policies	Tax incentives and political stability	Guha and Khuller (1999), Snyder and Daskin (2005), Temur (2016), Anvari and Turkey (2017), Ketokivi et al. (2017), Emeç and Akkaya (2018) and, Sakai et al. (2020)

The selection of a facility's location is a multi-criteria problem, something that the literature supports in opinion, both in quantitative and qualitative terms (Table 1). On the

other hand, there is also a consensus regarding conventional approaches to this type of problem, which tend to be less effective due to the complexity and the need to gather opinions in this selection (Rodrigue, 2020; Zhang et al., 2020).

Some authors such as Heitz et al. (2020), Sakai et al. (2020) and Zhang and Guhathakurta (2021) emphasize that at first glance, decisions about location appear to be applicable only to new ventures, something that must necessarily be rethought in the eyes of the contemporary and globalized market that is found.

III. ANALYTIC HIERARCHY PROCESS (AHP)

Daily decision making is something inherent to the commercial reality of organizations and, through this, even if unconsciously, the choice of alternatives that satisfy their needs is aimed. However, Şahin et al. (2019) note that, in various circumstances, this natural process has become complex and, for this reason, requires more time with analysis and judgment of the different ones that influence decisions. In such cases, there are methods that can support the decision-making process and gather opinions.

Traditionally, the literature highlights several studies on Multi-Criteria Decision Analysis (MCDA) that, in general, evaluate alternatives and indicate the most appropriate among different contradictory criteria (Ho & Ma, 2018; Santos et al., 2019; Sá et al., 2020; Ruiz Bargeño et al., 2021; Tuncel et al., 2021). According to Emeç and Akkaya (2018) the MCDA can be understood as instruments that help decision making and that seek the integration of objective measures through value judgment, allowing a broadening of the understanding of the problem and the prioritization of possible actions or alternatives.

In general, according to Şahin et al. (2019) and Ruiz Bargeño et al. (2021) multi-criteria methods are widely used in solving problems that aim to assist the decision-making process, as they provide diverse possibilities of choice. On the topic of location of facilities, for example, the work by Emeç and Akkaya (2018), used MCDA hybridly to propose a stochastic approach to multi-criteria decision-making to solve the problem of warehouse location, in an environment also with stochastic behavior that contained uncertain conditions. Similarly, Şahin et al. (2019) used the AHP as decision support for site selection to establish a new hospital, while Stević et al. (2018) used MCDA to analyze the location of a roundabout in an urban environment. The results of these researches suggest that the MCDA's, in addition to helping decision making, broaden the discussions around the problem studied, even

making it possible to gather opinions from different stakeholders.

In the opinion of Ho and Ma (2018), Santos et al. (2019) and Ruiz Bagueño et al. (2021), several multicriteria methods have been used in the literature, however, certain methods, due to their versatility, are used with high frequency, such as: Analytic Hierachy Process (AHP), Analytic Network Process (ANP), Elimination et Choix Traduisant la Realité (ELECTRE), Fuzzy Decision Approach (FDA), Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH), Preference Ranking Method for Enrichment Evaluation (PROMETHEE) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). As noted by these authors, multicriteria methods have been frequent in various problem areas and, over the last decade, several researchers have applied these methods in the field of production engineering (Santos et al., 2019; Ruiz Bagueño et al., 2021). For Ho and Ma (2018) all these methods are equally appropriate to assist in decision making under uncertainty, and each has its own advantages and disadvantages.

Corroborating this point, Badri (1999) and Emeç and Akkaya (2018) emphasize that the AHP, in addition to having as its operationalization principle, evaluate the nature of a problem, allowing different opinions of the actors involved to be considered. Furthermore, Thomas Lorie Saaty (Saaty, 1988) emphasizes that this method, considering a quali-quantitative approach in its design, has parameterizations that are adaptable to different conditions and situations. Also, for these reasons, in this work we chose to use the Analytic Hierarchy Process (AHP). This use is also based on the suitability of this method for unequal scenarios, in addition to being able to support decision-making that involve high complexity in relation to the multiplicity of criteria (Saaty, 1988; Şahin et al., 2019).

The AHP, due to the mixed use of quantitative and qualitative techniques, in addition to a structure in which the decision-making process is subdivided into hierarchical levels, allows for an expansion of reflections and, thus, favors decision-making (Sá et al., 2020). According to Saaty (1988), the method is based on three stages, namely: elaboration of a hierarchical structure, definition of priorities and verification of the logical consistency of judgments.

Thus, Sá et al. (2020) emphasize that in the first stage, the objective to be achieved, the attributes (factors and subfactors) related to the problem studied and the decision alternatives need to be organized in hierarchical levels

(Figure 1). Subsequently, judgments are made based on the scale proposed by Saaty (1988) shown in Table 2.

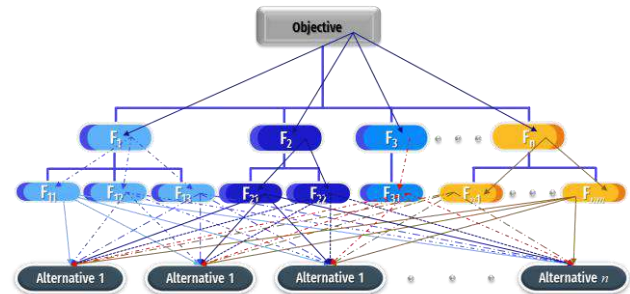


Fig. 1: Structure for operationalization of the AHP

Table 2: Numerical scale

Numerical scale	Verbal scale
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extremely important
2, 4, 6 and 8	Intermediate values
Increment 0.1	Intermediate values at the finest graduation of 0.1

According to Santos et al. (2019), regarding the operationalization of the congregation of opinions, the decision maker does not need to provide a numerical judgment; instead, it is recommended that a relative verbal analysis be carried out, ie, the comparisons of the different actors must be recorded in a positive reciprocal matrix A (Equation 1).

$$n(n-1)/2 \tag{1}$$

Where: n is the number of elements contained in matrix A (Saaty, 1988), defined as follows:

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ \frac{1}{a_{21}} & 1 & \dots & a_{2n} \\ a_{21} & \vdots & \dots & \vdots \\ \frac{1}{a_{n1}} & \frac{1}{a_{n2}} & \dots & 1 \end{bmatrix}$$

Whereupon:

$$a_{ij} > 0 \rightarrow \text{positive}; a_{ij} = 1 \therefore a_{ji} = 1; a_{ij} = \frac{1}{a_{ji}} \rightarrow \text{reciprocal};$$

$$a_{ik} = a_{ij} \cdot a_{jk} \rightarrow \text{consistency}$$

However, Ruiz Bagueño et al. (2021) show that the freedom provided by the method in defining attributes and

alternatives can promote the occurrence of inconsistencies in the evaluations. For this reason, Saaty (1988) proposed a maximum value of consistency for judgments to be considered coherent (Equation 2).

$$CR = CI / RI \tag{2}$$

To obtain the Consistency Ratio (CR) it is necessary to consider the Random consistency Index (RI), which consists of random judgments of 500 matrices of varying sizes, randomly filled (Şahin et al., 2019). Furthermore, Saaty (1988) also considers the Consistency Index (CI) that measures the coherence of judgments (Equation 3). This verification index has its use justification because the priorities of judgments only make sense if derived from consistent or quasi-consistent matrices are obtained. Saaty (1988) still emphasizes that the CI is related to the eigenvalue method.

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{3}$$

Being λ_{max} the maximum eigenvalue resulting from the splitting of the original matrix by the maximum eigenvector obtained after the normalization procedure of the comparison matrix and n is the number of criteria or sub-criteria calculated (Santos et al., 2019). Within this context, Saaty (1988) advocates that judgments will be considered reliable if they present a Consistency Ratio (CR) less than or equal to 0.10 ($CR \leq 0.10$). Thus, forward results of this value recommend the need to review judgments and/or previous phases of the AHP, however, if inconsistencies persist, it is necessary to carry out new judgments.

IV. METHODOLOGICAL APPROACH

This work presents an approach to the application of the Analytic Hierarchy Process (AHP) to identify attributes (factors and sub-factors) that were used in the indication of a location for the installation of a container rental and sale company in the northern region of the State of Espírito Santo (Brazil), which is considered a research unit. This choice was due to the representativeness and relevance that the region has within the local development scenario. Within this context, the population was defined as being entrepreneurs who have related businesses or that touch the research topic, in addition to companies, public institutions, municipalities and third-party organizations that also fit in. These are known through open databases, totaling a population of 857 potential respondents.

To help the analysis of statistical consistency, a confidence level (Z) of 90% was adopted, a maximum sampling error of 5% and a maximum percentage of 5

percentage points (Gonçalves, 2016). Thus, a minimum valid sample of 49 respondents was estimated. In addition, with the objective of contributing to the verification of the reliability of the data collected through the data collection instrument, the presence of missing values elements (missing data) and outliers (Z score with interval $|Z| < 3$, for a value of $p < 0,001$) were checked. If these elements occur, they would be removed from the sample due to the changes they may cause (Gonçalves, 2016). Cronbach's alpha ($C_\alpha \geq 0,7$) was used as a consistency checker of the data collection instrument (Khattak et al., 2019). To carry out these statistical analyses, the software SPSS 23.0 Trial version was used.

Thus, the methodological development took place in two complementary stages (Figure 2). The first stage of composition for the operationalization of the AHP initially made it possible to determine the delimitation of the problem and the proposed objectives, making it possible from this delimitation to visualize the breadth of the problem to be studied. After this procedure, the distinction and structuring of factors and sub-factors (attributes) and alternatives were made. Finally, in this first stage, opinions were judged in relation to these attributes and alternatives using the Saaty scale (Gonçalves, 2016).

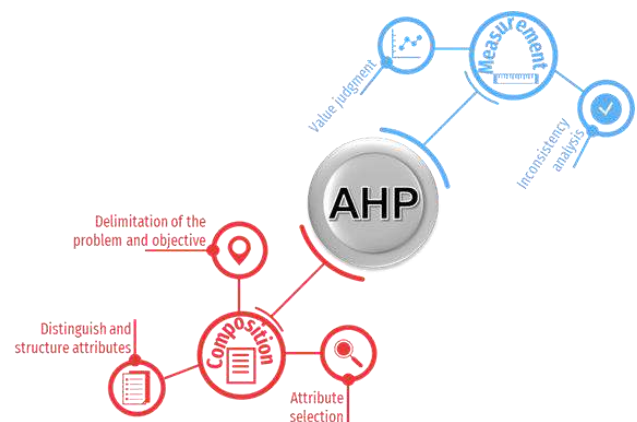


Fig. 2: Synthesis of the methodological approach

However, before starting the second stage, an opinion consultation was carried out with 7 experts with more than 10 years of professional experience, who work in the planning and regional development sector, industry management, city hall and government agency. This procedure contributed to elucidate the findings in the literature, as well as confirm these findings.

The second stage of the methodological development (measurement) consisted of applying a survey sent by email and social media to potential respondents, initially defined, for data collection, at which time value judgments were made for each attribute and alternatives.

Subsequently, the analysis of the inconsistency of these judgments was carried out, using the Expert Choice Trial software to support this operationalization.

V. RESULTS AND DISCUSSION

When verifying the proposed location problem, it was confirmed that in addition to the need for location, three municipalities were able to meet the needs and expectations expected by the respondents (Nova Venécia, Pedro Canário and São Mateus). Thus, in parallel with this discovery, a distinction and structuring of factors and subfactors (attributes) was initially performed (Table 3). After that, following the precepts of Gonçalves (2016), it was found by experts that these findings (attributes) and alternatives for the moment did not require additions and contributions. This concludes the first step proposed by the methodological approach (Figure 3).

Table 3: Attributes for checking the location of facilities

Factor	Subfactors
Costs (F ₁)	Transport (F ₁₁), land acquisition (F ₁₂) and maintenance (F ₁₃)
Demography (F ₂)	Demographic density (F ₂₁) and urban growth (F ₂₂)
Coverage (F ₃)	Proximity to suppliers (F ₃₁), proximity to highways (F ₃₂), proximity to customers (F ₃₃) and proximity to competitors (F ₃₄)
Regional development (F ₄)	Land availability (F ₄₁), skilled labor (F ₄₂) and industrial trend (F ₄₃)
Government policies (F ₅)	Tax incentives (F ₅₁) and political stability (F ₅₂)

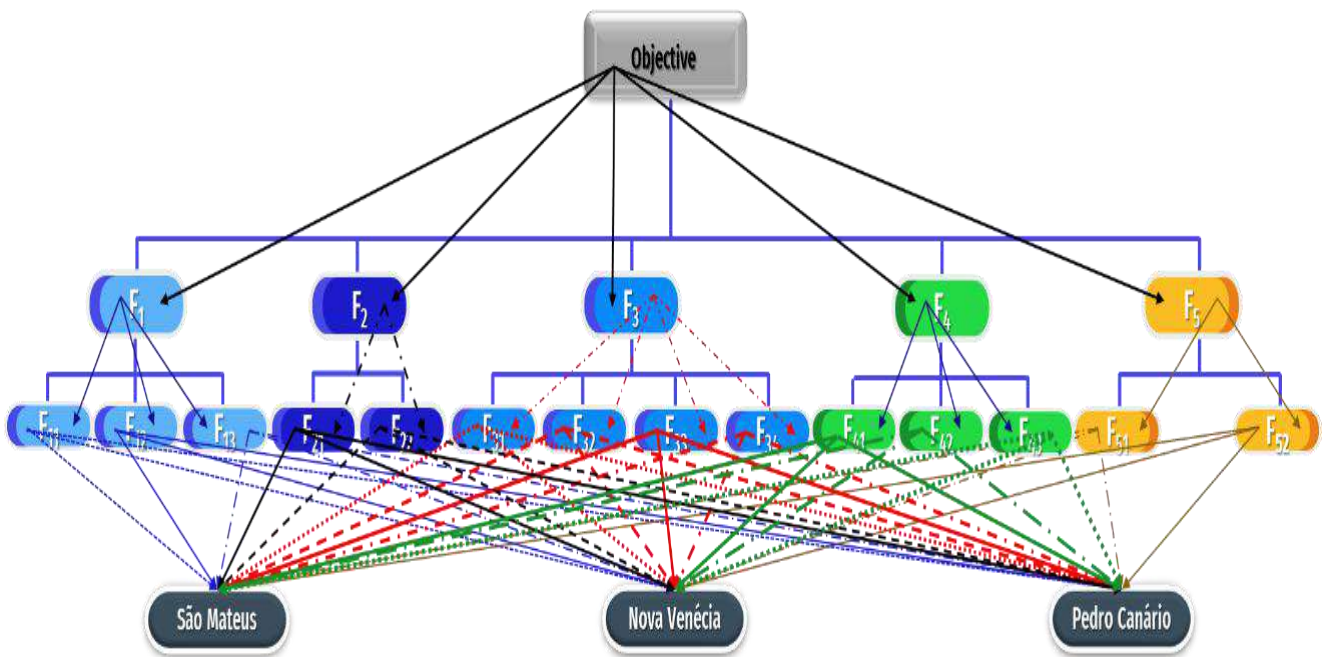


Fig. 3: Hierarchy for operationalizing the AHP

Based on the information obtained, a survey was carried out by e-mail and social media with potential respondents, considering a 5 year horizon for planning the installation, defined previously, and in this way equal weightings of the value of each attribute and alternatives considering the Saaty Scale (Table 2). The survey returned 459 answered forms, in this quantity there was the detection of 5 partially filled forms (missing values), which were removed from the sample. Proceeding with data mining and analysis, the presence of outliers 8 outliers were also verified, which, according to Gonçalves (2016) were also to be extracted. It is important to note that the

calculated Cronbach's alpha (0.897) suggests adequate internal consistency of the data collection instrument used (Khattak et al., 2019). Thus, the final sample now has 446 valid forms, which is higher than the number initially calculated, thus confirming this sampling.

In this way, the second stage of the methodological development (measurement) consisted in the application of a survey sent by e-mail and social media with potential respondents, initially defined, for data collection, at which time value judgments were made. each attribute and alternatives (Gonçalves, 2016).

Continuing the analysis of the collected data, the hierarchical structure for the operationalization of the AHP (Figure 3) was modeled in the Expert Choice Trial software and, from that, the parity judgments were inserted. Based on this, the parity judgments of attributes

(factors and subfactors) and alternatives were calculated (Table 4) observing their relationship and possible inconsistencies (Şahin et al., 2019).

Table 4: Synthesis of the operationalization of the AHP

Factor	Judgment	Inconsistency	Subfactors	Judgment	Inconsistency
F ₁	0.122		F ₁₁	0.661	0.04
			F ₁₂	0.067	
			F ₁₃	0.272	
F ₂	0.041		F ₂₁	0.200	0.00
			F ₂₂	0.800	
F ₃	0.272	0.08	F ₃₁	0.253	0.04
			F ₃₂	0.131	
			F ₃₃	0.575	
			F ₃₄	0.041	
F ₄	0.499		F ₄₁	0.117	0.01
			F ₄₂	0.200	
			F ₄₃	0.683	
F ₅	0.066		F ₅₁	0.833	0.00
			F ₅₂	0.167	

In this way, the concern of the respondents with the economic situation of the place of implantation, as well as its perspectives and growth trend is observed. Something that is corroborated by He et al. (2018) who highlight that it is fundamental for the sustainable continuity of the business and the success of the organization to have regional support and possibilities.

On the other hand, Esmailian et al. (2016) point out that it is important to avoid errors (behavioral and non-behavioral) when selecting a location. The findings are in line with this premise, showing that they also consider a strategic location to be important, which allows for a wide coverage, both in terms of ease of access and in terms of the proximity of customers to their suppliers. This issue is so emphatic that Sakai et al. (2020) reiterate that behavioral errors often lead to hasty decisions, such as considering personal factors before the success of the location. The lack of know-how is also relevant to be

considered, according to Wang et al. (2020) this absence, in most cases, generates a deficiency of analysis and appropriate investigative practice, disregarding critical factors and characteristics of the industry or business.

When analyzing each criterion, starting with Regional Development - F₄ (Figure 4), it can be seen that for the respondents, the industrial trend of the local potential over a five-year horizon is extremely relevant compared to the others, with almost 60% of weight, in addition to, there is also a need for the availability of skilled labor to carry out the activity. Confirming this perception, Zang et al. (2020) emphasize that the availability of specialized labor, with adequate education focused on the business and customers, experience and potential for the development of new skills, must be available, renewable.

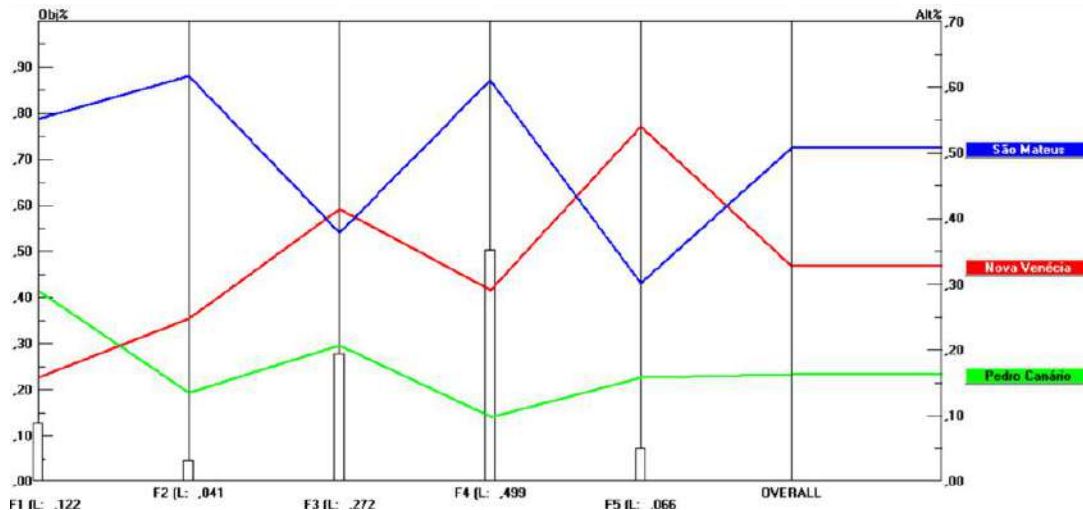


Fig. 4: Comparison of peer judgments

Thus, considering the F_4 attribute, São Mateus presented more adequate availability of land and land use, with an expectation of more expanded industrial development in relation to the other municipalities. On the other hand, when the Coverage factor (F_3) of the business was verified, the proximity of customers and suppliers was considered important (Table 4). In fact, for this reason Heitz et al. (2019), point out that in order to reduce costs, it is of great importance to be close to the consumer market and its suppliers, however, as the consolidation of this fact is almost impossible, the choice must be in accordance with the company's organizational strategy. From this point of view, the municipalities of São Mateus and Nova Venécia were evaluated as presenting more satisfactory conditions in two subfactors each, with the second municipality standing out with a small difference.

Analyzing Table 4, it is noticeable the high importance of considering transport costs in the location of a company, which according to Badri (1999) and Ketokivi et al. (2017) represent approximately 60% of logistics costs, something that still impacts between 5% and 26% of the company's gross revenue. It is worth noting that, in addition to transport costs, the respondents also consider maintenance costs to be important, with São Mateus standing out in both subfactors.

The results also reveal that the factor related to government policies (F_5) was not considered of solely decisive importance (Table 4), however, both states and municipalities are, in most cases, offering different types of benefits, according to Anvari and Turkay (2017) and, from there, seeking to attract new facilities to their regions, something that according to these authors can make a competitive difference when it comes exclusively to costs.

Another important result is related to tax incentives (F_{51}) which, in the opinion of the respondents, are the main

benefit in the search for the right place. Within this context, the judgments point to Nova Venécia as the most attractive place. It is worth noting that this municipality has Law No. 3014 of March 2010, which provides for the granting of tax incentives and economic incentives for new ventures to be installed in the municipality. The São Mateus Chamber also approved a Bill (040/2014) in August 2014, which creates tax incentives with the aim of attracting new companies. Something that, Rodrigue (2020) reports that it is necessary in terms of attractiveness, that a municipal area reserved for new ventures, has the forecast of exemption or incentive in the reduction of taxes. For this author, this is an important factor to be considered in a facility installation, due to the fact that taxes affect the final result in some financial statements.

On the other hand, the subfactors related to Demography (F_2) were considered to have less influence on the location selection, with urban growth highlighted (F_{22}). This growth, according to Simoni et al. (2018) is an important phenomenon to be understood and monitored throughout, and should even serve as a point of reflection regarding the location of an enterprise. In factor F_2 , the municipality of São Mateus prevailed.

Finally, a sensitivity analysis was performed to analyze the effect of changing the weights of the main factors in the ranking of municipalities. Differences in the classification of municipalities were not significant using three scenarios, as indicated by Gonçalves (2016). However, it is worth mentioning that with a change of 87.5%, the ranking is slightly altered, demonstrating that the judgments are consistent with the choice of the municipality of São Mateus for the new facilities of the company for leasing and selling containers.

VI. FINAL CONSIDERATIONS

The location of facilities has a high potential for sustainable regional development, promoting several benefits, such as diversifying the economic matrix, contributing to increase national and regional economic growth, as well as increasing employment opportunities. Thus, according to the findings of this work, which corroborate the literature, it is abundantly important to prioritize viable locations for facilities installations, as it is a multifaceted decision process.

In this way, taking into account the fact that there is no method, tool, approach or a comprehensive decision support structure for the selection of any location for facility installation, which cannot advance and indicate other points of view, this work tried to address this research gap. For this reason, it proposed a methodological approach that can be adapted, readjusted and improved for the selection of locations for the installation of companies.

Thus, according to the opinions of different stakeholders working in the researched sector, the main determinant attributes for the location of container rental and sale companies were identified, also using expert feedback, determined through the use of the multicriteria Analytic Hierarchy Process method. (AHP). In general, after using the different opinions and perceptual judgments regarding the decision alternatives gathered through the AHP, the following factors and sub-factors emerged as essential: regional development (regional trend and skilled labor); scope (closeness to customers and proximity to suppliers) and costs (transport and maintenance). The results revealed the municipality of São Mateus as the most ideal place for the installation of container rental and sale companies.

Within this context, it is important to emphasize that decisions to choose the location for the installation of companies are taken as a result of strategic management priorities, and should provide a sustainable competitive advantage over its competitors. We hope that research using the AHP will continue to be an important component of public and business management, policy and, above all, operational research. The results of this work can be useful for regional development policy makers, private economists and public and private investment decision makers to choose the most appropriate locations.

We use a limited number of attributes (factors and subfactors) and potential alternatives in this work. Some of these potentially significant attributes (land ownership, geographic information systems, etc.) that influence site selection for business installations were not included in the analysis. As an example, the cost of land is one of the important factors in this process. However, in this study

we evaluated the northern region of the State of Espírito Santo (Brazil) and did not cover specific locations within the areas that make up this region. Other limitations of the work were the omission of data and information from public agencies. Therefore, the results of this work cannot be generalized.

In future research, we recommend analyzing the adjustment of other approaches and methods to the problem of site selection for the installation of container rental and sale companies, such as the hybrid use with fuzzy logic, Structural Equation Modeling (SEM), Data Envelopment Analysis (DEA), among other resources. In choosing and weighting the attributes, it would be abundantly useful to assess the opinions of academics, in addition to the expanded diversity of specialists and stakeholders. This, if necessary, because the AHP has a dependency in terms of external validity.

ACKNOWLEDGEMENTS

We thank the Operations Research Laboratory, Logistics and Transport (POLT) of the Federal University of Espírito Santo (UFES)/ University Center North of the Espírito Santo (CEUNES) by the academic and technical support in the design and development of this work.

REFERENCES

- [1] Badri, M. A. (1999). Combining the analytic hierarchy process and goal programming for global facility location-allocation problem. *Int. J. Prod. Econ.*, 62(3), 237-248.
- [2] Şahin, T., Ocak, S., & Top, M. (2019). Analytic hierarchy process for hospital site selection. *Health Policy Technol.*, 8(1), 42-50.
- [3] Heitz, A., Launay, P., & Beziat, A. (2019). Heterogeneity of logistics facilities: an issue for a better understanding and planning of the location of logistics facilities. *Eur. Transp. Res. Rev.*, 11(1), 1-20.
- [4] He, M., Shen, J., Wu, X., & Luo, J. (2018). Logistics space: A literature review from the sustainability perspective. *Sustainability*, 10(8), 2815.
- [5] Onstein, A. T., Tavasszy, L. A., & van Damme, D. A. (2019). Factors determining distribution structure decisions in logistics: a literature review and research agenda. *Transp. Res.*, 39(2), 243-260.
- [6] Wang, Y., Peng, S., Zhou, X., Mahmoudi, M., & Zhen, L. (2020). Green logistics location-routing problem with eco-packages. *Transp. Res. E: Logist. Transp. Res.*, 143, 102118.
- [7] Faugère, L., White III, C., & Montreuil, B. (2020). Mobile access hub deployment for urban parcel logistics. *Sustainability*, 12(17), 7213.
- [8] Holl, A., & Mariotti, I. (2018). The geography of logistics firm location: the role of accessibility. *Netw. Spat. Econ.*, 18(2), 337-361.

- [9] Stević, Ž., Pamučar, D., Subotić, M., Antuchevičiene, J., & Zavadskas, E. K. (2018). The location selection for roundabout construction using Rough BWM-Rough WASPAS approach based on a new Rough Hamy aggregator. *Sustainability*, 10(8), 2817.
- [10] Santos, P. H., Neves, S. M., Sant'Anna, D. O., Oliveira, C. H., & Carvalho, H. D. (2019). The analytic hierarchy process supporting decision making for sustainable development: An overview of applications. *J. Clean. Prod.*, 212, 119-138.
- [11] Ho, W., & Ma, X. (2018). The state-of-the-art integrations and applications of the analytic hierarchy process. *Eur. J. Oper. Res.*, 267(2), 399-414.
- [12] Ruiz Bagueño, D., Salomon, V. A. P., Marins, F. A. S., Palominos, P., & Marrone, L. A. (2021). State of the art review on the analytic hierarchy process and urban mobility. *Mathematics*, 9(24), 3179.
- [13] Sá, G., Michels, C., Negrelli, A. Q., Gesuino, D. B., Martins, P. J., Bristot, V. M., ... & Yamaguchi, C. K. (2020). Analytic Hierarchy Process in Production Engineering: A Bibliometry Analysis. *Int. J. Adv. Eng. Res. Sci.*, 7, 209-219.
- [14] United Nations. (2019). *Division. World Urbanization Prospects: The 2018 Revision*. Department of Economic and Social Affairs, Population Division, United Nations. <https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf>.
- [15] Wojtyra, B., Kossowski, T. M., Březinová, M., Savov, R., & Lančarič, D. (2020). Geography of craft breweries in Central Europe: Location factors and the spatial dependence effect. *Appl. Geogr.*, 124, 102325.
- [16] Heitz, A., Dablanc, L., Olsson, J., Sanchez-Diaz, I., & Woxenius, J. (2020). Spatial patterns of logistics facilities in Gothenburg, Sweden. *J. Transp. Geogr.*, 88, 102191.
- [17] Rodrigue, J. P. (2020). The distribution network of Amazon and the footprint of freight digitalization. *J. Transp. Geogr.*, 88, 102825.
- [18] Zhang, W., Chong, Z., Li, X., & Nie, G. (2020). Spatial patterns and determinant factors of population flow networks in China: Analysis on Tencent Location Big Data. *Cities*, 99, 102640.
- [19] Crainic, T. G., Ricciardi, N., & Storchi, G. (2004). Advanced freight transportation systems for congested urban areas. *Transp. Res. Part C Emerg. Technol.*, 12(2), 119-137.
- [20] Browne, M., Sweet, M., Woodburn, A., & Allen, J. (2005). Urban freight consolidation centres final report. *Transport Studies Group, University of Westminster*, 10.
- [21] Tian, Z., Zhong, R. Y., Vatankeh Barenji, A., Wang, Y. T., Li, Z., & Rong, Y. (2021). A blockchain-based evaluation approach for customer delivery satisfaction in sustainable urban logistics. *Int. J. Prod. Res.*, 59(7), 2229-2249.
- [22] Simoni, M. D., Bujanovic, P., Boyles, S. D., & Kutanoglu, E. (2018). Urban consolidation solutions for parcel delivery considering location, fleet and route choice. *Case Stud. Transp. Policy*, 6(1), 112-124.
- [23] Laueremann, J. (2018). Geographies of mega-urbanization. *Geogr. Compass*, 12(8), e12396.
- [24] Weber, A. (1929). *Theory of the Location of Industries*. University of Chicago Press.
- [25] Lösch, A. (1954). *The Economics of Location*. Yale University Press.
- [26] Aldrich, H. (1999). *Organizations Evolving*. Sage.
- [27] Gordon, I. R., & McCann, P. (2000). Industrial clusters: complexes, agglomeration and/or social networks? *Urban Stud.*, 37(3), 513-532.
- [28] Zhang, W., & Guhathakurta, S. (2021). Residential location choice in the era of shared autonomous vehicles. *J. Plan. Educ. Res.*, 41(2), 135-148.
- [29] Guha, S., & Khuller, S. (1999). Greedy strikes back: Improved facility location algorithms. *J. Algorithms*, 31(1), 228-248.
- [30] Jain, K., Mahdian, M., Markakis, E., Saberi, A., & Vazirani, V. V. (2003). Greedy facility location algorithms analyzed using dual fitting with factor-revealing LP. *J. ACM*, 50(6), 795-824.
- [31] Snyder, L. V., & Daskin, M. S. (2005). Reliability models for facility location: the expected failure cost case. *Transp. Sci.*, 39(3), 400-416.
- [32] Chen, L., Olhager, J., & Tang, O. (2014). Manufacturing facility location and sustainability: A literature review and research agenda. *Int. J. Prod. Econ.*, 149, 154-163.
- [33] Govindan, K., Garg, K., Gupta, S., & Jha, P. C. (2016). Effect of product recovery and sustainability enhancing indicators on the location selection of manufacturing facility. *Ecol. Indic.*, 67, 517-532.
- [34] Temur, G. T. (2016). A novel multi attribute decision making approach for location decision under high uncertainty. *Appl. Soft Comput.*, 40, 674-682.
- [35] Wang, G., Gunasekaran, A., Ngai, E. W., & Papadopoulos, T. (2016). Big data analytics in logistics and supply chain management: Certain investigations for research and applications. *Int. J. Prod. Econ.*, 176, 98-110.
- [36] Emeç, Ş., & Akkaya, G. (2018). Stochastic AHP and fuzzy VIKOR approach for warehouse location selection problem. *J. Enterp. Inf. Manag.*, 31(6), 950-962.
- [37] Farahani, R. Z., Rashidi Bajgan, H., Fahimnia, B., & Kaviani, M. (2015). Location-inventory problem in supply chains: a modelling review. *Int. J. Prod. Res.*, 53(12), 3769-3788.
- [38] Esmaeilian, B., Behdad, S., & Wang, B. (2016). The evolution and future of manufacturing: A review. *J. Manuf. Syst.*, 39, 79-100.
- [39] Ghadge, A., Yang, Q., Caldwell, N., König, C., & Tiwari, M. K. (2016). Facility location for a closed-loop distribution network: a hybrid approach. *Int. J. Retail Distrib. Manag.*, 44(9), 884-902.
- [40] Anvari, S., & Turkey, M. (2017). The facility location problem from the perspective of triple bottom line accounting of sustainability. *Int. J. Prod. Res.*, 55(21), 6266-6287.
- [41] Ketokivi, M., Turkulainen, V., Seppälä, T., Rouvinen, P., & Ali-Yrkkö, J. (2017). Why locate manufacturing in a high-cost country? A case study of 35 production location decisions. *J. Oper. Manag.*, 49, 20-30.
- [42] Sakai, T., Beziat, A., & Heitz, A. (2020). Location factors for logistics facilities: Location choice modeling considering activity categories. *J. Transp. Geogr.*, 85, 102710.

- [43] Tuncel, S., Sipahi, C., Akçay, A., Altin, O., Sariözkan, S., Gökdağ, A., ... & Arıkan, M. S. (2021). Analysis of Different Production Systems in Laying Hen Enterprises with Analytic Hierarchy Process in Turkey. *Braz. J. Poultry Sci.*, 23(3), 1-10.
- [44] Saaty, T. L. (1988). *What is the analytic hierarchy process?* In *Mathematical models for decision support*. Springer.
- [45] Gonçalves, W. (2016). *Integração de Técnicas de Análise Multivariada e Método Multicritério para Localização de Centros de Distribuição* [Doctoral dissertation, Methodist University of Piracicaba]. UA Campus Repository. http://iepapp.unimep.br/biblioteca_digital/pdfs/docs/18112016_160918_wellingtongoncalves_ok.pdf.
- [46] Khattak, S. B., Hussain, I., & Nawaz, R. (2019). Evaluating the Social Aspect of Sustainable Construction for Pakistan via Analytical Hierarchy Process. *J. Eng. Appl. Sci.*, 38(1), 93-100.

The prevalence of Sepsis in a public maternity hospital in the Eastern Amazon

Francisco Otávio Alves Cordeiro¹, Silvia Ferrera Nunes², Xaene Maria Fernandes Duarte Mendonça³, Rubenilson Caldas Valois⁴, Heliana Helena de Moura Nunes⁵, Irna Carla Rosário Souza Carneiro⁶

¹Master's Student of the Postgraduate Program in Management and Health in the Amazon (PPGGAS), Belém, Pará, Brazil. Email: fcootavio@yahoo.com.br

^{2,3}PPGGAS Professors, Belém, Pará, Brazil.

⁴Doctor. Professor at the State University of Pará - UEPA, Belém, Pará, Brazil

⁵Co-supervisor Professor at PPGGAS, Belém, Pará, Brazil

⁶Supervisor Professor at PPGGAS, Belém, Pará, Brazil

Received: 21 Jun 2022,

Received in revised form: 19 Jul 2022,

Accepted: 23 July 2022,

Available online: 29 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Sepsis, Prevalence, Hospital Infection.

Abstract—This study aims to evaluate the prevalence of sepsis in a public maternity hospital in the Eastern Amazon. This is a descriptive, retrospective cross-sectional study with a quantitative approach, carried out with data from 135 medical records of patients affected by sepsis in a referral hospital, in 2021. The data were tabulated in the Statistics Program for Social Science for Windows (SPSS® 16.0) software. , SPSS Inc, Chicago, IL, USA) and the research complied with Resolution No. 466/12 of the National Health Council, which regulates research with human beings. The results show sepsis predominant in females (82.96%), aged 19 to 29 years (48.15%), coming from the capital Belém, from the obstetric clinic (62.22%), with a focus of pulmonary infection (37.78%), organ dysfunction characterized by Systolic Blood Pressure < 90 mmHg or MAP < 65 mmHg or BP drop > 40 mmHg (56.30%), with sepsis outcome (75%) and tachycardia symptom (88.15%). It is concluded that this study contributed to the knowledge of the sepsis profile, and consequently to the assessment of the need to implement new health practices.

I. INTRODUCTION

According to the European Society of Intensive Critical Care (ESICM) and the Society of Critical Care Medicine (SCCM), sepsis can be understood as the appearance of an organic dysfunction, which can cause damage to life, and can be characterized by the presence of signs of the body's systemic inflammatory response to the presence of infection. [1]

In addition, sepsis is considered one of the most common fatal diseases worldwide and affects all ages, ranking among the 10 leading causes of death. [2]

Thus, treating the patient with sepsis often requires specific and specialized care present in Intensive Care

Units (ICU), as it is a sector capable of offering the necessary technological and therapeutic resources and with greater technology. In addition, the presence of a trained multiprofessional team is of paramount importance, in order to identify early signs and suggestive symptoms, and subsequently offer adequate assistance. [1]

In Brazil, it is estimated that 600,000 new cases arise per year, and this is the country with the second highest mortality rate from sepsis in ICUs. Among the factors that contribute to this are: growth in the number of elderly people and immunosuppressed patients and the emergence of multidrug-resistant microorganisms.[1]

In addition, the Instituto Latino Americano de Sepsis (ILAS) developed the SPREAD study (Sepsis PREvalence Assessment Database), conducted in 227 Brazilian intensive care units (ICU) randomly selected to adequately represent the national scenario, pointed out that 30 % of the country's ICU beds are occupied by patients with sepsis or septic shock. Therefore, the lethality in these patients was 55%. This finding makes us realize the high cost of sepsis in our country, both from the point of view of lost lives and from the economic point of view. [3]

According to the Ministry of Health, through Datasus/tabnet, [4] 9,697 hospitalizations for septicemia were recorded in the Hospital Information System (SIH), in hospital morbidity from January 2018 to December 2020, in all hospitals. public and private hospitals in the State of Pará. And in the years 2018 and 2019, 1,046 deaths were recorded by the ICD10 A40 and A41, which correspond to streptococcal septicemia and other septicemias respectively. [1]

Furthermore, in a prevalence study carried out at the Adult Intensive Care Unit of the Hospital de Clínicas Gaspar Vianna, in the city of Belém-Pa, 200 cases of sepsis, severe sepsis or septic shock were analyzed in patients over 18 years of age admitted to that unit, in the period from January to December 2012, there was a prevalence of 44% of septic shock, 4% of severe sepsis and 18% of sepsis. [5]

The use of a clinical protocol is one of the strategies that has been widely used to obtain good results in the treatment of sepsis. These instruments have been gaining strength, as they contribute to the systematization of patient care, as well as reducing the variation of specialized care; promoting safe care for users and health professionals; in the empowerment of the multidisciplinary team within the decision-making process, whether simple or complex; in offering subsidies for the elaboration of care, epidemiological, process and result indicators; improving communication between members of the multidisciplinary team; and in the coordination of care. [6]

Therefore, through a clinical protocol for sepsis, which can also be activated for patients who are suspected of having sepsis, a higher level of efficiency in care can be obtained, thus impacting the survival of patients affected by the disease, in the same way. way, in the reduction of the length of hospital stay and in the rates of morbidity and mortality. [6]

With this, it is up to the clinical manager to propose to the multidisciplinary team the use of the protocol, as well as to offer training on each step of the protocol and to carry out the monitoring of the indicators of the work processes, which involve a whole network of professionals

in the care and diagnosis. Therefore, managing a protocol is of fundamental importance to evaluate clinical practice and ensure quality in patient care.

Therefore, it is extremely important to measure the prevalence, mortality of sepsis and the difficulties in complying with the processes of the sepsis protocol. In light of this concern, the following questions were asked: What is the prevalence of sepsis in a public maternity hospital in Pará? What are the risk factors that contribute to the evolution of sepsis?

In view of the above, this study aims to evaluate the prevalence of Sepsis in a public maternity hospital in the Eastern Amazon

II. METHOD

This article presents the results of a descriptive, retrospective cross-sectional research with a quantitative approach, carried out through data obtained from the medical records of patients affected by sepsis within the Santa Casa de Misericórdia do Pará Foundation (FSCMPA) in the year 2021.

The data collection, study and work process was submitted for approval by the Research Ethics Committee of the FSCMPA, requesting waiver of the Free and Informed Consent Term (ICF), due to the study design and data acquisition being based on information present in the Sepsis Management Protocol (PGS) of the FSCMPA, physical and electronic medical records, Emergency Care Bulletin (ECB) and Computerized Systems. However, a Declaration of Permission for the Use of Data from the aforementioned institution was requested.

It is worth mentioning that this study was based on Resolution No. 466/12 of the National Health Council, which regulates research with human beings and guides its development, and was approved with the opinion embodied in Number. 5,161,290 of the Research Ethics Committee of the FSCMPA.

As for the risks to the institution, the study presents risks related to the misuse of data from physical and electronic medical records, which may generate a risk of disclosing confidential data; risk to the safety of medical records; and the breach of confidentiality of the participants' identity, to avoid this breach, alpha numeric code was used with the letters SP followed by the number in ascending order in the analyzed files (SP1, SP2, SP3...).

In the study, cases of Managed Sepsis Protocol (PGS) of adults, opened in the period from January to December 2021, were analyzed. In this way, the investigation took place in a population of 208 cases of sepsis in adults notified in 2021, taking into account the Degree of

Confidence of 95% and a Margin of Error of 5%, the sample consisted of 135 medical records of patients diagnosed with sepsis admitted to the Inpatient Units of the Internal Medicine, Surgical Clinic and Tocogynecology of the FSCMPA, aged 18 years or older, of both gender, with a hospital admission form and a completed sepsis notification form, from January to December 2021.

However, medical records that were unavailable during the research period or that were incomplete, medical records of patients diagnosed with sepsis under 18 years of age, as well as patients without a diagnosis of sepsis, were excluded.

To obtain the data, a form was used, made from epidemiological variables: Gender, Age, Days of hospitalization, Type of patient (clinical, surgical, obstetric), Diagnosis of admission and discharge, presence of signs of SIRS, Sepsis and Septic Shock recorded in medical records and filled in sepsis notification form, and operational variables according to the FSCMPA protocol that corresponds to the package of measures adopted in the first hour of Sepsis treatment.

Data collection was carried out from January to March 2022. Furthermore, the quantification of the collected data

Table 01: Statistics of sociodemographic data of patients related to age group, sex, municipality and type of patient, FSCMPA, Pará, 2021.

Age Group (Years)	N	(%)
19 -----29	65	48,15%
29 -----39	29	21,48%
39 -----49	11	8,15%
49 -----59	9	6,67%
59 -----69	12	8,89%
69 -----79	4	2,96%
79 -----89	5	3,70%
Gender	N	(%)
Female	112	82,96%
Male	23	17,04%
City	N	(%)
Belém	52	38,52%
Ananindeua	12	8,89%
Castanhal	4	2,96%
Moju	4	2,96%
Barcarena	4	2,96%
Capitão Poço	3	2,22%
Igarapé-Miri	3	2,22%
Anajás	3	2,22%

was documented in spreadsheets in Microsoft Excel® software, with descriptive analysis being performed with absolute and percentage frequency presentation for the variables present in this study, with the Statistics Program for Social Science for Windows software (SPSS® 16.0, SPSS Inc, Chicago, IL, USA).

The research may provide reflections and deepen the understanding on the subject, and may, thus, offer subsidies for the improvement of the view of health professionals in the promotion of comprehensive, humanized and qualified care.

III. RESULTS

In the present study, the prevalence of sepsis stood out in females, with 82.96% (n=112), aged between 19 and 29 years, with 48.15% (n=65), coming from the capital Belém, with 38.52% (n=52), however, when adding up all the other municipalities in the interior of the state, these constitute the majority, with emphasis on the municipality of the Ananindeua metropolitan region, with 8.89% (n=12), according to it is observed in Table 1:

Salinópolis	3	2,22%
Cachoeira Do Piriá	2	1,48%
Marituba	2	1,48%
Paragominas	2	1,48%
Santa Barbara	2	1,48%
Cametá	2	1,48%
São Caetano De Odivelas	2	1,48%
Capanema	2	1,48%
Abaetetuba	2	1,48%
Others	31	22,96%
Patient characteristic	N	(%)
Pregnant	40	29,63%
Puerperal	36	26,67%
Man	23	17,04%
Abortion	8	5,93%
Others	28	20,74%
Total	135	100%

Source: FSCMPA, 2021.

Regarding the classification by inpatient clinic, there was a predominance of the obstetric clinic with 62.22% (n=84) of the cases. Regarding the type of infection, the community type predominated with 73.33% (n=99). Regarding the type of infectious focus,

the pulmonary predominated with 37.78% (n=51), followed by the urinary tract, with 19.26% (n=26) (Table 2).

Table 02: Statistics of clinical data of patients related to the type of hospitalization, type of infection and infectious focus, FSCMPA, Pará, 2021.

Classification by inpatient clinic	N	(%)
Obstetric Clinic	84	62,22%
Medical clinic	48	35,56%
Surgical Clinic	3	2,22%
Type of infection	N	(%)
Community	99	73,33%
Acute respiratory infection (ARI)	36	26,67%
Infectious focus type	N	(%)
Pulmonary	51	37,78%
Urinary	26	19,26%
Acute Abdominal Infection	13	9,63%
Undefined Focus	9	6,67%
Other Infections (Puerperal)	8	5,93%
Surgical Wound Infection	7	5,19%
Skin and Soft Tissues	6	4,44%

Bloodstream infection Associated with Central Catheter	4	2,96%
Other Infections (endometritis)	3	2,22%
Other Infections (Infected abortion)	2	1,48%
Other Infections (missed abortion)	2	1,48%
Other Infections (chorioamnionitis)	2	1,48%
Other Infections (Pelvic Infection)	1	0,74%
Other Infections (Hospital Otitis Media)	1	0,74%
Total	135	100%

Fonte: FSCMPA, 2021.

Table 3 describes the statistics of the clinical data of the patients related to the type of organ dysfunction, in which there is a predominance of organ dysfunction characterized by Systolic Blood Pressure < 90 mmHg or MAP < 65 mmHg or fall in BP > 40 mmHg, with 56.30 %

(n=76). In second place, dysfunction 7, pO₂/FiO₂ ratio < 300 or recent or increased need for O₂ for saturation < 90%, with 52.59% (n=71). The other dysfunctions were present in a smaller amount.

Table 03: Statistics of clinical data of patients related to the type of organ dysfunction, FSCMPA, Pará, 2021.

Organic dysfunction 1	Arterial Blood Pressure < 90 mmHg or Mean Arterial Pressure < 65 mmHg or fall of AP > 40 mmHg	ABP < 90 mmHg ou MAP < 65 mmHg or fall of AP > 40 mmHg (%)
Presented	76	56,30%
Not Presented	59	43,70%
Organic dysfunction 2	Creatinine > 2.0mg/dL or diuresis less than 0,5mL/Kg/h in the last 2h	Creatinine > 2.0mg/dL or diuresis less than 0,5mL/Kg/h in the last 2h (%)
Presented	42	31,11%
Not Presented	93	68,89%
Organic dysfunction 3	Bilirubin > 2.0mg/dL	Bilirubin > 2.0mg/dL (%)
Presented	15	11,11%
Not Presented	120	88,89%
Organic dysfunction 4	platelet count < 100.000mm ³	platelet count < 100.000mm ³ (%)
Presented	13	9,63%
Not Presented	122	90,37%
Organic dysfunction 5	coagulopathy - INR > 1,5 or TTPA > 60 seconds	coagulopathy - INR > 1,5 or TTPA > 60 seconds (%)
Presented	10	7,41%
Not Presented	125	92,59%
Organic dysfunction 6	Lactato > 2.0 mMol/dL ou acima do Valor de Referência	Lactato > 2.0 mMol/dL ou acima do Valor de Referência (%)
Presented	57	42,22%
Not Presented	78	57,78%
Organic dysfunction 7	Relation pO ₂ /FiO ₂ < 300 or recent or increased need for O ₂ for saturation	Relation pO ₂ /FiO ₂ < 300 or recent or increased need for O ₂ for

	< 90%	saturation < 90% (%)
Presented	71	52,59%
Not Presented	64	47,41%
Organic dysfunction 8	Lowering the Level of Consciousness	Lowering the Level of Consciousness (%)
Presented	45	33,33%
Not Presented	90	66,67%
Total	135	100%

Fonte: FSCMPA, 2021.

As for the outcome, the majority evolved to sepsis (75%; n=102) to the detriment of septic shock, which occurred in 24.44% (n=33) of the cases. The length of stay in the ICU was short in general, between 0 and 15 days, with 87.41%, with a maximum period of 75 to 90

days (0.74%; n=1). Regarding evolution, most evolved to cure, with 64.44% (n=87). However, the percentage of deaths is considered high, which was 35.56% (n=48) (Table 4).

Table 04: Statistics of clinical data of patients related to length of stay in the ICU, outcome of the situation and death, FSCMPA, Pará, 2021.

Outcome	N	(%)
Septic shock	33	24,44%
Sepsis	102	75,56%
Length of Stay in the ICU (Days)	N.	(%)
0 ----- 15	118	87,41%
15 ----- 30	10	7,41%
30 ----- 45	2	1,48%
45 ----- 60	2	1,48%
60 ----- 75	2	1,48%
75 ----- 90	1	0,74%
Evolution	N	(%)
Death	48	35,56%
Alive	87	64,44%
Total	135	100%

Source: FSCMPA, 2021.

Regarding the classification of symptoms, there was a predominance of tachycardia, with 88.15% (n=119), followed by leukocytosis (85.19%; 115). Other symptoms were present in smaller amounts, but

with expressive numbers, such as hyperthermia/hypothermia (48.15%; 65) and Tachypnea (46.67%; 63) (Table 5).

Table 05: Statistics of Symptoms of patients related to Leukocytosis/Leukopenia, Hyperthermia/Hypothermia, Tachycardia and Tachypnea, FSCMPA, Pará, 2021.

Symptom type 1	N	(%)
Tachycardia	119	88,15%
No Symptom	16	11,85%
Symptom type 2	N	(%)
Leukocytosis / Leukopenia	115	85,19%
No Symptom	20	14,81%
Symptom type 3	N	(%)
Hyperthermia / Hypothermia	65	48,15%
No Symptom	70	51,85%
Symptom type 4	N	(%)
Tachypnea	63	46,67%
No Symptom	72	53,33%
Total	135	100%

Source: FSCMPA, 2021.

IV. DISCUSSION

The mean age identified in the present study was in disagreement with other studies, as this was carried out in a maternity hospital and which attends other clinics, it was higher in women of childbearing age.

In a study conducted in Minas Gerais, Brazil, the mean among participants was 63.3 years ($SD \pm 16.9$). [7] The occurrence of sepsis in this age group observed is associated with a higher risk of this population of having more serious diseases, which may be related to their innate and acquired immunity, which is altered. [8,9]

In this study, females predominated, because the research scenario's audience was greater among females, also disagreeing with other literatures, where males predominated, as in an investigation carried out in Minas Gerais, Brazil, in which males prevailed with 63.6%; and in São Paulo, where it was found that 62.25% of sepsis cases were among males. This greater involvement is believed to be due to hormonal differences between the sexes and the presence of higher levels of anti-inflammatory mediators in women. [10]

The higher prevalence in the capital, Belém, is explained by the fact that the study scenario is located in this municipality, and because it is a state reference hospital that meets high demand from other municipalities, mainly in the metropolitan region.

As for the characteristics of the patients, pregnant and postpartum women predominated, corroborating a similar

study that found a high rate of sepsis in women in the postpartum period (18.3%). [11]

The causes of sepsis in pregnant women can be obstetric or non-obstetric. The first group includes causes related to pregnancy (infected abortion, chorioamnionitis), childbirth (cesarean section or episiotomy wound infections, postpartum endometritis) or invasive procedures (post-cerclage infection). The second group includes especially urinary tract infections and pneumonia. Of these, the main focus of infection is the urinary tract, which is already a region more predisposing to infections due to physiological mechanical changes during pregnancy. [12]

Regarding the classification by inpatient clinic, the Obstetric Clinic predominated, also because it is a maternity hospital, but which serves other clinics.

Specifically in relation to pregnant women, the incidence and morbidity and mortality rates are lower, given that they represent a younger group with fewer comorbidities. The most common aetiology in this group is polymicrobial in origin. [13]

However, the number of studies that address the prevalence of sepsis is scarce, associated with this, there was no consensus until 1991 for terminology and, over these years, new definitions were assigned for sepsis, which makes it difficult to make correlations, considering the definition current. [9]

Regarding the primary foci of infection, the studies corroborate the most prevalent focus being the pulmonary,

as is the case of a study carried out in Recife-PE, Brazil, whose origin of sepsis was pulmonary in 79.3% of the cases, followed by gastrointestinal (14.8%) and urinary (13.6%).[9]

In another study, there was a pulmonary focus with 88.1% and the genitourinary focus with 46.3%, while the gastrointestinal focus was the least evident, with only 3.0%. [2]

In the general population, the presence of sepsis with a primary focus of pulmonary infection may be related to the fact that most of the population is composed of elderly people, who had some comorbidity, and thus present a higher risk of respiratory infection, due to an impaired immune response, as well as due to the higher frequency of Mechanical Ventilation use and prolonged ICU stay.[11]

In addition, the large number of infections at the pulmonary and abdominal sites is mainly related to the presence of the endogenous microbiota, characteristic of such regions that favors the infectious process.[11]

Urinary sepsis is considered a common urinary problem during pregnancy, and is characterized by the presence of infectious agents that colonize, invade and spread through the urinary tract. This infection occurs in 17 to 20% of pregnancies, [14] corroborating the present study.

Furthermore, urinary sepsis is an important factor of morbidity and mortality during the pregnancy-puerperal cycle, as pregnancy is a predisposing factor for the onset of this disease, which can cause serious complications to the future fetus, as well as to the pregnant woman herself.[14]

In general, pregnancy-related infection is the third leading cause of maternal death in the world and in the United States of America, with almost constant mortality since 1990. In developing countries, the incidence of puerperal sepsis is estimated between 0.1% and 10%, although there is a great disparity in the estimates due to the difference in diagnostic criteria between the study sources. [15]

In short, the pulmonary focus stands out as the site with the highest number of infectious processes, which reflects the fact that most of the population studied presented mechanical ventilation as the most frequent invasive procedure, in addition to respiratory dysfunction, which is evident the relationship between such risk factors for the worsening of the patients' condition. This was also proven in Brazilian studies, which showed the main sites of infection as the pulmonary and urinary [16]

Regarding the clinical data of the patients related to the type of organ dysfunction, arterial hypotension and low O₂

saturation predominated, which may be related to the predominant focus of infection being respiratory.

As for the outcome, sepsis predominated, corroborating other studies, as shown in a retrospective cohort study with 124 patients, in which 50% corresponded to sepsis; 18.5%, severe sepsis; and 31.5%, septic shock.[9] Although most of these studies bring the classification, they do not present a reason for the predominance of such classification. However, it is associated with severity, requiring time to be established after the diagnosis, and it is appropriate to do it at the end of the fourth day of the sepsis diagnosis, since the severity is usually defined in the first days and, therefore, way, in this period, there is greater precision.[9]

Disagreeing with these findings, other studies presented shock as the most incident outcome, as observed in an observational analytical study, which showed a prevalence of 44% of septic shock, 4% of severe sepsis and 18% of sepsis [9] and in the study by Zastrow that had severe sepsis in 15% and those with septic shock added up to 6%. [11]

Regarding the length of stay in the ICU, a relatively short time was found in this study, from 0 to 15 days. Furthermore, most studies showed a mean length of stay longer than that found in the present study, as observed in a study carried out in Santa Catarina, whose mean length of stay was 19.8 days (SD ±11.3). In Fortaleza, the length of stay in the ICU was, on average, 16.6 days. These shorter periods of ICU stay can occur in institutions with high demand for specialized beds, where, soon after the clinical picture has stabilized, many patients are discharged to the ward.[9]

Regarding the evolution of the patients, most of them were cured, but there is a high mortality. In the clinical outcome of Carvalho and Carvalho (2021), the vast majority of patients died [9], differing from other studies that showed a lower mortality rate. In a cohort carried out in 75 ICUs, the overall mortality in the septic group was 46.6% and in the sepsis, severe sepsis and septic shock subgroups it was 16.7%, 34.4% and 65.3%, respectively. In an analytical descriptive study in Rio Grande do Norte, Brazil, 30.2% died.[9]

In the vast majority of studies, age was related to the potential probability of death, but this result is largely due to other reasons, such as the presence of comorbidities, severity, as well as the differentiated therapeutic approach. Thus, it is clear that the clinical outcome is closely related to the early treatment offered to the patient.[9]

The mortality rate ranged from 16.0% in uninfected patients to 53.6% in those with hospital-acquired infection. Another data that corroborates the current study was the result demonstrated by Sousa et al. (2017) [16] which

presented the pulmonary site as the most prevalent, with a rate of 66.7%. [18]

As for Andrade (2018), with regard to mortality, of the 67 patients, only 11 (16.4%) survived, and 56 (83.6%) died, with 35 (62.5%) male and 21(37.5%) female. [2]

Regarding the symptoms presented, tachycardia predominated in this study, followed by Leukocytosis/Leukopenia. A study from Rio Grande do Sul found similar data regarding tachycardia, with 82.3% and tachypnea (80%). [19]

Thus, it was found in the analyzed studies that the treatment of sepsis should be started as soon as possible, aiming to improve the prognosis and reduce the chances of mortality. Implementing a rapid response team in the identification and initial treatment of patients with sepsis increases the likelihood of survival.[20]

General tests, such as blood count, biochemistry, renal and hepatic function, electrolytes, coagulogram, arterial blood gas with lactate, glycemia and, above all, cultures, should be collected early, as they can help guide therapy and predict prognosis. As previously pointed out, patients with septic conditions tend to develop acidemia, mainly at the expense of anaerobic metabolism and consequent production of lactate. Thus, monitoring arterial lactate levels and its evolution during treatment are an important tool in monitoring the response to therapy and contribute to a better prediction of the prognosis.[20]

As sepsis is one of the leading causes of mortality in the world, with an estimated incidence of up to 19 million people per year, it is consequently a major public health problem. In general, it has high mortality in Brazil, reaching around 60% of cases, while the world average is around 30%. [21]

In view of the significant reduction in mortality from sepsis in countries such as New Zealand and Australia associated with improvements in early diagnosis and treatment [22], the need to establish adequate diagnostic criteria for sepsis in Brazilian ICUs is irrefutable. Since sepsis morbidity and mortality is mainly related to late treatment and diagnosis, [22] and Brazil has a very high sepsis lethality, it is extremely important to contribute to reducing this rate, establishing supported scientific evidence that will contribute to diagnosis. and early treatment and lower burden for the Unified Health System (SUS). [21]

V. CONCLUSION

From this study, it was possible to evaluate the prevalence of sepsis in a public maternity hospital of reference in the North region of Brazil, where a

predominance of the disease was observed in the female population, in the young adult age group, with length of stay in the hospital. relatively short ICU.

The evolution towards cure was also evidenced in most cases, however, the percentage of deaths is still high, which lacks decision-making by managers and health professionals who work in the hospital environment. home, especially in the ICU and Obstetrics sectors, as they have the highest rates of sepsis.

It is believed that the data generated by this research can be used to evaluate the evolution of the disease, expanding the knowledge about the possible factors that can lead the patient to death, as well as, for the evaluation of the need to implement new health practices.

In this way, there is a need for the multidisciplinary team that provides assistance in the critical care sector to always be attentive to the clinical manifestations of patients, so that the diagnosis of sepsis and the definition of the appropriate treatment be instituted as early as possible to reduce the high rates of morbidity and mortality associated with sepsis.

Sepsis is considered one of the four main causes of mortality during pregnancy and has been showing a progressive increase in its incidence. Despite the implementation of the sepsis protocol developed by the Instituto Latino Americano de Sepsis, aiming to increase the perception of this syndrome and the new advances in sepsis therapy, morbidity and mortality still register significant numbers.

Specific physiological alterations related to pregnancy contribute to a potential site of infection that is easily identified, as well as easier access to the infectious focus in the event of the need for surgical exploration. Taking these aspects into consideration, it is possible to make an early diagnosis and avoid the serious consequences of sepsis.

REFERENCES

- [1] Carvalho, M.; Carvalho, M. Prevalência de sepse em um centro de terapia intensiva de um hospital de ensino. *Enfermagem Foco*, v. 12, n.3, p. 582-7. 2021. Available: <http://revista.cofen.gov.br/index.php/enfermagem/article/view/4382>.
- [2] Andrade, D.C. Prevalência de sepse na unidade de tratamento intensivo e os fatores associados. *Revista Brasileira de Inovação Tecnológica em Saúde*, p. 11-11, 2018.
- [3] A Sepse se não tratar ela mata. (2019). ILAS - Instituto Latino-Americano de Sepse. Available: <https://www.ilas.org.br/o-que-e-sepse.php>. Access: October 25, 2021.

- [4] Sistemas de Informações Hospitalares do SUS (SIH/SUS): Internações por Septicemia segundo ano de processamento 2018 a 2020. (n.d.). MINISTÉRIO DA SAÚDE - Datasus. Available: <http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sih/cnv/nrpa.def>. Acess: October 25, 2021.
- [5] Xavier, S., Andriolo, B., Carneiro, I., Andriolo, R. Prevalência de sepse em unidade de terapia intensiva da região norte do Brasil. *Braz. J. Surg. Clin. Res.-BJSCR*, 22(3), 07-12. 2018. Available: <http://www.mastereditora.com.br/bjscr>.
- [6] Silva, D. F. D., et al. Conhecimento de enfermeiros emergencistas acerca do protocolo clínico de sepse. *Rev. enferm. UFPE on line*, 1-14. 2021.
- [7] Aquino, R.L.; Inacio, A.C.; Diogo Filho, A., Araújo, L.B. Sepse em pacientes com lesão renal aguda severa. *Rev Enferm UFPE Online*. V.11, n.12, p.4845-53, 2017.
- [8] Barros, L.L.; Maia, C.S.; Monteiro, M.C. Fatores de risco associados ao agravamento de sepse em pacientes em Unidade de Terapia Intensiva. *Cad Saúde Colet.* v.24, n.4, p. 388-96.2016.
- [9] Carvalho, M.K.R.; Carvalho, M.R.D. Prevalência de sepse em um centro de terapia intensiva de um hospital de ensino. *Enfermagem em Foco*, v. 12, n. 3, 2021.
- [10] Moura, J.M.et al. Diagnóstico de sepse em pacientes após internação em unidade de terapia intensiva. *Arq Ciênc Saúde*. V.24, n.3, p.55-60.2017.
- [11] Zastrow, J.B.et al. Sepse em gestantes atendidas em um hospital público de Curitiba-PR. *Revista da Sociedade Brasileira de Clínica Médica*, v. 16, n. 4, p. 208-211, 2018.
- [12] Matos, K.L.A. et al. Sepse durante o período gestacional. *Revista Eletrônica Acervo Saúde*, v. 11, n. 17, p. e1166-e1166, 2019.
- [13] Cordioli, Ricardo Luiz et al. Sepse e gravidez: sabemos tratar?. *Revista Brasileira de Terapia Intensiva*, v. 25, p. 334-344, 2013.
- [14] Souza, Jéssica Pereira Lima de; Mendes, Daniella Ribeiro Guimarães. Prevalência de sepse urinária em gestantes da UBS/ESF do Cruzeiro do Sul. *Revista de Divulgação Científica Sena Aires*, v. 4, n. 1, p. 40-51, 2015.
- [15] Silva, Antonio Paulo Nunes et al. Sepse puerperal: Uma revisão integrativa. *Research, Society and Development*, v. 10, n. 8, p. e31710817374-e31710817374, 2021.
- [16] Barreto, M. C. F. et al. Sepse em um hospital universitário: estudo prospectivo para análise de custo da hospitalização de pacientes. *Revista da Escola de Enfermagem da USP*, v. 50, n. 2, 2016. Available: http://www.scielo.br/pdf/reeusp/v50n2/pt_0080-6234-reeusp-50-02-0302.pdf. Acess: 13 jun. 2022.
- [17] Sousa, A.F.L.; Layze, B.O.; Moura, M.E.B. Perfil epidemiológico das infecções hospitalares causadas por procedimentos invasivos em unidade de terapia intensiva. *Rev Prevenção Infecção e Saúde*.v.2, n.1, p.11-7.2017.
- [18] Reiner, Gabriela Longhi et al. Desfecho clínico e fatores associados ao óbito em pacientes com sepse internados em unidade de terapia intensiva. *Arquivos Catarinenses de Medicina*, v. 49, n. 1, p. 02-09, 2020.
- [19] Zanon, Fernando et al. Sepse na unidade de terapia intensiva: etiologias, fatores prognósticos e mortalidade. *Revista Brasileira de Terapia Intensiva*, v. 20, p. 128-134, 2008.
- [20] Pires, Henrique Fernandes de Moura et al. Sepse em unidade de terapia intensiva em um hospital público: estudo da prevalência, critérios diagnósticos, fatores de risco e mortalidade. *Brazilian Journal of Development*, v. 6, n. 7, p. 53755-53773, 2020.
- [21] Cruz, Leonardo Lopes; Macedo, Cícero Cruz. Perfil Epidemiológico da Sepse em Hospital de Referência no Interior do Ceará. *Revista de psicologia*, v. 10, n. 29, p. 71-99, 2016.
- [22] Besen, Bruno Adler Maccagnan Pinheiro, et al. Sepsis-3 definitions predict ICU mortality in a low- middle-income country. *Annals of Intensive Care*, v.6, n.1, p.107, 2016

Interdisciplinarity as a Natural Strand of Scientific Knowledge

Interdisciplinari dade Como Uma Vertente Natural do Saber Científico

Sandro Dau, Sérgio Rodrigues de Souza, Vinícius da Silva Santos, Adébio de Jesus Ribeiro Lisboa

Received: 24 Jun 2022,

Received in revised form: 15 Jul 2022,

Accepted: 21 July 2022,

Available online: 29 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *Interdisciplinarity, Didactic-pedagogical actions; teaching-learning*

Palavras-Chave— *Interdisciplinaridade; Ações didático-pedagógicas; ensino-aprendizagem.*

Abstract— *This article addresses a theme that meant to interpret interdisciplinarity as a scientific natural aspect of one strand. It is a study that aims to discuss a dimension of the theme from the epistemic strand. The general aim is to present concepts defended by various renowned authors in the subject in order to get the best understanding of the subject in question. Have a specific objective to discuss the application of interdisciplinarity the academic field (basic school level-bachelors and higher education) and analyse as a intervention proposal in teaching. It's scientific relevance lies in expanding the field of theoretical argumentation about didactic-pedagogical praxis. Based on the thoughts of Olga Pombo, Ivani Fazenda and Oppenheimer these are the authors who best explore the problem of Interdisciplinarity in pedagogical performance.*

Resumo— *Este artigo aborda a temática que visa a interpretar a interdisciplinaridade como uma vertente natural do saber científico. Trata-se de um estudo onde se pretende discutir a dimensão do tema a partir de uma vertente epistêmica. Tem como objetivo geral, apresentar conceitos defendidos por autores renomados no assunto, a fim de aproximar-se de um entendimento mais amplo sobre o assunto em questão. Tem como objetivos específicos discutir a aplicação da interdisciplinaridade no âmbito acadêmico [nível escolar básico – bacharelado e superior] e analisá-la como proposta de intervenção no ensino. A sua relevância científica está em ampliar o campo da argumentação teórica acerca da práxis didático-pedagógica. Fundamenta-se no pensamento de Olga Pombo, Ivani Fazenda e Oppenheimer, por ser estes os autores que melhor exploram a problemática da interdisciplinaridade na atuação pedagógica.*

INTRODUÇÃO

Toda ciência é, por natureza, interdisciplinar, estando sempre ligada de uma forma objetiva ou subjetiva a outras categorias de ciências. Isto se dá porque ao se construir os elementos de conexão entre o pensamento, realizando a transposição didática processual, termina-se,

assim, por adentrar nos campos respectivos de outras disciplinas e/ou ciências ou a fazer uso de seus recursos específicos, como a linguagem, ferramentas, princípios, categorias e domínios.

Interdisciplinaridade pode ser entendida, *grosso modo*, como a integração de dois ou mais componentes

curriculares na construção do conhecimento. Ela surge como uma das respostas mais prementes à necessidade de uma reconciliação epistemológica, processo necessário devido à fragmentação dos conhecimentos ocorrido com a revolução industrial e a necessidade de mão de obra especializada.

Desde a origem de seus estudos formais, tem buscado conciliar os conceitos pertencentes às diversas áreas do conhecimento, a fim de promover avanços como a produção de novos conhecimentos ou mesmo, novas subáreas que propiciem maior clareza lógica às áreas de estudos sistemáticos.

Trata-se de um movimento, um conceito e uma prática que está em processo permanente de construção e desenvolvimento dentro das ciências e do ensino, sendo estes, dois campos distintos nos quais a interdisciplinaridade se faz presente. Ela surge no século XX como um esforço de superar o movimento de especialização da ciência e superar a fragmentação do conhecimento em diversas áreas de estudo e pesquisa.

Esta divisão que, *a priori*, representa uma proposta muito válida, defendida por B. Pascal (1623-1662), no intuito de que se pudesse ver melhor, com mais transparência e profundidade as partes que compõem o conjunto sistêmico do processo e/ou do objeto. No entanto, ao longo dos anos, estas divisões tornaram-se arbitrárias e transformaram-se em verdadeiros departamentos, zonas proibidas aos não iniciados naquela disciplina, naquele ramo que passou a ser tomado como a ciência em si.

A fim de minimizar o impacto provocado por esta desestruturação do conhecimento, o ensino formal teve que passar por mudanças à medida que as definições de mundo e de homem e educação o confronto e as nuances entre estes elementos tangíveis e intangíveis imbricavam-se na construção de uma nova ordem social.

Dentro destas mudanças ocorreu que as formas de ensinar e aprender também tiveram que se adaptarem aos sujeitos e às novas exigências epistemológicas. Ou seja, deixaram de formar blocos isolados de conhecimentos fragmentados para se unirem a um novo paradigma educativo que se traduzissem em um aprendizado contínuo e inerente com o mundo exógeno do indivíduo.

Esta proposta de ensino agregado a outros campos nunca foi novidade, somente cabendo a uma mente obtusa imaginar que sua doutrina é uma ilha que se respalda por si só. Os elos que compõem uma pequena parte do pensamento humano estão todos imbricados em cadeias lógicas que se complementam em sequências perfeitas, no entanto, nunca isoladas, como se fossem independentes entre si.

Quando tudo isto se anexa ao ser, termina por formar o que se convencionou chamar de conhecimento, mas que é algo que está bastante além do sujeitado ao convencionalismo acadêmico e as propostas colocadas como elementos de formação do pensamento superior estão conectados na proposta de construção cognitiva, que é a execução da intelectualidade sobre determinados processos dinâmicos, resultando em construções primorosas de entendimento, compreensão e síntese da realidade objetiva e subjetiva.

O Conhecimento é uma parcela mínima da infinitude de tudo que é desconhecido ao homem: é o que sobra depois que já se esqueceu tudo. Numa definição empírica, poder-se-ia dizer que é a alavanca que faz a civilização humana sair de seu ponto estático, para um movimento uniformemente variado que é a constante necessidade de novos conhecimentos, a fim de suprir necessidades que antes não existiam e que agora necessitam ser dominadas.

A educação moderna é, ainda, *ad orecchio*, ou seja, ainda se privilegia dentro do processo de ensino-aprendizagem, apenas uma função, e para ajudar, o estudante fica confinado entre quatro paredes ouvindo um professor a recitar velhas fórmulas que não terão utilidade alguma na vida futura do aluno. A pergunta que não quer calar é “de que forma poderá haver aprendizagem significativa se o que é ensinado não possui nenhum significado”? Literária ou científica, liberal ou especializada, toda a nossa educação é predominantemente verbalista e, pois não consegue atingir plenamente seus objetivos [*se é que possui algum definido*]. Em vez de transformar crianças em adultos completamente desenvolvidos, ela produz estudantes de ciências naturais que não tem a menor noção do papel primordial da Natureza como elemento fundamental da experiência; entrega ao mundo estudantes de humanidades que nada sabem sobre a humanidade, seja ela a sua, ou de quem mais for, ou simplesmente a humanidade em geral.

A etimologia de cada palavra representa a base substancial para a compreensão do seu significado e, por conseguinte, do seu conteúdo. Assim, para dar-se conta do esclarecimento do conceito (que vem a ser uma abstração do real), recorreremos ao significado do signo linguístico: do latim *discere*, disciplina quer dizer aprender e, de seu derivado, *discipulus*, aquele que aprende. Disciplina significa também, no campo da pedagogia, um conjunto de normas de conduta estabelecidas com vistas a manter a ordem e o desenvolvimento normal das atividades numa classe ou numa escola. Logo, interdisciplinaridade, seria expressa por aquela categoria didática que aprende enquanto ensina agindo dentro de outras categorias do saber.

Em termos práticos, a interdisciplinaridade é um esforço de superar a fragmentação do conhecimento, tornar este relacionado com a realidade e os problemas da vida moderna. Muitos esforços têm sido feitos neste sentido na educação. Na ciência, por sua vez, os esforços estão na busca de respostas, impossíveis com os conhecimentos fragmentados de uma única área especializada.

Segundo H. Japiassú (1976), na interdisciplinaridade faz-se *mister* a intercomunicação entre as disciplinas, de modo que resulte uma modificação entre elas, através de diálogo compreensível, uma vez que a simples troca de informações entre organizações disciplinares não constitui um método interdisciplinar, ou seja, não há como conceber um processo educativo onde o aluno aprende anatomia sem ter, jamais, visto um corpo inteiro. Na Matemática, ensina-se as 4 (quatro) operações básicas ao estudante; mas, em nenhum momento este experimenta a oportunidade de fazer uma compra, efetuar uma venda, fazer os cálculos das margens de lucros e dividendos e etc., ou seja, não lhe é oferecido a oportunidade de experienciar a realidade objetiva que lhe foi ensinada.

Este tipo de ensino, em que se prende exclusivamente ao abstrato, cria uma ilusão de sabedoria e de domínio do conhecimento, em que as notas elevadas dos estudantes são a resposta positivista ao problema posto e isto passa a ser tomado como determinante de inteligência, de habilidade e de competência técnica. Assim, quando se propõe exames práticos para se auferir o grau de domínio das habilidades adquiridas teoricamente, tem-se críticas e resistências, quando deveria haver incentivo a tais situações, porque neste processo não se está a medir a capacidade do estudante [*unicamente*]; o objetivo é saber até que ponto os empreendimentos didáticos necessitam de intervenção, ajustes, aprimoramento, aperfeiçoamento, considerando que assim, ter-se-á um ensino mais vinculado à necessidade real que a vida coloca aos estudantes e a aprendizagem seja centrada naquilo que realmente interessa aprender.

Quando se faz com que o estudante confronte o seu saber na prática, acontece aí, uma verdadeira situação interdisciplinar, porque necessita, entre outras coisas, mobilizar saberes que estão armazenados em sua memória desde muito tempo, o que exige esforço intelectual de sua parte, capacidade mnemônica, respeito a regras de outras disciplinas e ciências e contrapontos, surgimento de conflitos e solução dos mesmos. Permite-se a construção de um amplo processo de pensamento em que os elementos se entrecruzam e confluem para determinar o que se pode chamar de aprendizagem significativa.

Esta questão de aprendizagem significativa é complexa e de difícil esclarecimento e mais embaraçoso ainda definir o seu dimensionamento, porque quem decide se aquilo que se vai ensinar é significativo para quem aprende? Geralmente, os pensadores [*que não sabem nem pensar*], responsáveis pela elaboração do currículo e do recorte de disciplinas e conteúdos ali presente ficam surpresas, quando o estudante arrota que não aprendeu nada, porque tudo aquilo é vazio e opaco, estas mesmas figuras olímpicas, capitólicas, lançam a culpa sobre o professor, justamente sobre aquele que é o grande promotor do processo.

A fusão de ideias, bem como a troca simbólica de saberes em torno de elementos [*aparentemente*] conflitantes é uma situação cotidiana a que qualquer ser humano ver-se-á posto um dia e o mais intrigante é que não é ensinado desde os primeiros anos escolares a pensar soluções a partir de outras ciências e sim, somente a buscar a solução, não a pensá-las como objetos que se intercomunicam.

O aprendizado deve ter uma condição, a destacar a utilidade para o estudante e isto, somente se prova a partir de que se proponha desafios que mostrem sua relevância para a vida do aluno. Muitas coisas que se aprende na escola são tão abstratas que, anos mais tarde, não se conseguiu uma resposta objetiva sobre a razão de ter-se dedicado com tanto esmero a aprender algo que se mostrou inútil para sua existência, não representando retornos diretos em suas carreiras.

Nisto, se busca certo apoio na interdisciplinaridade, como forma de aliviar esta carga de abstração inútil que passa a fazer parte de toda a grade curricular do estudante, como se isto fosse a única coisa que a escola tivesse a oferecer-lhes e não fosse procurar inovar; termina sendo somente isto o que vai ter a ofertar, tornando-se carraça como mecanismo de mostrar sua força empreendedora, não se sabe em que sentido.

A questão da inserção de um pensamento interdisciplinar na escola não é uma tarefa fácil de ser alcançada, porque criaram-se departamentos povoados por teóricos, pensadores, livros, obras, jargões, paradigmas e outras condições que se mostram quase impossível de serem transpostas pelo simples aspecto de domínio de saber erudito ou a intenção de aproximar-se deste.

O primeiro desafio posto é onde se pretende chegar com todo o planejamento, coisa que, geralmente não se sabe. Elabora-se projetos fantásticos, sem nenhum nexos causal com a realidade objetiva e muito menos, sem saber o que se pretende que o estudante alcance após todo o seu esforço epistemológico. Coloca-se que, com isto, o estudante vai dominar aquilo, jamais trabalham na questão

da expectativa e das possibilidades sobre o que se pode alcançar. Fazem isto, porque com estas colocações impositivas, ficam livres de proceder a uma avaliação séria e sistemática e que irá mostrar o quanto o processo é complexo e dependente de estudos profundos.

Estes estudos não são necessariamente para auferir respostas exatas a problemas abstratos; trata-se de tentar dar a devida dimensão a um problema que se vincula ao ser humano em si, como ser que existe no tempo e no espaço e que a cada geração, o desafio está posto novamente, cabendo àqueles que aprimoraram conhecimentos sobre o uso e a aplicação das técnicas de ensino e de aprendizagem, as empregarem, com o fim de obter respostas mais objetivas e eficientes. Portanto, a compreensão e o domínio sobre a interdisciplinaridade é uma busca constante e que, a cada descoberta nova, tem-se a possibilidade de aperfeiçoá-la, enquanto técnica de estudo e didática. Neste sentido, é que, a interdisciplinaridade vai tentar “horizontalizar a verticalização, para que a visão complexa seja também profunda, e verticalizar a horizontalização, para que a visão profunda seja também complexa” (DEMO, 1988, p. 88).

O que o autor classifica, nesta epígrafe, como horizontalização e verticalização são mecanismos de posturas diante do mesmo objeto em que a visão sobre um e outro se torna mais próxima de um entendimento real e não apenas uma explanação sem nexos e sem sentido. Ensinar presume muito mais que transferir potenciais conhecimentos a outros; é, além disto, oferecer condições especiais para que aquilo que o outro está absorvendo possa ser aplicado à sua realidade e resolver problemas cotidianos [*simples e/ou complexos*], mas que possa auferir a satisfação de domínio e avanço no sentido de responder às questões mais desafiadoras.

Observa-se todo tipo de propaganda prometendo o sucesso absoluto com empreendimentos fantásticos, mas em nenhum destes panegíricos ouve-se um destes seres iluminados [*e tão iluminados pela Razão teórica que estão até em condições de ensinar coisas impossíveis a outros*], abordarem a questão da necessidade absoluta de domínio da matemática e de suas regras essenciais. Da forma como ensinam aos outros a obterem sucesso em diversos ramos, não fazem mais que provocar um estado esquizofrênico que alimenta a ânsia e a expectativa vazia de qualquer coisa no espírito de um delirante.

Isto não é ensinar nada. Há que aprender a ciência real, aquela que foge ao controle de todos e que somente o seu entendimento mais complexo pode permitir a que se aproxime da compreensão factual e fenomenológica do objeto, da função mais próxima do que se deseja. Da forma

como tem-se ensinado nas escolas e mesmo nos cursos superiores, as ciências aparecem como coadjuvante, não indo muito além disto.

Ensinar algo útil a alguém presume que este saiba realizá-lo, uma vez aprendido e mesmo que possa dissertar sobre o mesmo, ainda que não seja um conteúdo que promova realizações na vida, mas que consiga agregar muitas coisas ao estudante ao longo do seu estudo, funcionando como um objeto idealizado, em que a sua conquista representa uma mera conquista, no entanto, tudo o que foi agregado de valor no tocante àquela conquista em particular é o que passa a fazer diferença real na vida do estudante, como pessoas que veio a conhecer, sistemas de valores, mecanismos de ação, de reação e de trocas simbólicas.

No caso em questão, onde se tem a preocupação com o desenvolvimento de um ideal interdisciplinar, como as ciências se ligam e desligam para formar o conhecimento necessário torna-se o eixo mais pertinente de desenvolvimento da existência humana. Não basta ao estudante ter conhecimentos, é preciso que saiba onde, quando e como aplicá-lo, na expectativa de que confira retornos epistêmicos objetivos aos estudiosos do problema posto.

Quando se pensa em vincular uma determinada disciplina a outra, não se pode deixar de preservar a essência de cada uma delas, o que geralmente, não ocorre, porque utiliza-se uma técnica que sobre a qual se detenha domínio ou que seja mais simples e fácil de ser aplicada e deduz, arbitrariamente que, ao estudante concluir determinada tarefa, estará aprendendo a outra, automaticamente e alcançando domínio cognitivo sobre esta tal matéria de caráter, antes, complexo.

Isto é nada mais que banalizar a aprendizagem, trazendo-a a um nível que não existe em nenhuma sociedade conhecida. Dinamizar conhecimentos é uma coisa e que não tem nada a ver com aprendizagem, porque esta encerra em si o desejo individual e autônomo de apreender o que está sendo ofertado. O aprendiz se vê motivado a buscar outras formas de entendimento do mesmo objeto, vinculando-o a outros espaços de tempo, figuras, normalidades e anormalidades até que possa criar sua própria estrutura intelectual sobre o ser.

Pedro Demo define a interdisciplinaridade “como a arte do aprofundamento com sentido de abrangência, para dar conta, ao mesmo tempo, da particularidade e da complexidade do real” (DEMO, 1988, pp. 88-9).

Neste ponto é que Demo vai apresentar a questão da necessidade de manutenção da essência de cada disciplina, extraíndo o que de melhor cada uma das que estejam envolvidas no processo tenha a ofertar, de acordo

com o plano curricular de ensino e fomentação dos trabalhos de ensino e de aprendizagem. Quando este autor explana aqui, a questão da arte, está subentendida a condição técnica a que se liga o procedimento, ou seja, necessita-se de um projeto, este bem elaborado, do âmbito didático e pedagógico, contendo uma situação-problema clara, uma descrição da problemática muito lúcida.

Seguindo esta mesma linha de pensamento, há que se dispor de um planejamento bem estruturado, que contemple as dimensões inseridas nas bases de elaboração do ensino da Matemática, em todas as esferas, especialmente, quando se infere da Educação Básica. E, por que, tanta ênfase neste tópico? A resposta é que, é nesta etapa da formação acadêmica do indivíduo, que se tem a oportunidade de promover o encontro dele com todos os outros campos, estes que vão, particularmente, fundamentar os processos vindouros em todo o resto de sua vida e, em todos os sentidos, não somente acadêmico-científicos.

Aqui cabe uma discussão bastante complexa, mas que não pode deixar de ser tratada que é a discussão de que a existência humana é atravessada, a todo instante pela interdisciplinaridade e, no entanto, quando a criança chega à escola, seu mundo é esfacelado em micro fragmentos e aprende a ver cada um deles de modo isolado, sendo depois disto, incapaz de enxergar o todo, não porque não o conheça [*às vezes e, não raro, até que é isto mesmo*], mas é que depois de tanto tempo manipulando peças soltas de um quebra-cabeça que nunca consegue montar, porque até mesmo aqueles que estão ali ensinando algo a ele não dominam, jamais o viram na íntegra, ninguém mais tem a imagem consciente de um mundo conexo; assim, quando se defronta com uma realidade conexas, se assusta ou a acusa de qualquer coisa e foge, quando não se atenta [*violentamente*] contra ela.

Não foi apenas a fragmentação do currículo em pequenas partes que promoveu a ruína do ensino e da aprendizagem, em si; foi toda a segmentação em disciplinas com seus conteúdos distantes uns dos outros, sem uma sequência lógica adequada à idade dos estudantes que provocou a derrocada final ao processo. Portanto, a questão central da interdisciplinaridade está mais centrada na condição de discurso e apresentação da mesma pelo professor que de uma elaboração complexa. A abordagem pedagógica auferida aos processos didáticos é que promovem tal distanciamento e a solução perpassa pela melhor preparação do professor, para que amplie a potencialização do diálogo com outros campos científicos, em nível de aprendizagem, porque em nível de ensino sistemático, isto já está dado pela própria dimensão dos conteúdos.

Entretanto, esta condição faz surgir outras dimensões mais complexas que é como relacionar estes conteúdos, a partir dos estudiosos clássicos sobre os mesmos e buscar as vertentes que os aglutinem sob um mesmo contexto de desenvolvimento epistemológico. Há que esclarecer que não adianta ter domínio sobre os conteúdos ensinados e/ou aprendidos; mas, muito além disto que, se os compreenda em suas dimensões particulares e singulares e isto só se torna possível quando se reúne pensadores de áreas distintas.

Pedro Demo sugere a prática de pesquisa em equipe como metodologia mais indicada, pela possibilidade da cooperação qualitativa entre especialistas. “Esta prática será viabilizada através das equipes de profissionais ou pesquisadores especialistas, mediados pela linguagem, pelo diálogo e pelos métodos acessíveis a todos” (ALVES, BRASILEIRO e BRITO, 2004, p. 139).

O que estes autores propõem é a troca não mais simbólica de suposições de conhecimentos, mas uma relação efetiva de saberes e experiências científicas, inclusive aquelas que fracassaram, porque assim, tem-se a oportunidade de analisar situações de aplicação de conhecimentos, práticas pedagógicas, situações didáticas, influências, compromissos e técnicas de ensino e de aprendizagem. Da forma como tem-se preconizado a chamada troca simbólica de saberes, é com a presença de algum professor que tenha obtido algum sucesso em sabe-se lá o quê e quando é chamado a expressar sua ação, não sabe nem o que falar, porque não existe registro de sua prática; ele simplesmente vai lá e faz, não considera o perfil do rigor acadêmico na aplicação do seu processo pedagógico, ou seja, ele ensina nada a ninguém.

Isto acontece porque surgiu a ideia de que tudo na vida, e mesmo na vida acadêmica, as coisas vão acontecendo sem um plano diretor, sem uma estratégia de ação devidamente planejada e que isto caracteriza-se como educação. A começar que nada disto se define como tal, depois que a elaboração de projetos e definições de objetivos e metas são formas de estudos sistemáticos que auxiliam na condução do pensamento e na análise dos procedimentos pedagógicos, quando de uma interpretação dos mesmos no futuro.

O uso de ferramentas inovadoras, instrumentos técnicos perpassa pela organização das ideias de forma a que permitam deduções, respostas mais objetivas para problemas que se repetem a cada ano, porque novas turmas chegam e estas são produto de uma sociedade e de uma cultura que não se renova ao sabor do vento. Este, outro grande erro do pensamento educacional moderno, em que, pelo simples fato de se ter como obter respostas com maior velocidade e mais facilidade que antes, isto seja mostra de

inteligência. Ter acesso à informação não garante que se saiba manuseá-la e nem mesmo, transformá-la em conhecimento útil. É aí que entra uma gama muito profunda de conhecimentos e técnicas oriundas de outros campos do saber erudito, os quais o professor e o estudante devem ter pleno conhecimento e domínio, até mesmo para dizer se está ao seu alcance ou não a possibilidade de investir em sua solução.

Esta é uma questão que se torna muito intrigante quando se trata de interdisciplinaridade, em que o professor de determinada disciplina necessita conhecer muito bem o seu campo de domínio e os campos que não domina para poder elaborar os projetos e os planejamentos de maneira tal que possa atender às necessidades epistemológicas de seus estudantes e aquilo que pretende proporcionar em termos de aprendizagem efetiva.

Ao se pensar uma questão de aprendizagem que se integre como eficiente, o professor tem à sua disposição que elaborar planos de ação que proporcione a capacidade de levar o estudante mais longe do que ele iria por si só e o que parece óbvio não é assim tão simplório, porque basta mudar o foco da investigação que se tem descortinado um mundo à frente, disponível para ser explorado e elucidado, quando ele próprio já não apresenta muitas respostas, antes impossíveis de serem alcançadas.

Este é o papel que cabe à interdisciplinaridade, o de possibilitar que outras ciências respondam aquilo que a ciência sobre a qual se debruça não encontra condições de o fazer. A exemplo, a Psicologia, antes de ser uma ciência autônoma, era uma disciplina da Antropologia, isto porque havia situações, comportamentos, costumes, entre outras coisas que se necessitava de uma disciplina diferente que pudesse conferir explicações plausíveis e, com isto, aproximar um pouco mais do entendimento sobre o objeto estudado, porque é isto o que as ciências fazem, elaboram teorias que ajudam a lançar luz sobre determinado problema, tornando-o menos complexo, sem a pretensão de revelar-se uma verdade absoluta.

Conhecer o tempo em que atua e a forma como o mundo tem se comportado é uma forma bem lúcida de traçar os planos de ação didático-pedagógicos. Neste sentido, Jantsche e Bianchetti (1997a) argumentam que a interdisciplinaridade não pode ser concebida fora dos modos de produção históricos em vigor. Significa que é produto de um processo que foi engendrado no meio da construção do conhecimento ao qual subjazem a filosofia e a ciência: inclui-se, aí, a fragmentação do conhecimento. A abordagem interdisciplinar deve ser entendida como produto histórico; tal compreensão não exclui a necessidade de avançar na direção de outro paradigma que permita uma aproximação maior da visão histórica. Não

implica também que interdisciplinaridade e especialidade não possam conviver de forma harmoniosa, dado que o *genérico e o específico não são excludentes*.

Estas situações são complementares, porque nem tudo vai sobreviver no plano do genérico e muito menos vai-se estabelecer no plano específico, dado que a ciência é social, aberta ao confronto e ao conflito, uma vez que é este sentimento que provoca os avanços epistemológicos e científicos. Nesta mesma seara, encontra-se disciplinas e ciências que são de caráter mais amplo e outras que são mais reservadas a interpretações mais complexas, portanto, não tão sujeita a ser explorada por todos os campos e suas ramificações são determinantes para que se explique aquilo que foge ao domínio do comum. Geralmente, estão na base dos problemas sociais e que, somente com sua ajuda, aliada a métodos específicos de investigação se torna possível uma compreensão mais ampla e, necessariamente, esta dimensão alargada do horizonte permite compreender o que ocorre no espaço restrito da vida privada.

Trazendo esta breve discussão para o campo da aprendizagem, tem-se, de repente, em uma sala de aula, um contingente de estudantes, em que, aparentemente, todos estão a buscar a solução do mesmo problema e isto, porque ele foi posto pelo mesmo indivíduo, que relativizou todo o esquema de pensamento. Ainda assim, cada um deles continua sendo um mundo fechado sobre si mesmo e que, ao saírem dali, o que aprenderam terá valores distintos em cada momento de suas respectivas vidas.

O papel do professor é demonstrar que em todos os campos, estão presentes todas as disciplinas, em maior ou menor grau, mas que haverá sempre a necessidade de entendimento de suas funções que são singulares em cada segmento e em cada momento e espaço. A primeira questão que isto invoca é que a divisão das ciências em áreas cada vez mais distintas é recente na história da humanidade e é quando tal ocorre que se começa a pensar na questão da interdisciplinaridade, dado que era desnecessário pensar nisto antes, quando não havia divisões tão radicais de pensamento. A empáfia que foi se formando em torno dos elementos teóricos, como se cada ciência ou, pior, cada disciplina pudesse responder às ansias sociais fez com que se recorresse a um tempo em que estavam todas reunidas, buscando a solução que se mostrasse mais plausível aos sintomas apresentados. Ao sábio era dado encontrar todas as respostas e sobre qual técnica específica se debruçava este estudioso, o mesmo que o médico e o sacerdote, porém, não era nenhum e nem outro, preocupando-se com os sintomas que o indivíduo apresentasse.

Em uma sala de aula, qual o sintoma que todos apresentam? Este é o problema histórico posto em busca

de solução pelo professor e para azar seu, terá que repetir a dose de investimento no ano seguinte, chegando a ficar entediado porque já ensinou isto tantas vezes. Sim, é fato; porém, o fez a um grupo distinto do que está a trabalhar neste exato momento, que detém outra psicologia e outra forma de enxergar o mundo, outras perspectivas. Mas, terá que anexar elementos novos, porque as pessoas se comunicam.

Este tem se mostrado o grande desafio posto à educação, em que se deve aprender a formar distintas personalidades, em momentos diferentes, mas não deixando de compreender que gerações de diferentes tempos comunicam, trocam informações e as comparam, com seus respectivos graus de conhecimento, o que aprendem, como aprendem e mais, o que é ensinado e como os professores administram estes processos, suas metodologias, suas práxis, seus modos de atuar e como reproduzem os formatos didáticos.

Por este motivo, é interessante que a cada ano, o professor de determinada disciplina vá introjetando saberes/conhecimentos de outras áreas, a fim de que possa construir um processo interdisciplinar, já mostrando aos estudantes que diversos campos científicos comunicam entre si, formando uma estrutura cognitiva de elevado grau de conexão direta com o que se tem de mais profundo no campo acadêmico.

Ensinar, através da interdisciplinaridade, implica muito mais que apenas juntar disciplinas [*aparentemente*] diferentes sob um mesmo enunciado; trata-se de mostrar ao estudante que, aquilo que ele busca como conhecimento pode ser encontrado em outros campos, porque está tudo disperso ao longo das várias ciências e dos sistemas de pensamentos, não exatamente em um único espaço restrito, como se deseja fazer pensar no modelo positivista e estruturalista de educação.

Desde os primeiros críticos da educação que já advém este questionamento sobre a origem do conhecimento e como ele se comporta ao longo do tempo, especialmente, quando se pretende transferi-lo a alguém, pensando já, na premissa do nascimento e fundamentação da didática, como uma ciência, como vir-se-ia a conhecer no futuro bem distante.

Etges faz uma crítica à reflexão atual sobre a interdisciplinaridade, por ser a sua orientação a-histórica. Para ele, a interdisciplinaridade deve orientar-se na direção da visão dialética ou histórica. Os elementos constitutivos do seu conceito partem das seguintes considerações: o fenômeno interdisciplinar não é metafísico; funda-se no trabalho dos cientistas; a ciência é vista como meio de produção de novos mundos adequados aos sujeitos; a ciência é uma totalidade fechada cuja existência somente é

possível quando exteriorizada pela linguagem; serve para “mediar a comunicação entre eles e o mundo do senso comum” (ETGES, 1997, p. 71). Ela é concebida como princípio mediador entre as disciplinas, não podendo ser entendida como função reducionista das disciplinas a um denominador comum, levando-as à destruição. Na visão histórica, ao contrário, reforçam-se os princípios da criatividade e da diferença.

Mas, este é o ponto mais interessante, em que a confirmação do diferente como algo sólido e que deve ser explorado e apreciado, torna-se o que marca a eficiência de trabalho e motiva para a contínua criatividade epistemológica. Diferença não é um termo abjeto que distancia os indivíduos, é nada mais que uma realidade notória e que a aceitação disto como fato social e como fato biológico a grande construção potencial de toda sociedade, no que se refere a seus valores intrínsecos, caracterizando sua personalidade e razão de ser e estar no mundo.

Foram nos momentos em que mais se preservou o direito ao pensamento contrário, respeitando as partes envolvidas que a humanidade pode alcançar os seus maiores êxitos, mesmo que isto se mostrasse aos olhos dos menos preparados como contrastes mortíferos e estranhos de se permitir a existência. Mas, o que mais desperta a atenção é o fato de que a interdisciplinaridade somente ganha seu espaço entre as metodologias de ensino, entre as práxis pedagógicas, proporcionando a efetiva relação de reciprocidade e simultaneidade entre teoria e prática quando se permite que os contrários, os diferentes, os dissonantes dialoguem entre si.

Quando se pensa um planejamento de ensino a partir da conjuntura histórica do objeto de estudo, surgem aspectos vinculados à curiosidade sobre como superou os desafios que lhe foram postos em determinados momentos da história e a partir daí, tem-se todo um desdobrar contextual, em que se descobrem os aspectos inerentes àquele tempo e que, por sinal, representam traços de similitude com o que se experimenta na atualidade.

A Matemática é considerada uma ciência pura, isto porque não derivou de nenhuma outra, não representando ramificações de técnicas já existentes; no entanto, sua aplicação prática e mesmo a aprendizagem dos seus domínios, do conhecimento de suas práticas, dependem de todas as outras ciências, isto porque a existência é interdisciplinar e assim o é, até que seja fragmentada pela educação formal e daí em diante não se tem mais a noção de unidade que a natureza proporcionou aos humanos em sua formação.

À medida que se vai adentrando o sistema de formação do pensamento complexo, mais simplificado vai

se tornando as formas de interpretar o mundo, transformando-o em pequenos blocos, com nomes definidos e aonde tudo e todos devem receber a marca de conceitos, de classificação, como se a vida estivesse definida em moldes que se justificam para além e para aquém do real. Este foi o modelo finito que foi dado ao ser humano, como resposta à sua capacidade de pensar abstratamente, imposição que tem se mostrado como uma produtora de conflitos de todas as ordens epistêmicas, em que, à certa altura, se perde a fé nos modos científicos de pensar que, de complexos, não tem nada, mas de sim de complicados, na intenção de afastar os indivíduos de sua condição de leveza espiritual, que é a aprendizagem por métodos mais convenientes à capacidade de cada um. Lógico que na escola não se tem esta oportunidade, porque ali é um sistema organizado para ser daquela forma e o objetivo não são os estudantes, mas transmitir um saber que vai, aos poucos, se tornando mitificado, em que o simples fato de ter passado por aquele sistema já o coloca na linha de entendimento do orgânico.

Não há aprendizagem que se mostre à altura do ser humano, ausente a condição interdisciplinar, em que dentro de uma mesma ciência, para que se possa compreendê-la há que conhecer diversos fatos e ocorrências que os interliga, como parte essencial do estofo paradigmático. Se posto à solidão, cada parte será nada mais que uma parte isolada de qualquer coisa possível, não um composto orgânico. Mesmo o pensamento do indivíduo necessita estar ciente da existência de outros marcos, para que possa, assim, criar processos inovadores sobre si e a partir de si.

Interdisciplinaridade não pode ser pensada a partir de conceitos, isto é uma construção que não se coaduna com o que se processa em meio aos procedimentos de ensino e aprendizagem técnica. E, quando afirmamos aqui, especialização técnica, não está se referindo ao que foi classificado como *ensino tecnicista*, em que se pretendia formar mão de obra qualificada para atender a um mercado em expansão e que, de repente, tornou-se inchado e sem espaço para novos incrementos de ação direta, em que este tipo de aprendizagem brutal, fechado sobre si mesmo não contempla a exigência que o mundo tem apresentado, o que não se traduz como nada novo, apenas um desejo de ter de volta aquela harmonia que contemplou o pensamento humano.

Outro erro que se tem cometido à exaustão e não se corrige, é o de acreditar que interdisciplinaridade é colocar no mesmo barco profissionais de diversas áreas para atuarem como professores, consultores e outras funções, como se isto fosse resultar em alguma coisa útil aos estudantes. Quando se pensa em didática ou uma práxis interdisciplinar, tomemos como exemplo, a

Pedagogia e suas vertentes epistêmicas, de nada vai adiantar colocar no mesmo espaço, um advogado, um psicólogo, um sociólogo, um filósofo e acreditar que ao final vai se produzir um estudante mais capaz que, a única coisa que resultará é na formação de um maluco que não sabe em quem acreditar ou quem é mais louco naquela nau.

Interdisciplinaridade presume inserção de conhecimentos de outros campos, em departamentos que possuem sua própria estrutura de pensamento e visão de mundo, métodos de interpretá-lo e nisto, não se fala em colocar ambos os representantes de ciências distintas no mesmo espaço, com a ideia pueril de que a democratização produz harmonização de pensamento, porque assim não é. Tem-se confundido participação com democratização e esta confusão que é produto da ignorância e da prepotência do Século XXI¹, tem provocado somente caos e desordem e uma geração de estudantes e futuros profissionais que não sabem mais como buscar conhecimentos e agregar outros, à medida que se mostra necessário.

A metodologia de trabalho, bem como a psicologia de cada objeto, de cada grupo, não se coaduna com nenhuma outra, porque possuem visões muito particulares e mesmo singulares de tudo o que os rodeia, de mundo, de homem, de ser, de estar, de viver, como buscar, alcançar e processar o conhecimento, com seu respectivo tempo de aprendizagem individual e coletiva. E estas peculiaridades, inerentes a cada ciência, são espaços individualíssimos, personalíssimos, que a sua submissão a qualquer juízo de outra categoria que não seja por seus pares gera conflitos que se mostram inconvenientes e desnecessários.

Quando Sócrates apresenta suas discussões sobre a sabedoria e defende que precisava-se trazer o pensamento para a luz, aí estava o marco inovador sobre o modo de pensar o pensamento e esta nova postura epistemológica vem na esteira dos filósofos que foram chamados pejorativamente de sofistas por Platão, figura esta que, simplesmente, impôs o silêncio sobre outros pensadores que não coadunassem com sua visão de mundo, porque eles abriram espaço para discussões que antes estava restrita aos espaços fechados das religiões e das famílias oligarcas. Esta abertura provoca o surgimento de incrementos de diversas áreas do saber ao debate público, com indivíduos que tinham visões múltiplas sobre o mesmo objeto e isto, faz com que pensadores de vários campos opinem sobre temas, antes considerados complexos, sob outras perspectivas.

¹ Destaca-se que a democratização do ensino ocorreu no século XIX na Europa e no final do XX no Brasil (DAU, S., 2022).

No pensamento de I. Fazenda toda esta “indefinição sobre interdisciplinaridade origina-se ainda dos equívocos sobre o conceito de disciplina” (FAZENDA, 1999, p. 66). Portanto, se há equívocos é pelo fato de que não se tenha estudos sistemáticos, os quais demonstrem a linha mais correta a se seguir e a orientar os estudos e as discussões acadêmicas.

Este tem se mostrado o pior de todos os problemas, que é dado pela falta de estudos científicos eficientes e quando ocorrem alguns estudos, não se tem uma diretriz prévia a seguir, o que gera resultados os mais escabrosos e na ausência de um parâmetro, tudo passa a ser considerado como a nova essência do pensamento, ou seja, faz-se qualquer coisa para não dizer que não fez nada ou mesmo para justificar que estão fazendo alguma coisa que, no fim, somente leva a ninguém a lugar algum.

Segundo O. Pombo, “a interdisciplinaridade não é qualquer coisa que nós tenhamos que fazer. É qualquer coisa que se está a fazer quer nós queiramos ou não. Nós estamos colocados numa situação de transição e os nossos projectos particulares não são mais do que formas, mais ou menos conscientes, de inscrição nesse movimento. Podemos compreender este processo e, discursivamente, desenhar projectos que visam acompanhar esse movimento, ir ao encontro de uma realidade que se está a transformar, para além das nossas próprias vontades e dos nossos próprios projectos. Ou podemos não perceber o que se está a passar e reagir pela recusa da interdisciplinaridade ou pela sua utilização fútil, superficial, como se se tratasse de um mero projecto voluntarista formulado no contexto de uma simples moda, passageira como todas as modas” (POMBO, 2005, s.p.).

O que a pesquisadora traz é a ideia de que, com esta divisão da ciência em bairros, distritos, departamentos ocorreu uma supra especialização em que Nietzsche vem a apresentar como uma perda sensível de intelectualidade e de poder sobre o conhecimento, porque em pouco tempo, começa a acreditar que aquilo que domina é a essência do saber, não se preocupando em tecer uma rede de saberes eruditos.

Como sempre acontece com uma ideia que parece encantadora, com a interdisciplinaridade tende a ocorrer o mesmo, sendo uma ideia que vem e quando se esgota os recursos do Estado voltado para pesquisas nesta direção, todo o entusiasmo se esvai e os pesquisadores, escritores e teóricos descobrem uma nova vedete sobre a qual possam destilar seu ar sapiencial de laboratório. Não é assim que funciona, porque quando se toma a ideia de que todas as ciências e todas as disciplinas são atravessadas por outras, em maior ou menor grau, o que conduz ao fenómeno da

interdisciplinaridade como algo que acontece de forma natural, independente do desejo ou da ojeriza humana.

Tratar da questão da interdisciplinaridade é um assunto bastante complexo, porque presume que o estudante tenha que conhecer vários campos ou ainda que buscar em outros ramos, junto a outros cientistas, a fim de compreender o que de fato está desenvolvendo, e muito mais que isto, saber em que épocas anteriores o mesmo problema tenha sido suscitado e investigado pelas autoridades académico-científicas.

Neste sentido, os PCN’s procuram esclarecer que “o conceito de interdisciplinaridade fica mais claro quando se considera o fato trivial de que todo conhecimento mantém um diálogo permanente como os outros conhecimentos, que pode ser de questionamento, de confirmação, de complementação, de negação, de ampliação, [...]” (BRASIL, 1999, p. 88).

Desde as séries escolares iniciais, o caminho a seguir é o de ensinar as crianças a pensar de modo complexo, o que se traduz por pensar dentro de um escopo interdisciplinar, com cada uma delas dialogando e oferecendo o que possui de melhor para o entendimento dos processos de mudanças e variações sociais. E, na esteira disto Olga Pombo diz que “a interdisciplinaridade se deixa pensar, não apenas na sua faceta cognitiva - sensibilidade à complexidade, capacidade para procurar mecanismos comuns, atenção a estruturas profundas que possam articular o que aparentemente não é articulável - mas também em termos de *atitude* - curiosidade, abertura de espírito, gosto pela colaboração, pela cooperação, pelo trabalho em comum. Sem interesse real por aquilo que o outro tem para dizer não se faz interdisciplinaridade” (POMBO, 2005, s.p.).

Importa saber de antemão, o que o outro tem a dizer. Ouvir apenas por ouvir ou para dizer-se aberto ao novo é estar em sintonia com o nada, com um futuro que se mostra inepto, incapaz de promover as mudanças que se fazem necessária a todos. A interdisciplinaridade pressupõe construção científica, elaboração madura de propostas de investigação conjunta e a busca por respostas em campos que, se não podem esclarecer o que se pretende, ao menos pode orientar quanto ao resultado do processo, ampliando a carga de saberes eruditos com que se chegou até ali.

Lógico que a professora Pombo está correta em sua colocação que o outro deve estar disposto a partilhar saberes que já domina, uma vez que aquele que está a buscar não possui o conhecimento mínimo necessário para explorar os campos e extrair os elementos necessários para a definição de conteúdos a serem aceitos ou rejeitados no processo. Uma ciência contribui com a outra é através de

seus autores e estudiosos, não de modo automático e como que por meio de automatismo ou por osmose. Há que dedicar-se a explorar os pensamentos dos autores em determinados sentidos e como forma de aproximar, ao máximo, da verdade pretendida e como ela auxiliaria na resposta sobre o objeto-alvo de estudo.

Olga Pombo afirma que, “só há interdisciplinaridade se somos capazes de partilhar o nosso pequeno domínio do saber, se temos a coragem necessária para abandonar o conforto da nossa linguagem técnica e para nos aventurarmos num domínio que é de todos e de que ninguém é proprietário exclusivo. Não se trata de defender que, com a interdisciplinaridade, se alcançaria uma forma de anular o *poder* que todo *saber* implica (o que equivaleria a cair na utopia beata do sábio sem poder), mas de acreditar na possibilidade de partilhar o poder que se tem, ou melhor, de *desejar* partilhá-lo. Como? Desocultando o saber que lhe corresponde, explicitando-o, tornando-o discursivo, discutindo-o” (POMBO, 2005, s.p.), ou seja, pensar a interdisciplinaridade é interpretar as nuances de pensamentos que fazem com que a ciência seja capaz de produzir conhecimento que integre o homem ao seu meio e a outros meios de comunicação e de linguagem.

Ao conceituar o termo Interdisciplinaridade, não se possui ainda um sentido único e estável, tratando-se de um conceito que varia, não somente no nome, mas também no seu significado. Entender o vocábulo Interdisciplinaridade foi e ainda é muito discutido, pois existem várias definições para ela, que depende do ponto de vista e da vivência de cada profissional, da experiência educacional, que é particular.

Esta indefinição do termo é problemática, porque, assim, o que cada um faz, pode considerar como sendo ações interdisciplinares, simplesmente porque acha que é e, como não existe um parâmetro que a defina didaticamente, os supervisores educacionais ficam sem ter como orientar tais procedimentos de ensino e de aprendizagem.

Quando um professor monta uma aula técnica com seus estudantes, já está evidente que está a fazer uso da interdisciplinaridade. O que se tem que esclarecer que não é somente ao realizar este tipo de ação que a coloca em atividade; as aulas normais, cotidianas, estão repletas deste tipo de ação pedagógica, em que existe todo um conjunto de mediações empíricas que estão fora do escopo da aula regular.

Com o método de estudo atomizado que se impôs sobre a academia, em que o estudante fica confinado a territórios fechados em si mesmos, com autores que sempre falam a mesma coisa, é quase impossível que, mais tarde, na carreira docente saiba conduzir processos de

ensino e aprendizagem por métodos interdisciplinares, porque ficou restrito a pensar em blocos fechados de ideias que não se comunicam com outros campos do saber. Aprendeu a aprender a partir dos autores e não dos campos de conflitos e confluências entre as ciências e suas respectivas disciplinas.

A crença de que a interdisciplinaridade vai fazer com que as disciplinas se diluam em fatores equidistantes é falsa e apenas demonstra medo de ter as meias verdades confrontadas e destruídas pela ausência de força cognitiva e de potencial didático. A ignorância sobre os processos cognitivos, relativos a cada ciência em particular, é a principal causa do medo e do afastamento dos profissionais dos campos mais vinculados aos estudos em profundidade, em suas respectivas áreas a compreender como se dá a relação com outras composições de pensamento científico.

Resultados marcados por processos históricos, em que se tem avaliações determinadas por um único instrumento de medição da capacidade cognitiva leva a entendimentos forçados sobre como se atua na produção de conhecimentos e de valorização do saber sistemático. Há todo um estofado de componentes históricos que ajudam a comprovar que esta separação dos saberes para campos distintos tenha proporcionado avanços na conquista de novos saberes, o que não é de todo falso; mas, por outro lado, a verdade sobre os resultados não podem ser compreendidos, a partir do que se pretende como verdade, porque desta forma se começa a transmitir um tipo de conhecimento fragmentado à toda a população em que a falta de preparo técnico, científico e acadêmico, provoca distorções no entendimento da realidade objetiva.

Daí que a interdisciplinaridade se mostre como um elemento essencial para a formação existencial e não somente acadêmica do indivíduo, entendendo que “a interdisciplinaridade não dilui as disciplinas, ao contrário, mantém sua individualidade. Mas, integra as disciplinas a partir da compreensão das múltiplas causas ou fatores que intervêm sobre a realidade e trabalha todas as linguagens necessárias para a constituição de conhecimentos, comunicação e negociação de significados e registro sistemático dos resultados” (BRASIL, 1999, p. 88).

Para que a interdisciplinaridade aconteça, não se trata de eliminar as disciplinas paralelas, como se estas fossem inimigas históricas, ou mesmo que não pudessem acrescentar nada ao rol do saber daquela que se elegeu como objeto principal de estudos sistemáticos; isto, por si só, é um pensamento descabido, porque a vida humana é permeada por vários campos de domínios e necessidade de aprofundamento destes; portanto, trata-se de torná-las comunicativas entre si, concebê-las como processos

históricos e culturais, e sim torná-la necessária a atualização quando se refere às práticas do processo de ensino-aprendizagem.

É exatamente a ausência de domínio dos processos didáticos sobre outras disciplinas que conduz a este problema crucial da aplicabilidade da interdisciplinaridade nos procedimentos escolares formais. Não se está falando de rejeição de ideias oriundas de outros campos teóricos, apenas uma busca para a definição de um espaço que se fixa pelo poder absoluto de ideias, mas que não está assim determinado em nenhum lugar e quanto mais se departamentaliza estas questões, mais se distancia de encontrar uma justa medida para os mecanismos de aprendizagem neste momento histórico, onde a internet se impôs ou acabou imposta como *alguém* que pode substituir, de forma plena, o professor de carne e osso e por esta expressão, entenda-se o contato presencial entre aquele que ensina e aquele disposto a aprender.

Esta representa uma das maiores perdas que se teve notícias na história da educação, porque, de repente, o entendimento de qualquer um passa a ser o verdadeiro, não exigindo o exercício efetivo do ato de pensar sobre determinado problema. As respostas se tornam automáticas, não possibilitando ao estudante, fazer todo aquele caminhar exaustivo que, se não o conduz à resposta que busca lhe oportuniza contato com inúmeras outras possibilidades de entendimento do problema posto e, com isto, oferece-lhe condições de alcançar a sabedoria epistemológica.

Os avanços (?) nos campos da Neurociência provocaram mais arroubos que soluções viáveis aos professores de fato, isto porque criam teorias que departamentalizam os sistemas de aprendizagem, ideia esta que teve origem com René Descartes, como se cada coisa que se fosse aprender estivesse vinculada a um campo específico do cérebro, negando todas as outras ações de consumo de energia libidinal que se fazem necessárias para que uma aprendizagem, que possa ser compreendida como significativa, de fato, ocorra.

Há que esclarecer que os processos de aprendizagem devem ser interdisciplinares, porque nisto se ensina aos estudantes como buscar respostas em outros campos do saber acadêmico e científico. Quando se discute que a reunião de profissionais de diversos setores das ciências não significa postura interdisciplinar, o mesmo não se aplica quando se leva o aprendiz a pensar de modo autônomo, independente, compreendendo que muitas discussões estão marcadas por outras dimensões mais amplas, mais profundas e mais complexas, demandando uma maior dedicação em áreas que, aparentemente não fariam qualquer sentido a sua investigação para que

contribuísse para solucionar o problema posto, como fato e que está a provocar fenômenos.

Cada ciência, em particular, possui um escopo de apresentação de suas condições de pensamento e de abrangência sobre como se comportar diante de cada espaço epistemológico, sem que necessite de outras ciências/disciplinas, para que possa apresentar respostas muito objetivas sobre os questionamentos que a sociedade coloca como situações-problema para ela e que ela desenvolve assumindo-as como problemáticas, sobre as quais irá debruçar em busca da verdade científica.

No entanto, a fragmentação do conhecimento reduziu tudo na natureza a pedaços de objetos, em que a noção de unidade se esvai como se ela fosse algo completamente à parte dos seres que estão postos como objetos pacíficos de estudos sistemáticos. Esta atitude conduz a um beco sem saída, em que algumas respostas não podem ser encontradas em determinadas ciências, carecendo que se tente encontrá-las em outros campos epistemológicos que, ainda que não consigam dar uma resposta objetivamente sistemática, que permita uma aproximação maior da verdade científica que envolva aquele objeto, fato ou fenômeno.

Aprender algo presume ter que estudar e isto, por sua vez, não significa tão somente a leitura oral; está muito além, vinculada a observações sistemáticas, produções de ideias, levantamentos de hipóteses, induções, deduções, troca de diálogos com outros colegas, sínteses, intervenções em sistemas, além de toda uma dedicação afetiva ao problema que se busca solucionar por intermédio da investigação científica.

A Matemática, por exemplo, pode ser tomada como o exemplo de uma ciência a qual se pode dedicar todo o tempo na solução dos problemas, encerrado em um espaço fechado, sem contato direto com o mundo externo; no entanto, as ciências como a Sociologia, a Linguística e a Filosofia dependem de observar o mundo que as envolve, para que se possa construir toda uma proposta de intervenção, depois de interpretá-lo e compreendê-lo. Não se pode elaborar a ideia de um mundo ideal, sem confrontá-lo com o mundo real, porque isto seria nada mais que a expressão da loucura e conhecimento é gerado a partir do contato direto com outros tipos de conhecimento, aqueles que parecem objetivos e aqueles muito subjetivos.

Não dá para compreender bem os motivos, porque uma maioria continua presa a conceitos, como se o fato de dominar estes conhecimentos limitados ao que se define já basta para ampliar o domínio sobre os campos que se pretende aplicar, na prática. Isto não só é um desperdício de tempo como ausência completa de intelectualidade,

porque na elaboração dos processos e desenvolvimentos mais profundos o que importa é a capacidade de aplicar os conceitos e os elementos que compõem a tarefa até que se chegue ao final da mesma tendo atingido os objetivos traçados, *a priori*, seja parcialmente, seja totalmente.

Portanto, já se está, antes de mais nada, referindo-se a um plano de ação detalhado, em que se tem uma visão do que se pretende, podendo esta vir a consumir-se ou não, em sua totalidade, o que vai depender de inúmeros fatores, alguns relativos à competência do professor, outros, nem tanto e tudo isto é objeto pacífico de análise acurada, tendo em vista a intenção de se formar o estudante, não apenas o mero cumprimento de um dever objetivado.

Cada disciplina em si traz uma carga enorme de conhecimentos que, ao debruçar sobre sua compreensão mais acurada, já se atinge o nível de interdisciplinaridade que ultrapassa a norma sensível de adequação que se requer para formar um estudante de ampla capacidade intelectual, bastando que se explore e se faça com que o mesmo procure ir além do que é ofertado em doses homeopáticas durante as poucas horas que passa na escola, aprendendo a pensar sobre processos distintos.

Muitos profissionais da educação, em todos os níveis, têm confundido o pensar interdisciplinar com ensino interdisciplinar e equipe interdisciplinar com equipe multidisciplinar, que são coisas as mais diversas. O mundo abstrato e o mundo concreto não podem representar coisas dicotômicas, simplesmente porque um deles está no plano do pensamento e o outro no plano da realidade; mas, até que ponto um pensamento pode ser entendido como uma ilusão e a realidade como factualidade? Estas linhas imaginárias que com as quais se pretende separar o mundo em tangível e intangível e, nas entrelinhas, se destaca, real e fantasioso, quando não apelam para dizer mentiroso, alucinante.

O que se espera é que o estudante compreenda que, ao expor o conteúdo sistemático de sua aula, o professor está a tratar de um tema específico, não importando a dimensão se sua abordagem, seja empírica, teórica ou produto de uma hipótese, uma suposição. O que se deve buscar mais profundamente é destacar qual matéria e quais ciências estão a dar suporte epistemológico à expressão do pensamento retratado, exposto.

Ademais, o pensar didático-pedagógico fundamentado na interdisciplinaridade pressupõe que o professor saiba em que campo científico fora do seu possa buscar as informações necessárias para explicar os fenômenos que o atravessam e desafiam, em sua práxis.

Pensar de modo interdisciplinar trata-se de pensar holisticamente, ou seja, uma visão ampla do que compõe o

tudo, em suas partes componentes e não apenas no objeto como um monobloco fechado sobre si mesmo. É esta visão medíocre que tem feito com que a cada vez mais os pensadores sejam vistos como figuras excêntricas pelos professores que estão na ponta de produção, aplicando aos estudantes os métodos e metodologias de estudos.

Este pode virar outro engodo, quando o professor começa a crer que o uso de vários métodos de ensino representa interdisciplinaridade. Primeiro há que esclarecer que metodologia é um estudo sobre quais são os melhores caminhos a se seguir, a fim de alcançar os objetivos e isto vai depender de estudos profundos e complexos, traçando metas claras, conhecendo o objeto-alvo e toda a sua conjuntura psicológica, estrutura de pensamento fluido, interesses, alcance epistemológico, objetivos pessoais, entre outras coisas.

Já a didática interdisciplinar presume a inserção de várias disciplinas e mecanismos inerentes a estas, de modo singular, até que se chegue ao ponto em que se compreende aquilo que se pretende alcançar no campo da didática, ou seja, no espectro do ensino e da aprendizagem. Muito se tem pensado que ao juntar duas ou três ciências e falar um *pouquinho* de cada está se promovendo um tipo de ensino interdisciplinar. Outro engodo pedagógico, porque quando se domina a técnica, não há a menor necessidade de expor uma ou outra ciência a que se esteja a inferir, porque da mesma forma que o professor sabe que campo explorar, seu aluno saberá que está em outra seara, ainda que não domine o conteúdo exposto, o que em primeira mão, não faz a menor diferença, porque este momento se refere àquele em que se introduz o tema, provocando uma *brainstorm*, não necessariamente objetivando um fim em si mesmo.

É esta compreensão da interdisciplinaridade como um componente didático que conduz a professor e estudante a desenvolverem os campos da aprendizagem a tal ponto que sua capacidade de análise, interpretação e síntese da realidade que o envolve se eleva até que se ponha na compreensão de todas as redes que envolvem a sua existência como indivíduo imerso em uma natureza complexa e multifacetada.

Quando o estudante compreende isto antes ou independentemente de seu professor [*ou ainda pior, apesar de seu professor*], é que se tem o entendimento de um gênio [*ou mesmo de um sobrevivente*] de um terrível naufrágio chamado educação formal que não forma ninguém para nada. Todos querem discutir tudo, fundamentados no que acreditam como verdade, jamais apoiados sobre ela, porque tão logo a busquem vão descobrir que nada sabem acerca de nada [*de modo absoluto*], demandando que atuem como Sócrates, sempre

a submeter seus saberes ao escrutínio de outros e a cada imbecil que arpoava, descobria a dimensão da própria ignorância, porque se o outro não sabia aquilo que interrogava, ele também partia daquele encontro sem uma resposta capaz de satisfazê-lo, ou mais frustrado do que havia chegado até ali. Assim que, a argumentação científica deve buscar interlocutores que dominem os assuntos de interesse da discussão, aliada à decência para ouvir e aprender e, somente após a apropriação e a assimilação cuidar de submeter ao escrutínio da dúvida, o que se espera conduza a pesquisas profundas e esclarecedoras.

Em uma aula, o professor deve compreender quando é hora de solicitar auxílio a profissionais de outro campo do saber ou mesmo a orientar os estudantes a buscar soluções para suas dúvidas nestes outros espaços de conhecimento. Ao se aplicar este tipo de ação didática, está a realizar uma dinâmica interdisciplinar, onde possibilita a troca simbólica de informações e a aquisição profunda dos conhecimentos, permitindo que, automaticamente, o estudante aprenda a sintetizar os pensamentos simples, isolados, tornando-os complexos, profundos e carregados de vieses que perpassam a discussão científica de elevado nível.

É quando se tenta reduzir a interdisciplinaridade a um conceito, com o princípio de dominá-la pela força brutal que a transforma em algo que não consegue contribuir para o aprimoramento da intelectualidade, tornando-a uma camisa de força para os profissionais e estudantes. É neste sentido que, na concepção de Fortes, “o conceito de interdisciplinaridade permanece irredutível a uma única apreensão retórica e que a sua prática é exercida mais por iniciativas individuais ou por equipes de educadores do que procedimentos generalizados e incorporados às práticas pedagógicas. A [famigerada] polissemia da noção de interdisciplinaridade, por outro lado, reserva a cada iniciativa interdisciplinar seu estatuto próprio de entendimento teórico-prático, ainda que haja o consenso entre os estudiosos da mesma de que se trata de desfragmentar o saber, ou seja, fazer com que as disciplinas dialoguem entre si a fim de que se perceba a unidade na diversidade dos conhecimentos, tanto em nível de pesquisas científicas quanto nas relações pedagógicas em sala de aula” (FORTES, *s.d.*, p. 09).

A formação intelecto-epistemológica que vem sendo oferecida pelos centros de ensino superior, são propostos e executados de forma fragmentada, baseada no método cartesiano e, a saída para enfrentar este furacão é travar contato com outras áreas do saber, também, fragmentadas pelo vigente sistema beligerante de ensino.

Termina que, é neste campo minado e de difícil acesso que a interdisciplinaridade chega para dar ênfase ao processo educativo, proposta esta entendida por Vygotsky (1896-1934) como uma ponte interminável entre o ensino e o aprendizado, ou seja, representada neste processo, pela aprendizagem, que vai acontecendo de modo contínuo, através do contato do estudante com os instrumentos, as técnicas e as ações didático-pedagógicas e que apresenta como resultado toda a sua capacidade intelectual, interpretada por todos como sinônimo de inteligência.

A questão da interdisciplinaridade não tem se mostrado como uma solução muito eficiente, em terras tupiniquins, primeiro porque os indivíduos saem da escola, destinados a formar outros indivíduos desde as primeiras letras até o mais alto grau de científico sem saber o mínimo sobre seus respectivos campos de formação acadêmica, logo, torna-se muito interessante pensar na hipótese de que este ser será capaz de pensar em uma ciência se fundindo a outra, quando é incapaz de pensar em uma única movendo-se de maneira solitária.

Ensinar, através de métodos interdisciplinares, requer preparo profundo do professor e mais, que ele saiba conduzir os processos de aprendizagem, apresentando aos seus estudantes as variações que procedem ao longo de desenvolvimento do pensamento, passando do simples ao complexo e vice-versa. O que está posto, como exigência, é que se deve aprender conteúdos de outras disciplinas e ciências, para que, no exato instante em que se proceda à inserção de novos paradigmas, o aprendiz esteja pronto para compreender que está passando do campo de domínio de uma ciência para outra e que isto não altera o itinerário de sua interpretação, apenas atravessa outros princípios que se mostram pertinentes ou que se fazem necessários para um maior esclarecimento sobre o objeto/fenômeno estudado.

No caso específico do ensino da Matemática, transita-se pelo campo da Lógica, da Filosofia e da Língua Portuguesa, enquanto ela mesma está presente em todas as ciências conhecidas, de uma forma ou de outra e não é por imposição e sim, por causa do estilo de vida que a civilização impôs como ideal, em que os processos de trocas de mercadorias que, no passado eram simbólicas e equivalentes em necessidades particulares, desde muito tempo desenvolveu o seu equivalente universal e isto é a causa da complexidade, porque permitiu surgir diversos fatores de valor, antes desconhecidos de todos.

A dificuldade clássica em levar os estudantes a entenderem que tudo no mundo está interligado, no entanto, não adianta querer entender tudo de uma única vez e à medida que se aprofunda, torna-se muito mais complexo, porque ao menos se dispor a entender sem ter

acesso aos conteúdos já se mostra uma ação inócua e condenada, antecipadamente, ao fracasso.

Nenhuma ciência perde a sua condição de singularidade quando agregada a outros pensamentos mais dinâmicos e que proporcionam melhores respostas aos desafios postos pela sociedade e pelos cientistas. Fica difícil entender todo protecionismo que se coloca em volta de uma ou outra técnica, como se ela fosse divina e tão pura e imaculada que, ao agregá-la a pensamentos distintos, como mecanismo de ampliação da discussão isto pudesse romper com a essência que a compõe, enquanto tal.

Com empirismo como método de investigação, esta técnica permitiu melhores e maiores possibilidades de se enxergar a interação entre os elementos endógenos e exógenos que compõem a estrutura formal das coisas. Antes, se poderia dizer que esta função caberia à psicologia e não estaria de todo errado, no entanto, não se pode ater a uma determinada ciência enquanto tal, quando se o que, de fato, se necessita é de uma ferramenta de ação que, permita aproximar um pouco mais ou o máximo possível da verdade gnosiológica.

Assim que, a função do conjunto de disciplinas técnicas e/ou teóricas, especulativas é ampliar o campo de atuação do pensamento superior, abstrato, complexo, até que se chegue ao ponto de poder interpretar a realidade à sua volta sem maiores esforços. Isto não significa a dispensa de estudos profundos e sistemáticos, apenas que as conclusões podem ser alcançadas de modo mais dinâmico e com maior possibilidade de ganhos epistemológicos, porque agrega saberes e visões de outros campos que, aprofundaram-se tanto ou mais em determinados espaços de investigação. Com isto, se faz esclarecer que a Pedagogia está composta por diversas estruturas e dentro destas cada uma delas possui princípios que norteiam a práxis pedagógica.

Entre os princípios pedagógicos que estruturam as áreas de conhecimento destaca-se como eixo articulador, a interdisciplinaridade. Há, ainda, outro aspecto pertinente à Pedagogia, que é o de esclarecer o sujeito para a sua condição cósmica de ator neste novo paradigma. Esclarecimento, na concepção kantiana significa a saída do homem de sua minoridade, pela qual ele próprio é responsável. E esta minoridade, para ele é a incapacidade de se servir de seu próprio entendimento sem a tutela de outro [anomia]. E é a si próprio que o indivíduo deve atribuir essa minoridade, continua ele, uma vez que ela não resulta da falta de entendimento, mas da falta de resolução e de coragem necessárias para utilizar seu entendimento sem a tutela de outro.

Paralelamente às palavras de Kant, na concepção de Huxley (2000), ser esclarecido é ser sempre cômico da realidade plena em sua diversidade intrínseca - ter ciência disso, sem deixar de velar por sua sobrevivência como animal, de pensar e sentir como ser humano; de recorrer, sempre que necessário, ao raciocínio sistemático.

No âmbito da existência humana, o processo de evolução sistemática impôs e ainda continua impondo grandes constelações de pensamentos que se entrecruzam e formam novas ideias, estas cada vez mais complexas, exigindo cada vez mais aprofundamentos que as tornem simples, o que nem sempre é possível, cabendo, no máximo que torne alguns pontos específicos menos obscuros e isto possibilite que se continue avançando na construção de novos saberes.

O que não se pode perder de vista, é que estes conhecimentos que virão a ser agregados ao escopo fenomenológico já existente, deve mostrar-se útil, não apenas pontos isolados que não trazem nenhum incentivo a novas e futuras investigações pertinentes aos processos de intelectualidade e inovação do pensamento erudito. Muito do que tem se ofertado ao estofado humano é nada além de um conjunto de ideias soltas, desconexas da realidade objetiva e que apenas cria um emaranhado de qualquer coisa que se parece com alguma coisa. Isto não é ciência...

A construção de um pensamento científico sólido e bem estruturado perpassa por todos os campos científicos, especialmente pelas ciências humanas, porque o mundo é formado por sociedades que convivem entre si, trocam diversas coisas e nestas produções existem componentes variáveis que necessitam ser, também, compreendidos naquilo que trazem em si, como verdades presentes e ausentes. É neste sentido que tudo o que envolve a existência e a educação vai se tornando mais complexo, chegando ao ponto de haver um limite para sua compreensão de modo simples e de aí em diante, vai-se necessitar de outros campos de domínios para que se aproxime do entendimento dos processos de formação histórica ou até mesmo como se perdeu algumas particularidades essenciais ao longo do desenvolvimento histórico das comunidades.

Em muitos casos, o caminho que se percorre é vazio daquilo que se esperava alcançar, devendo retornar ao ponto de origem dos fenômenos sociais, estudando seu contexto histórico e como se comportava naquele ambiente específico. Isto aconteceu com a questão da língua em especial, porque com as mudanças de ambiente e adaptações a outros dialetos e normas de expressão, certos vocábulos distanciaram-se de seus respectivos universos léxicos, restando uma interpretação vazia e sem nexo causal.

Neste ponto específico, o uso da interdisciplinaridade auxilia sobremaneira, porque vai-se ter que aprofundar em diversos campos até encontrar, ao menos, uma resposta plausível que ajude a explicar a ocorrência do fenômeno, porque muitas vezes, não se alcança uma explicação viável, apenas uma hipótese que, como ninguém mais apresenta outra mais forte, ela termina por tornar-se uma teoria; mas, de forma alguma mostrou força erudita para ser considerada, de fato, como tal.

Para observância da interdisciplinaridade é preciso entender que as disciplinas escolares resultam de recortes e seleções arbitrários, historicamente constituídos, expressões de interesses e relações de poder que ressaltam, ocultam ou negam saberes. Com isto, pode-se inferir que “[...] a ação educativa reúne em si as características da arte e da ciência. Ninguém pode ensinar se não sabe o conteúdo proposto. Mas, o processo de conhecer e ensinar é tão peculiar que, ao ensinar se aprende e, ao educar existe toda a possibilidade de desenvolvimento e de transformação do conhecimento. Por isto, a práxis pedagógico-educativa é, ao mesmo tempo arte e ciência: arte de educar enquanto pressupõe um modo específico de produzir, de transmitir e de transformar o conhecimento, ciência de educar enquanto pressupõe o conhecimento como material originário que se transforma no efetivar-se do próprio processo” (BOMBASSARO, 1994, p. 74).

Esta relação dialética do conhecimento e suas propriedades de comunicação, troca e valorização é o que conduz ao produto final, a elaboração de processos intermitentes de construção intelectual do saber. Quando o estudante atinge este nível, ele já não acha que sabe, sendo original em suas avaliações e mesmo admitindo aquilo que não sabe, proporcionando caminhos para a aquisição de novos entendimentos sobre o que o cerca e o que virá. Utilizar as ciências existentes para criar novas ciências é uma situação que foge ao possível, isto devido ao tempo e ao esforço demandado; mas, pode-se criar novos caminhos que conduzem à compreensão daquilo que se está posto como elementos obscuros e que se mostram de difícil entendimento, por motivos vários.

A primeira tarefa posta é decifrar estes elementos que tornam obscuro a compreensão direta dos fatos e dos fenômenos, em seguida, há que interpretá-los até se chegar ao ponto de síntese, etapa em que se espera que esta represente algo inovador à sociedade e ao meio científico formal. Geralmente, se espera que as inovações sejam algo que transcenda todo o escopo existencial e nem tanto é o que se está a dar como resultado direto do procedimento. O fato de possibilitar discussões novas, perspectivas mais profundas sobre temas que parecem *[exaustivamente]* tratados importa em sucessões de novas conduções e

direcionamentos de pensamentos que proporcionam avanços científicos.

As discussões que mais deveriam interessar aos professores são aquelas que se debruçam sobre metodologias de ensino e aprendizagem, porque todo o tempo investido pelos pais e pelos indivíduos na escola é no sentido de aprenderem a aperfeiçoar aquilo com o qual já possuem contato direto e com o que virão a travar contato no futuro distante, de forma abstrata. Os conteúdos que serão ministrados importam, porque abrem espaço para uma dimensão de contato com a realidade objetiva e com uma realidade subjetiva, em que se tem a oportunidade de esclarecer dúvidas, ampliar discussões, trocas de saberes e outras condições que permitem a formação cognitiva do estudante, proporcionando contato com outros campos de visão sistemática. Assim, o que se pode ser realizado no sentido de aprimorar o ensino das ciências e das disciplinas na escola?

O ensino das disciplinas vem sendo aprimorado de acordo com as novas tendências de ensino. Atualmente o papel do professor está além dos conteúdos programáticos, em que ele precisa aplicar todo o seu conhecimento específico nas áreas de influência da matéria que ensina, na expectativa de que isto auxilie seu estudante a aprender e a apreender melhor os conteúdos sistemáticos.

O sistema de ciclos, utilizados nos sistemas de ensino atuais, não contém preparação adequada dos professores e de metodologias que permita o acompanhamento imediato apresentando-se com casos problemáticos. Então é necessário conhecer a história da matemática permitindo tentativas de por de pé situações metodológicas mais pertinentes para conseguir aprendizagem graças ao conhecimento que se pode ter sobre a origem da noção a ensinar sobre o tipo de problema que ela visa resolver, as dificuldades que surgiram e o modo como foram superadas. A cultura profissional dos docentes de matemática é muito marcada pelo individualismo, pela falta de colaboração e pela falta de iniciativas e os espaços institucionais tendem a ser vividos de forma burocrática. Enfim, o trabalho do professor de matemática é marcado por laços negativos, reduzidos ao nível de troca de experiência; isto termina dificultando a relação professor/aluno, dificultando, ainda mais, as práticas inovadoras e não tendo a essência dos questionamentos e as verdadeiras concepções ao trabalho característicos dos professores desta disciplina. Com isso, a avaliação da aprendizagem deve ser exclusivamente diagnóstica, não se esquecendo dos traços de sua cultura primeira. Uma postura verdadeiramente dialética não se colocaria em nenhum dos pólos a dicotomia entre o ecletismo mediador e as teorias divergentes.

A única coisa que se faz necessária de fato é o discurso do professor em que destaca uma coisa e outra, em direção a esta ou aquela proposta, onde está presente uma ou outra disciplina entre os conteúdos que são ministrados, muitas das vezes, não necessariamente, através de uma disciplina, mas através do pensamento de algum autor, uma música, uma gravura, um texto literário, um poema. Não existe limite para que se possa explorar as possibilidades de conhecimento que estão presentes no mundo e em tudo o que o compõe.

O avanço epistemológico vai acontecer na medida em que se permite a exploração de todos os campos do saber e não necessariamente com a exploração destes, o que pode parecer um paradoxo, mas, eis uma explicação razoável: a aprendizagem não é resultado vertical ou horizontal de estudos sistemáticos, é uma acumulação que vai se dando e que quando se confronta com a realidade e que presencia a ocorrência dos fenômenos é que se tem a oportunidade de aproximar-se do entendimento e, ao refletir sobre o ocorrido, buscando entender tudo aquilo e o que está em seu entorno que as coisas vão se mostrando mais próximas de esclarecimento, o que permite uma compreensão real do que aconteceu, ou ao menos, uma explicação mais plausível.

Uma coisa difícil de se aceitar é que um fenômeno será sempre um fenômeno e isto não irá mudar; o que diferencia são as explicações envolvendo-os que, de acordo com a gama de materiais teóricos que se tenha à disposição, está mostrar-se-á mais profunda, portanto, mais passível de aceitação social, ou mais superficial, mais passível de ser refutada pelos pares.

Uma articulação possível é a de diversos campos de conhecimento, a partir de eixos conceituais. Uma metodologia importante de trabalho didático é a que se dá através de conceitos, como tempo, espaço, dinâmica das transformações sociais, a consciência da complexidade humana e da ética nas relações, a importância da preservação ambiental, o conhecimento básico das condições para o exercício pleno da cidadania. A articulação do currículo a partir de conceitos-chave, sem dúvida, dá uma organicidade ao planejamento curricular.

O desenvolvimento tecnológico moderno só veio agregar um valor a mais. Computadores não são máquinas mágicas que podem adivinhar coisas que estão escondidas das pessoas. Maravilhosas como elas são, estão limitadas aos conhecimentos que damos a elas. Computadores dependem de nós para adquirirem conhecimento. O máximo que conseguem fazer é proporcionar uma resposta verticalizada para fenômenos de diversas magnitudes, isto, de acordo com os dados ofertados, em que a resposta auferida é resultado de um jogo de dados eletrônicos que

não consideram as variáveis e as variantes, sempre presentes nos processos.

É necessário um planejamento conjunto que possibilite a eleição de um eixo integrador, que pode ser um objeto de conhecimento, um projeto de intervenção e, principalmente, o desenvolvimento de uma compreensão da realidade sob a ótica da globalidade e da complexidade, uma perspectiva holística da realidade, na qual está-se inserido e que atravessa professor e estudante.

O que se pretende, com este elemento de integração, não é somente atingir a excelência acadêmica de ensino e aprendizagem, proporcionando uma didática interdisciplinar e sim, alcançar um nível de formação onde se possa pensar a dialética entre situações-problema e soluções que se mostrem disponíveis a partir de uma discussão mais ampla entre um e outro. Da maneira como tem sido posta, tudo se torna fluido demais, aparentemente fácil demais, quando nada é possível sem uma dose elevada de esforço e dedicação ao objeto de interesse científico.

Assim que, à medida que os procedimentos pedagógicos vão amadurecendo, a preocupação deve estar focada em que o estudante aprenda a buscar informações pertinentes em todos os campos conhecidos e não somente ater-se a uma busca fácil determinada pela facilidade com que as redes lhes possibilitam. Mesmo que encontrar informações válidas tenha se tornado um procedimento mais rápido, o processo de análise, interpretação e síntese não obedece ao mesmo princípio. Saber e sabedoria continuam sendo dois princípios distintos em que o segundo depende absolutamente do primeiro e estes conceitos na Antiguidade podem ser comparados a se ter acesso à informação e a saber utilizá-la da maneira mais pragmática possível.

Pensadas, elaboradas e postas ações didático-pedagógicas que propiciem confrontos com a realidade factual, a tendência é que o conhecimento surja como consequência dos conflitos diretos inerentes ao desempenho do saber quando em busca de respostas. Novamente, o que parece ser uma confusão, mostra-se que, adquirir experiência não coincide com o fato de aquisição de conhecimentos válidos para alguma coisa útil, ou seja, pensar de modo pragmático é uma situação complexa, porque envolve propostas e resultados sobre o que incide o pensar. Três perguntas devem ser respondidas e isto, geralmente, é o que desafia os estudantes, porque além de não saber fazê-las, via de regra, são consumidos pela vaidade e pela pouca ou nenhuma experiência em pesquisa, resultando em respostas fáceis de serem compreendidas por eles mesmos, uma vez que avaliam a

capacidade dos outros a partir de suas limitadas condições de pensamento horizontal.

Não se pode elaborar uma construção intelectual a partir do entendimento superficial e, no máximo, raso de algum estudante sem que isto seja submetido a todo o rigor acadêmico de validação e em seguida à refutação pelos pares. Da forma como tudo tem sido aplicado aos procedimentos de formação acadêmica, o que se tem ao fim de um processo, supostamente formativo é um engodo intelectual e epistemológico, nada mais que isto.

Falar em interdisciplinaridade com este grupo é o mesmo que falar em javanês com um brasileiro, porque não sabem o básico de suas respectivas ciências, as quais dedicaram anos de suas vidas a compreendê-la e depois de tanto tempo, sabem nada mais que render reverência ao primeiro palhaço que explique o porquê seus alunos não aprendem. A resposta mais objetiva e transparente para a burrice de alguém é a falta de estudo sistemático, falta de empenho na busca de soluções para os problemas que se apresentam naturalmente a qualquer professor, não importando em qual modalidade atue como tal.

Quanto ao seu aluno, este, de igual forma deve buscar respostas para suas dúvidas em outros espaços que não seja somente o seu professor e nos livros que este indica para si. A autonomia é um passo para a independência e não pode ser diferente, porque chegará o dia em que o *estudante* passa deste *status quo* para o de *professor* e não haverá alguém que o ordene para que estude, que busque, que ouse; terá que fazer isto como condição inerente à sua profissão e ao cargo que ocupa, inevitavelmente, na cadeia de desenvolvimento do pensar epistemológico.

Quando um indivíduo é desafiado a superar a si mesmo, no aspecto do conhecimento a sua primeira e mais árdua tarefa é a de compreender o problema que lhe foi posto e, para azar maior de todos, na atualidade, isto é algo que ninguém deseja fazer, porque são monitorados pelo relógio que calcula a produção de um pensador na mesma proporção que um operário de uma fábrica de produtos manufaturados. Este é o absurdo que se coloca, porque uma ideia revolucionária não surge como em uma produção em série, que faz com que os resultados sejam previstos em uma planilha de *excell*.

Oferecer respostas aos problemas sociais, de todas as ordens, demanda uma gama extensa de estudos, a começar que a escola é o lugar do exercício da tradição, não da adequação ao tempo e ao desejo volitivo de qualquer espécie que surja pretendendo mudar o curso de uma sociedade inteira. Mesmo que professoras como Isabel García, da Universidade Enrique José Varona (La Habana - CU) tenha razão ao afirmar que este recinto

segue os ditames ideológicos da sociedade na qual esteja inserida, não é tão simples de fazê-la adaptar-se a este pensamento, porque ao mesmo tempo em que se tem um grupo desejoso de provocar uma mudança radical em todo o pensamento social a partir da escola, é nela que se guarda a forma de transmitir os valores que sustentaram desde tempos imemoriais.

Assim, está posto o conflito direto entre forças de pensamentos contrários, em que de um lado, têm-se aqueles que arrotam conhecimentos que exigem mudanças e de outro lado, aqueles que detêm conhecimento erudito e que, exigem que as coisas se mantenham como sempre foram.

A interdisciplinaridade oferece uma nova postura diante do conhecimento, uma mudança de atitude em busca do contexto do saber erudito, em busca do ser como pessoa integral. A interdisciplinaridade visa garantir a construção de um conhecimento global, amplo, rompendo com os limites que foram impostos às disciplinas. Para isso, será preciso, que se adote, como propõe Ivani Fazenda, *uma postura interdisciplinar*, que nada mais é do que uma atitude de busca, de inclusão, de acordo e de sintonia entre o ideal e o real, diante do conhecimento.

Todos os envolvidos no processo ganham com a implementação da interdisciplinaridade, como componente metodológico efetivo da doutrina docente. Os alunos, porque aprendem a trabalhar em grupo, não apenas de indivíduos como de ciências, pensamentos diversos, hipóteses, teorias; e com isto, habitam-se à experiência de aprendizagem grupal e os professores, também terminam sendo beneficiados, porque se veem compelidos a melhorar a interação com os colegas e, pelos próprios alunos, a ampliar os conhecimentos de outras áreas; têm menos problemas de disciplina e melhoram a interação com os colegas de trabalho. A escola, porque a sua proposta pedagógica é executada de maneira ágil e eficiente; tem menos problemas com disciplina e os alunos passam a estabelecer um relacionamento de colaboração e parceria com o pessoal da equipe escolar, assim como, com a comunidade onde está inserida a escola.

Neste íterim, tem-se que a metodologia do trabalho interdisciplinar supõe atitude e método, envolvendo integração de conteúdos; passando de uma percepção fragmentária, racionalista para uma concepção unitária do conhecimento; superando a dicotomia entre ensino e pesquisa, ponderando sobre o estudo e a pesquisa, a partir do apoio das diversas ciências. Além disso, o ensino-aprendizagem é centrado na perspectiva de que o ser humano aprende ao longo de toda a vida (educação continuada). Articular saber, informação, experiência, meio ambiente, escola, comunidade *etc.*, tornou-se,

atualmente, o objetivo da interdisciplinaridade que se manifesta por um fazer coletivo e solidário na organização das disciplinas técnico-pedagógicas.

Esta coletividade que se apresenta aqui não se pode correr o risco de confundir participação com democracia, porque ambas referem-se a coisas distintas, em momentos distintos, em que a primeira sugere uma discussão, argumentação entre as partes, interesses plurais e a segunda coloca em xeque toda uma condição de igualdade na tomada de decisões, o que não é saudável em um estabelecimento onde a autoridade deve prevalecer, porque as responsabilidades são muitas e cabe aos professores o ensino catedrático, formal, a imposição de sua autoridade de forma a que o estudante possa desenvolver bem o seu papel de aprendiz e de pesquisador, característica que deverá assumir de modo autônomo em seu futuro.

A interdisciplinaridade pressupõe ainda isto, o exercício autônomo da busca pelo saber, o que faz com que o estudante procure outras fontes para além de seu mentor e nisto tenha acesso a conhecimentos que se mostrem úteis ao seu desenvolvimento gnosiológico. Não se pode tratar a questão da aprendizagem como algo linear, produto direto de leituras, porque não é assim que funciona. O estudante-aprendiz, além de estudar e ler muito, há que submeter seu aprendizado a juízos de pares e de outras categorias científicas até que se alcance um critério de valor sobre sua condição de sabedoria e domínio dos conteúdos. É aí que se fomenta a participação da coletividade; na validação e na refutação científica do que se supõe como saber autêntico.

Alguns campos do saber acabaram sendo privilegiados em suas representações como disciplinas escolares e outros, não. Historicamente, são valorizados determinados campos do conhecimento escolar, sob o argumento de que se mostram úteis para resolver problemas de dia a dia. A forma de inserção e abordagem das disciplinas num currículo escolar é em si mesma indicadora de uma opção pedagógica de se propiciar ao estudante a construção de um conhecimento fragmentário ou orgânico e significativo, quanto à compreensão dos fenômenos naturais, sociais e culturais. Nesta epopeia demagógica que se encobre todo o processo de construção curricular é que se percebe todo o engodo que está escondido por baixo da seleção de disciplinas e de conteúdos adotados. A única coisa ausente nestes momentos é a ciência erudita, em que se tem a entrada proibida porque seu nome é Éris, a deusa da discórdia. Como nenhum cientista moderno tolera a discordância com relação às suas ideias que defende com a vida, é melhor que a causadora de todo o mal fique de fora destes processos, permitindo tão somente que a ignorância,

travestida com o nome de concórdia faça-se presente ao obituário da razão didática.

Assim, os currículos são montados a portas fechadas por especialistas que nunca estiveram no exercício do magistério da Educação Básica. Geralmente, estes currículos visam atender ao mercado capitalista e não à formação científica, nos níveis de erudição, ou da ética e da moral do educando.

O desenvolvimento das ciências e os avanços da tecnologia, no século XX, constataram que o sujeito pesquisador interfere no objeto pesquisado, que não há neutralidade no conhecimento, que a consciência da realidade se constrói num processo de interpenetração dos diferentes campos do saber. Até porque o professor, acinte ou acidentalmente [*muito implicitamente*], transmite a seguinte mensagem: “Esqueçam o que vocês sabem, desconfiem do senso comum e do que lhe contaram e escutem-me, pois vou dizer-lhes como as coisas realmente acontecem” (PERRENOUD, 2007, p. 28). E esta atitude acaba por cercear o livre pensar e acaba por produzir uma nação que ignora o real valor dos saberes interligados em uma teia produtiva de novas *epistemes*.

É neste jogo de interesses e de poder, sobre quem determina o ponto até onde os outros podem ir ou não que se tem construído toda a história contemporânea da educação formal, em que não existem conflitos entre grandes áreas de conhecimento e nem entre grandes pensadores. Mesmo que a postura acima citada por Perrenoud (2007) se mostre como abusiva, muito se perdeu neste espaço em que o estudante se põe como alguém que sabe de alguma coisa e tenta impor esta verdade, ainda incauta sobre alguém que possui toda uma história de investigação científica e didática.

Construir novas estruturas de conhecimento precisa-se de diretrizes bem pensadas, bem planejadas, bem conduzidas e bem planejadas. Não podem ser trazidas à luz por qualquer um que se diga no direito de os fazerem porque é especialista ou porque detém anos de experiência em um determinado assunto. A condição necessária está mais além de tudo isto, fazendo com que proporcione a junção de conhecimentos de diversas áreas até que se tenha a oportunidade de algo novo e consistente com o que se planeja e com o que põe a exigência da sociedade sobre os cientistas.

Uma vez compreendida esta dimensão social do pensamento científico, o que resta é a efetivação dos procedimentos teóricos em que isto demanda uma carga extensiva de estudos e de trabalho analítico, interpretativo e dedutivo sobre tudo o que se coletou. Não se trata somente de chegar a saber o que outros estudaram e a que conclusões chegaram, importa saber que caminhos

seguiram e como isto pode ser repetido, até que se tenha condições de alcançar as respostas, mesmo que os dados sejam atualizados e as exigências postas parecem distintas, o que geralmente não é assim tão distante da realidade objetiva histórica. Mais uma vez realçamos aqui, o valor que o método empirista impõe sobre a conquista de respostas esclarecedoras, ampliando a dimensão de entendimento e compreensão dos fenômenos sociais, porque obriga a compreender os procedimentos analíticos e sintéticos que compõem a investigação científica.

Isto permite que os envolvidos estejam cientes de seus limites de conhecimento e ao mesmo tempo de seu potencial epistemológico, o que os permite pensar com clareza sobre o que tem a disposição ou não para atingir os objetivos traçados, quando da elaboração do projeto de investigação. Nestes últimos tempos, com os métodos de ensino e de aprendizagem que se fazem uso, criou-se estudantes que não sabem nem dos seus domínios e assim, não sabem nem como buscar novas estruturas epistêmicas que possam agregar saberes ao que já possuem, ampliando seu universo intelectual e cognitivo, podendo transformar tudo em inteligência aplicada. Resulta em nada mais que professores que ensinam, relativamente bem aos outros; mas, quando são desafiados a autoaprendizagem, mostram-se inaptos para a ação e isto termina em tragédia, porque via de regra estão ao lado de seus alunos seus, os quais guardavam uma respeitosa reverência a seus antigos mentores.

Muito do que se busca em ciência não é o que se encontra, e se isto representar uma frustração para o estudante ou para o cientista, então ambos estão no lugar errado, porque nada do que se vai encontrar na busca científica estava fora do esperado e nada disto pode ser creditado como sendo culpa do investigador. Uma das coisas a que se deve buscar compreender é a respeito das limitações humanas no tempo e no espaço e quando se chega a tal entendimento, sobrevém outro mais pesado, o de que as mudanças, sejam elas o mais sutis que possam parecer, são provocadas pela interação social e pelas resistências que elas provocam em nós mesmos e nos outros.

Esta é a questão dialética que se impõe ao estudante, porque ao sentir a resistência com relação a algum conteúdo, a premissa básica é tentar encontrar formas de compreendê-la e depois superá-la e não o contrário, porque estar a exercer o princípio da negação e ao tentar vencer algo sobre o qual não detém conhecimento, pode-se chegar a repetir, *ipsis litteris*, aquilo que está, supostamente, a negar como verdade.

Ensinar e aprender de modo interdisciplinar implica em conhecer a fundo os sistemas psicológicos que

fomentam a existência humana de tal forma que este auto-conhecimento propicie a interação com o saber, com o desejo de saber e, de igual forma, com as resistências que atravessam a todos, sem fazer distinção. Porque não se trata de encontrar mecanismos de resistências individuais, na maioria das vezes, elas são de caráter cultural, vinculados à tradição e implantadas na estrutura epistemológica formativa da personalidade coletiva, fato que culmina na formação da condição psicológica individual sem que se perceba o que de fato a construiu. Muitas vezes, as respostas dadas para justificar este ou aquele tipo de resistência a determinado saber são hilárias e algumas outras, aparentemente, muito bem elaboradas, são de caráter pueris.

Buscar a elucidação dos fatos através de estudos programados é um desafio posto desde muito tempo e por mais que se tenha aprimorado as técnicas científicas referentes à aquisição de aprendizagem formal, os resultados não têm satisfeito aos organizadores e técnicos da educação, porque não se mostram com efetividade ganhos diretos demonstráveis de eficiência epistêmica. Há que acreditar que a aplicação de estratégias de ensino possa garantir melhoras substanciais nos processos de formação e é neste ponto de inflexão que se pretende trabalhar com a interdisciplinaridade, como um elemento que proporciona conquistas diretas na autonomia do estudante, por possibilitar que transite em outras áreas não exploradas diretamente por aquilo que está estudando. Isto o conduz a sofrer menos pressão sobre si, no que se refere a resultados, sem contar que, por estar fora de seu escopo de investigação, esta busca paralela pode funcionar como uma válvula de escape para as tensões correntes que surgem da busca gnosiológica.

Resistências, conflitos, negação, todo tipo pensado de confrontos ideológicos... Tudo isto é o que compõe o estofado da produção acadêmica e que provoca o avanço epistemológico das nações e das ciências em particular. Quando isto tudo começa a ser negado em nome da política de boa vizinhança e da camaradagem, tem-se o começo do fim da inteligência. É neste sentido que Oppenheimer (1955, p. 55) vai afirmar que, “hoje, não são só os nossos reis que não sabem matemática, mas também os nossos filósofos não sabem matemática e, para ir um pouco mais longe, são também os nossos matemáticos que não sabem matemática. Cada um deles conhece apenas um ramo do assunto e escutam-se uns aos outros com um respeito fraternal e honesto.”

A provocação que o autor traz aqui é próximo ao pensamento de que, onde está a máxima de que se deve questionar de tudo o que se ouve, vê, sente e percebe? Protágoras de Abdera (481-411 a.C.) argumenta que o homem é a medida de todas as coisas, e esta termina por

tornar-se a base de todo ceticismo ou de todo o questionamento. Pior que isto, é crer que a Filosofia e a reflexão sobre tudo o que nos atravessa foi se perdendo em meio ao discurso barato e bajulador. Não se trata somente de saber determinada ciência ou disciplina, mas de saber questionar o que quer que seja que esteja posto como verdade a todos, sem que isto atrapalhe a existência com nossos pares.

A interdisciplinaridade pressupõe a crítica de outras ciências e não somente o vínculo afetivo entre elas; o olhar perscrutador da análise acurada, o juízo técnico e a emissão de valores devem estar em sintonia com as exigências de avanços epistemológicos e não em acordo com o que um grupo pensa ou deixa de pensar, adotando isto como verdade absoluta e definida. A partir do instante em que uma ciência deixa de ser crítica por excelência, deixa, automaticamente, de ser relevante para a aprendizagem sistemática de alguém.

Esta condição de questionamento social das ciências e dos experimentos, descobertas acadêmicas, científicas, sempre coube, historicamente, à Filosofia, e dentro dela uma disciplina específica, a *Filosofia das Ciências*. Ter domínio de vários campos científicos não se traduz como conhecer a fundo, mas o necessário para que se possa fazer entender os procedimentos de elaboração do pensamento dentro de suas ações. Ocorre que, da forma como têm sido preparados os estudantes, mal conseguem pensar para além de suas próprias disciplinas e isto termina como um processo marcado por um retrocesso formal de aprendizagem, se é que é possível que isto seja passível de acontecer, didaticamente.

No campo da formação do pensamento epistemológico, cria-se um grupo de néscios que não conseguem pensar nem para frente e nem para trás em seus campos de atuação e isto provoca um desperdício de energia absurdo, porque pensam sem nenhum destino objetivo; aprendem uma técnica, mas não como a tecer críticas sobre ela e a como aplicá-la a outros campos do saber erudito. Pior que tudo isto é ter a sua ciência como uma mera técnica e não uma ciência em si, com princípios e valores próprios, um objeto de estudo, uma definição de mundo, de homem, de existência própria.

Todo este vazio existencial a que foram outorgadas as ciências, produz, ao fim de um longo período de formação, o que Nietzsche chamou de *indivíduo abstrato*, aquele vazio de tudo, que não consegue enxergar-se a si mesmo como uma ferramenta da mudança estrutural em sua sociedade. Ele apenas é formado em algo, mas não se tornou este algo.

Oppenheimer continua explanação argumentando que, “o conhecimento científico hoje não se traduz num

enriquecimento da cultura geral. Pelo contrário, é posse de comunidades altamente especializadas que se interessam muito por ele, que gostariam de o partilhar, que se esforçam por o comunicar. Mas não faz parte do entendimento humano comum... O que temos em comum são os simples meios pelos quais aprendemos a viver, a falar e a trabalhar juntos. Além disso, temos as disciplinas especializadas que se desenvolveram como os dedos da mão: unidos na origem, mas já sem contacto” (Idem, 1955, p. 55).

Segundo as palavras do autor supracitado, houve um rompimento entre as epistemologias, o que provocou o enfraquecimento da construção científica. Esta perda de vínculo entre as ciências se deve ao fracasso em aceitar que as mudanças ocorrem de modo lento e gradual, à medida que vai se tomando posse dos saberes como o intelecto humano funciona e responde às exigências da natureza em termos de adaptação e avanços técnicos nos diferentes campos de exploração tecnológica.

As mudanças de paradigmas que ocorreram nos campos da educação após a *Segunda Revolução Industrial* levaram toda a sociedade formal a rever seus conceitos em termos de valores e questionamentos, pois acabou-se por acreditar que o lucro estivesse baseado na produção em larga escala, feita por uma máquina fria e que não pensava, ou seja, a mercadoria representava o lucro e não os encantos que ela encerrava em si. E desde as diversas catástrofes éticas que a humanidade tem atravessado que os paradigmas têm mudado de estrutura e de direção. Da ideologia do capital físico se passou para a do capital social, depois para o capital intelectual e por último, para o *capital humano*.

Nenhuma destas mudanças foi capaz de promover o crescimento cognitivo e intelectual que a humanidade necessita para atingir o nível da excelência, porque faltou a disciplina e o domínio desta. Há que esclarecer que, do ponto de vista da ciência, disciplina é um tipo de saber específico e possui um objeto determinado e reconhecido, bem como conhecimentos e saberes relativos a este objeto e métodos próprios. A noção de disciplina científica (diferentemente da disciplina escolar) está ligada, pois, ao conhecimento científico. Constitui-se a partir de uma determinada subdivisão de um domínio específico do conhecimento. A tentativa de estabelecer relações entre as disciplinas é que dá origem ao que chamamos interdisciplinaridade.

E, por que as chamamos de tentativas? Não é pelo fato de que disciplinas e ciências não se comunicam. Indivíduos não se comunicam. E é aí que se situa o grande problema que é posto aos professores e estudantes neste momento histórico da evolução científica e do pensamento

teórico: Como pensar de modo a que as diversas áreas e campos do saber possam comunicar-se integralmente, visando à formação do homem em sua totalidade, indo desde a psíquica até a mais profunda interação investigativa deste com a natureza na e com a qual está inserido. À medida que se vai adquirindo esta aproximação com os procedimentos didáticos e pedagógicos, mais tem-se a possibilidade de se atingir a condição de uma formação integral do ser.

O saber escolar e, por consequência, as disciplinas escolares não se constituem de uma transposição direta do saber científico ou do saber erudito para as matérias escolares. Representam um conhecimento organizado e ordenado didaticamente, classificado por graus de dificuldades e dirigidos a públicos com idades e capacidades cognitivas diferenciadas. Portanto, as finalidades e os objetos das disciplinas escolares são completamente diferentes dos referenciais das disciplinas científicas. A lógica científica é compartilhada pelos dois tipos de disciplina, mas isso não as torna idênticas.

Disto, se pode concluir que, a interdisciplinaridade estaria na via de construção de um estudante que se compreendesse autônomo quanto ao seu desenvolvimento cognitivo e intelectual, comprometido com seu desenvolvimento enquanto se compromete com o de seus pares, transformando aquilo que aprende e desenvolve em algo útil.

O grande desafio posto ao ensino interdisciplinar neste momento é a dificuldade que os professores enfrentam para condensar as propostas de ensino e de aprendizagem em grupos interligados, formando cadeias de pensamentos complexos. Existe sobre esta geração toda uma cultura secular de uma metodologia cartesiana, em que os sistemas foram fragmentados de tal forma que o estudante entra na escola, passa por lá décadas inteiras e sai sem conhecer o objeto de seu estudo em sua totalidade. Sai, no máximo, um especialista em fragmentos de textos, de ideias, de pensamentos, de leituras, de homem, de existência, não sendo capaz de realizar a construção de um pensamento em sua íntegra, porque além de ser ensinado a pensar somente por partes, fragmentariamente, não foi induzido a pensar em como seria a composição essencial do objeto.

Quanto à interdisciplinaridade, enquanto uma metodologia de ensino, carece de ferramentas próprias que possam subsidiar o estudante em sua construção epistemológica, entendendo que não basta conhecer os elementos da natureza, faz-se necessário saber aplicar sobre eles toda a capacidade intelectual que se disponha e a partir desta ação, gerar novos produtos que, aplicados à realidade, sejam capazes de transformá-la. Ao resultado

alcançado, através desta ação, dá-se o nome de inteligência, ou seja, esta é produto, somente existindo empiricamente.

Muitos indivíduos confundem capacidade mnemônica com inteligência. A condição desenvolvida para armazenagem de dados na memória e sua assimilação rápida é uma potencialidade admirável e que contribui sobremaneira para a formação da inteligência abstrata, porque permite ao intelecto ter acesso instantâneo a uma gama diversificada de ferramentas úteis para a produção de pensamentos, ideias e inovações em todos os campos técnicos, tecnológicos e científicos conhecidos.

Para que isto se consolide como fato, é necessário que se supere as metodologias de ensino e aprendizagem arcaicas que foram impostas sobre a educação e a escola contemporâneas com o pensamento positivista, ação que somente auxilia ao burocrata no processo de construção do currículo formal, mas que não contribui em nada para a expansão da capacidade cognitiva e do pensar abstrato, criando um eterno dependente da interpretação alheia dos fatos e fenômenos, porque na natureza, as coisas acontecem seguindo princípios interligados, o que demanda, para seu amplo conhecimento, interpretação, compreensão e síntese, o domínio de vários campos do saber humano e de disciplinas categorizadas e como estas se fundem, formando um pensamento singular.

Este novo formato, único e determinante da postura acadêmica de estudantes e professores engajados na tentativa de superar a dicotomia saber teórico-saber empírico é a marca que se pode imprimir à interdisciplinaridade neste momento de transformação que as ciências experimentam. Não há como pensar as disciplinas em blocos fechados, como se preconizou a doutrina de Auguste Comte, o Positivismo, que representa a ruptura com a metafísica, acontecimento que tanto mal causou e ainda causa ao mundo e à educação, principalmente.

Este pensamento fechou todo o ensino em torno de si mesmo e foi a partir da especialização que aconteceu um distanciamento cada vez mais amplo entre as disciplinas e a interdisciplinaridade é uma tentativa de resgate de integração do homem ao seu escopo científico natural.

CONSIDERAÇÕES FINAIS

A interdisciplinaridade, pensada a partir de um viés pedagógico, didático, já se mostra necessária de uma ciência que a auxilie neste processo, a saber a Filosofia da Educação, em que todo um escopo epistemológico se agrega aos princípios de argumentação científica até que se

obtenha um entendimento mais amplo e mais profundo acerca do tema, proporcionando o que os autores citados neste trabalho classificaram como verticalização e horizontalização.

Toda ação didático-pedagógica, subsidiada por uma práxis, visa a um fim específico, que é a aprendizagem formal, o domínio dos conteúdos ofertados pelo professor quando em determinação de ensino, a realizar a sua prática. No entanto, existem inúmeras variáveis que dificultam o processo e um deles faz referência à questão do entendimento teórico do assunto, momento este em que o mestre tem de recorrer a outros campos do saber científico, a fim de tornar mais inteligível, mais transparente o que pretende expor.

Este assunto é algo que não se esgota neste trabalho, em que se buscou ampliar a discussão acadêmica acerca do tema e a ideia de apresentar conceitos acerca da interdisciplinaridade e sua aplicabilidade no ensino regular, em nível básico e superior, mostrou-se satisfatório. Quanto a uma proposta de aplicabilidade da mesma como mecanismo de intervenção didático-pedagógico, mostra-se muito útil e o que falta são estudos empíricos em larga escala que pudessem apontar os pontos fortes e os pontos débeis, com a intenção de que se pudesse replicá-los e, de igual forma, corrigi-los, de modo respectivo e paralelamente aos resultados atingidos.

REFERÊNCIAS

- [1] ALVES, Railda F.; BRASILEIRO, Maria do Carmo E.; BRITO, Suerde M. de O. Interdisciplinaridade: Um conceito em construção. *In: Episteme*, Porto Alegre, n. 19, jul./dez. 2004.
- [2] BOMBASSARO, Luiz Carlos. *Epistemologia: produção, transmissão e transformação do conhecimento*. Anais do VII ENDIPE. Goiânia, 1994.
- [3] BRASIL. PARÂMETROS Curriculares Nacionais (1ª a 4ª série): *Matemática*. Brasília: MEC/ SEF, 1999.
- [4] DEMO, P. *Conhecimento moderno: sobre ética e intervenção do conhecimento*. Petrópolis: Vozes, 1998.
- [5] ETGES, N. J. Ciência, interdisciplinaridade e educação. *In: Jantsch, A. P. & Bianchetti, L. (Orgs.) Interdisciplinaridade - para além da filosofia do sujeito*. Petrópolis: Vozes, 1997.
- [6] FAZENDA, I. C. A. *Interdisciplinaridade: história, teoria e pesquisa*. Campinas: Papirus, 1999.
- [7] FORTES, [s.d.], p.09.
- [8] JANTSCH, A. P. & BIANCHETTI, L. Interdisciplinaridade - Para além da filosofia do sujeito. *In: JANTSCH, A. P.; BIANCHETTI, L. (Orgs.) Interdisciplinaridade. Para além da filosofia do sujeito*. Petrópolis: Vozes, 1997a.
- [9] JAPIASSÚ, H. *Interdisciplinaridade e patologia do saber*. Rio de Janeiro: Imago, 1976.
- [10] HUXLEY, A. *As portas da percepção*. Rio de Janeiro: Globo, 2000.
- [11] OPPENHEIMER, J. R. *La science et le bon sens*. Paris: Gallimard, 1955.
- [12] PERRENOUD, Philippe. *10 Novas Competências para Ensinar*. Porto Alegre: Artmed, 2007.
- [13] POMBO, Olga. Interdisciplinaridade e integração dos saberes. *In: Liinc em Revista*, v.1, n.1, março 2005. <http://www.ibict.br/liinc>. Acesso em 20/06/2022.

Farmers Affected by Hematological Neoplasms and Exposed to Pesticides: A study in southern Brazil

Mariana Portela de Assis¹, Patrik Nepomuceno², Taila Francieli da Silva³, Marcela Lange⁴, Guilherme Mocelin⁵, Hildegard Hedwig Pohl⁶, Suzane Beatriz Frantz Krug⁷

¹Graduate Program in Health Promotion. University of Santa Cruz do Sul (UNISC), Santa Cruz do Sul, RS, Brazil. Email: portela1311@gmail.com

²Graduate Program in Health Promotion. University of Santa Cruz do Sul (UNISC), Santa Cruz do Sul, RS, Brazil. Email: patrik.np@hotmail.com

³Multiprofessional Residency Program – Oncology Patient Care. Hospital Bruno Born, Lajeado, RS, Brazil. Email: tailaa.silva@gmail.com

⁴Multiprofessional Residency Program - Oncology Patient Care. Hospital Bruno Born, Lajeado, RS, Brazil. Email: marcelaklange@gmail.com

⁵Graduate Program in Health Promotion. University of Santa Cruz do Sul (UNISC), Santa Cruz do Sul, RS, Brazil. Email: hildegardpohl@outlook.com

⁶Graduate Program in Health Promotion. University of Santa Cruz do Sul (UNISC), Santa Cruz do Sul, RS, Brazil. Email: skrug@unisc.br

⁷Nurse and master's Program in Health Promotion- University of Santa Cruz do Sul (UNISC), Santa Cruz do Sul, RS, Brazil. Email: mocelinguilherme@gmail.com

Received: 22 Jun 2022,

Received in revised form: 15 Jul 2022,

Accepted: 21 July 2022,

Available online: 29 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Hematologic Neoplasms, Farmers, Agrochemicals, Occupational Health.

Abstract— The study analyzed the relationship between the variables of the sociodemographic, clinical and occupational profile of farmers exposed to pesticides undergoing treatment at a reference unit in oncology in southern Brazil with the presence of hematological neoplasms. 72 farmers participated, mostly female, elderly, low education level and rural residents. Leukemia, non-Hodgkin's lymphomas and multiple myeloma prevailed. There was statistical significance between the variables tobacco cultivation and health region with the existence of the disease and when comparing the initial age in agriculture and the daily working hours with the use of different types of pesticides, pointing to a possible relationship between these variables with the presence of hematological neoplasms. Changes in lifestyle and work become important for promoting the health of the rural population.

I. INTRODUCTION

Rural workers, in their occupational activity, may be exposed to pesticides, being vulnerable to the harm that contact with these chemicals can cause, making it difficult to measure the effects of chronic exposure on health.^{1,2} Pesticides are used on a large scale in the world, including in Brazil, considered one of the world's largest consumers of these products and Rio Grande do Sul is among the states with the highest consumption in the country.³⁻⁵ This excessive use causes numerous damages to the environment and impacts on human health, especially to

farmers, since these products are present in the spaces of life and work of these professionals.²

Cancer cases have been increasing significantly, especially in developing countries, being considered by the World Health Organization as one of the most significant public health problems today.⁶ This disease is characterized by the proliferation of altered cells, which can reach organs and tissues of the human body and become fatal to individuals.⁷ In the same proportion, there is also an increase in the worldwide incidence of hematological cancers.⁸ In Brazil, leukemia, Hodgkin's

lymphomas (LK) and Non-Hodgkin's lymphoma (NHL), are among the 10 most prevalent types of cancers in the population, with an estimated 12,790 cases in men and 10,720 in women. In the Southern Region, the estimate is 4,790 new cases, 2,720 in men and 2,070 in women, and in the state of RS alone, the projection is 2,170 new cases of the disease, 1,220 in men and 950 in women.⁹

Recent studies are evaluating the association of occupational exposure of farmers exposed to pesticides during their activities with the incidence of cancer, especially with hematological neoplasm.¹⁰⁻¹³ Carvalho¹⁴ pointed out the importance of investigating the social and economic factors of rural workers and how they influence the health / disease process, taking into account the occupational risks of this class.

A case-control study, conducted in Brazil, investigated the association between being an agricultural worker and the risk of mortality from (NHL) and found that farmers aged 20-39 years had a 31% higher chance of death from NHL when compared to non-farmers of the same age group.¹⁵ Another study evaluated agricultural use of insecticides, fungicides and specific fumigants and the risk of NHL subtypes, chronic lymphocytic leukemia and multiple myeloma (MM), and demonstrated that pesticides of different chemical and functional classes were associated with the risk of NHL subtypes.¹⁶

Although the number of cases of hematological neoplasm is not representative when compared to other types of cancer, in Brazil, the increase of the neoplasm is observed, representing an increase of more than 100% in the number of cases in the last 10 years.⁹ This fact calls for the investigation of the variables involved in the causes of this increase; however, there are not many studies carried out in the country involving this theme.^{8, 15}

Farmers are seen as a group that is vulnerable to cancer. They are considered as a risk group, due to the environment in which they work and because of their work activities, they demand greater exposure to pesticides, since they involve the application of products, transportation, mixing of syrups, handling and disposal of packaging.^{14,17} Taking into account that in the South region and in the state of Rio Grande do Sul the pesticide market represents a significant amount in Brazil¹⁸, it is important to study the social demographic and occupational characteristics of the population living in the region, since it is known that there is cultivation of agricultural products, such as tobacco, vegetables and grains, which require the use of pesticides, as already reported in other studies. In addition, in Rio Grande do Sul, cancer is the main cause of death in 140 of its municipalities.¹⁹

In this context, the objective of this study was to analyze the relationship between the variables of the social demographic, clinical and occupational profile of farmers exposed to pesticides with the presence of hematological neoplasm.

II. MATERIAL AND METHODS

This is a prospective, quantitative, descriptive, cross-sectional study. This was carried out in a Unit of High complexity in oncology (UNACON) in the interior of the state of Rio Grande do Sul, reference in cancer treatment by the Unified Health System, offering surgical treatment, chemotherapy and radiotherapy. This unit is a reference for 62 municipalities in the 8th, 13th and 16th Regional Health Coordinators (CRS) of the state of Rio Grande do Sul (Figure 1) comprising a population of 852,834 people (SES RS, 2018).

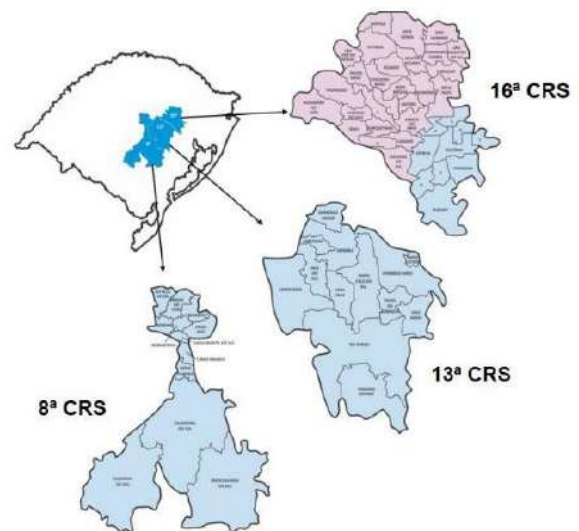


Fig.1. Map of the 8th, 13th municipalities and 16th Regional Health Coordinators (CRS) of Rio Grande do Sul.

Source: State Health Secretariat of Rio Grande do Sul, 2020.

The 8th CRS is made up of 12 municipalities, with a population of 200,264 inhabitants. Trade services and activities predominate, corresponding to 42.8% of the Gross Domestic Product (GDP), as well as agricultural activities (36%) and industry (15.8%). Rice, corn, beans, tobacco, soybeans, among others, predominate. The 13th CRS is made up of 13 municipalities, with a population of 327,158 inhabitants, of which 63% live in urban areas and 37% in rural areas. In this region, with regard to products from temporary crops, tobacco stands out in a greater proportion, also the breeding of dairy and beef cattle and

the cultivation of grains, such as rice and wheat, in addition to silviculture and forest exploration. Regarding the Gross Added Value of the Manufacturing Industry, 80% of this is linked to the cultivation of tobacco in the agriculture sector. The 16th CRS is made up of 37 municipalities, with a population of 325,412 inhabitants. The municipalities in this region are responsible for 25% of chicken production, 15% of pig production and 8% of dairy production in RS. The rural properties are small, with an average of 13.50 hectares and are characterized by low grain production in the region.²¹ Regarding products from temporary crops, tobacco planting is responsible for 9.3% of the total and for permanent crops, the predominant

cultivation is yerba mate, corresponding to 2.7%. The region is second in the state in terms of rural productivity, with a predominant feature in agribusiness activities, with emphasis on the food sector.²²

The study participants were farmers aged ≥ 18 years, of both sexes, being treated at UNACON during the period of data collection - April and July 2019 -, with a diagnosis of hematological cancer, according to the International Classification of Diseases (ICD), as described in Chart 1. Farmers who did not have exposure to pesticides or who died during the collection period were excluded from the study.

Chart 1. List of neoplasms according to the International Classification of Diseases (ICD)

CODE ICD-10*	NEOPLASM
C81	Hodgkin's disease
C82	Non-Hodgkin's lymphoma, follicular (nodular)
C83	Diffuse non-Hodgkin's lymphoma
C84	Cutaneous and peripheral T cell lymphomas
C85	Non-Hodgkin's lymphoma of other types and unspecified types
C90	Multiple myeloma and plasma cell malignancies
C91	Lymphoid leukemia
C92	Myeloid leukemia
C93	Monocytic leukemia
C94	Other cell leukemias of specified type
C95	Leukemia of unspecified cell type
C96	Other and unspecified malignancies of lymphatic, hematopoietic and related tissues

Source: DATASUS²³* International Nomenclature of Diseases, established by the World Health Organization.

The total number of patients undergoing cancer treatment for the treatment of hematological neoplasm at UNACON during the study period was 210 patients. Figure 2 shows the patient selection process.

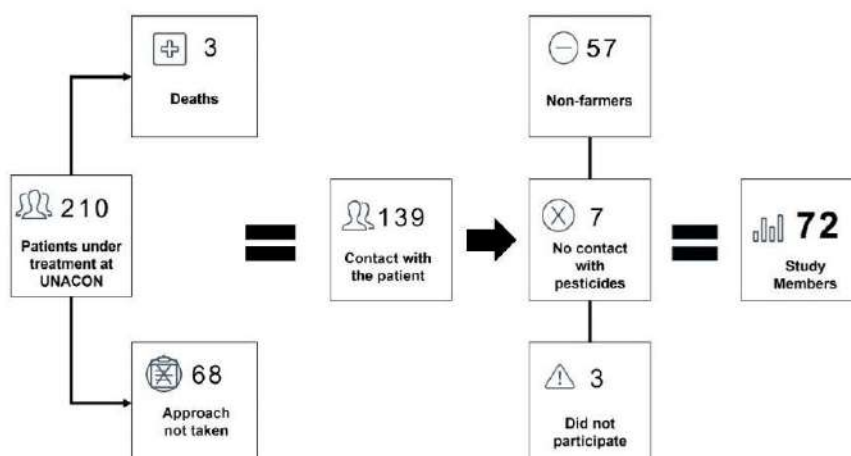


Fig.2. Selection of the sample of farmers participating in the study.

Data collection took place in two stages: in the first, a report was extracted from the institution's computerized management system with the list of patients diagnosed with hematological neoplasm being treated and some information from the electronic medical record, which included the data identification of the subjects, treatment data and the number of services at the institution. Subsequently, in the second stage, the data were collected directly with the patient, through a questionnaire with 42 questions, completed by the collector, which included the following data: social demographic, behavioral, clinical, occupational and referring to previous poisoning by pesticides. The collection instrument was developed by the researcher, based on the adaptation of other research instruments, carried out by Rocha²⁴, Martins²⁵ and Faria¹⁷, who used a questionnaire adapted from the international cohort study of the Agricultural Health Study.²⁶

The approach to patients took place on the premises of the institution's chemotherapy outpatient clinic, while waiting for the consultation with the doctor or for the application of chemotherapy. An invitation to participate in the research was carried out and, if agreed, the patient signed the Free and Informed Consent Form. The questionnaire was administered to patients individually, on the premises of a multi-professional, comfortable and adequate office, with a table and chair available for the collector, participant and family and / or responsible person.

The questionnaire was applied by the researcher and by two pharmacists from the multi-professional Residency Program in Health - Attention to the Cancer Patient, a proposal developed by the UNACON institution, which aims at the technical training of health professionals to work in the oncology area. The residents received training regarding the application of the questionnaire by the researcher before the collection started.

The data were tabulated and later analyzed using the software Statistical Package for the Social Sciences (SPSS - version 23.0). The analysis consisted of descriptive statistics, with the results expressed as mean and standard deviation, frequency and percentage. The normality of age was verified by the Shapiro-Wilk test. One-Way ANOVA (normal distribution) and Kruskal-Wallis test (non-normal distribution) were used to compare means. For categorical variables, the Chi-Square test was used, considering $p < 0.05$. Multinomial Logistic Regression was used to calculate the odds ratio (odds ratio) between the groups.

The study was approved by the Research Ethics Committee of the University of Santa Cruz do Sul, under opinion number 3.017.507.

III. RESULTS

The characteristics of the social demographic and lifestyle profile of the farmers participating in the study are described in table 1.

Table 1. Social demographic and lifestyle profile of farmers

Variable	n = 72 n (%)
Sex	
Male	29 (40.3)
Female	43 (59.7)
Age*	63.0±12.8
Marital Status^a	
Married	51 (71.8)
Widower	13 (18.3)
Others	7 (9.9)
Skin color	
White	63 (87.5)

Brown	7 (9.7)
Black	2 (2.8)
Health region^a	
8th HRS	12 (16.9)
13th HRS	20 (28.2)
16th HRS	39 (54.9)
Residencearea^a	
Rural	36 (50.7)
Urban	35 (49.3)
Education	
Illiterate	8 (11.1)
IncompleteElementarySchool	55 (72.2)
Complete ElementarySchool	7 (9.7)
Complete high school	5 (7.0)
Family income	
≤ R\$ 1.000,00	1 (1.4)
R\$ 1.001,00 a 2.000,00	26 (36.1)
R\$ 2.001,00 a 5.000,00	28 (38.9)
> R\$ 5.000,00	6 (8.3)
Notinformed	11 (15.3)
Physicalactivity	
Yes	32 (45.1)
No	40 (54.9)
Bodymass index	
Lowweight	1 (1.6)
Eutrophic	27 (42.9)
Overweight	19 (30.2)
Obese	16 (25.4)
Smoking	
Neversmoked	28 (38.9)
Yes	4 (5.6)
Ex-smoker	24 (33.3)
Passive smoking	16 (22.2)
Alcoholconsumption	
Never	51 (70.8)
Rarely	17 (23.6)
1 to 2 times a week	2 (2.8)
Daily	2 (2.8)

*: average and standard deviation; a: 1 missing.

Table 2 shows the data related to the occupational profile, as well as the exposure to pesticides when exercising the activity of a farmer. Regarding the occupational profile, 9.7% of the participants still worked

in agriculture; 77.7% were already retired and / or received some type of aid. As for length of service, 95.8% started agricultural activities before turning 18 and 62.3% worked more than 30 years in agricultural activity.

Table 2. Occupational characteristics and exposure to farmers' pesticides

Variable	n=72 (100) n (%)
Professional activity	
Retired / sickleave	56 (77.7)
Unemployed	7 (9.7)
Farmer	7 (9.7)
Formal employee	2 (2.8)
Employmentbond	
Owner	45 (62.5)
Employee	14 (19.4)
Temporary	2 (2.8)
Others	11 (15.3)
Age of onset in agriculture	
<10 anos	42 (58.3)
11 a 18 anos	27 (37.5)
>18 anos	3 (4.2)
Time of activity in agriculture^a	
<10 anos	7 (11.5)
11 a 20 anos	9 (14.8)
21 a 30 anos	7 (11.5)
>31anos	38 (62.3)
Cultivation	
Grains	69 (95.8)
Vegetables	55 (76.4)
Tobacco	52 (72.2)
Yerba mate	10 (13.9)
Hours of work in the field / day	

Upto 8h	23 (31.9)
More than 8h	49 (68.1)
How do you feel after a workday	
Well	30 (41.6)
A littletired	18 (25.0)
Verytired	22 (30.6)
Don'tremember	2 (2.8)
Pesticidesused	
Insecticide	13 (18.1)
Herbicides	9 (12.5)
Fungicides	2 (2.8)
All	48 (66.6)
Disposalofpackaging	
Adequate	29 (40.3)
Inappropriate	43 (59.7)
Use de PPE	
Yes	38 (52.8)
Frequencyof use	
Sometimes	8 (21.1)
Frequently	19 (50.0)
Always	11 (28.9)
Whatequipment?	
Closedshoes	33 (86.9)
Hat	30 (78.9)
Gloves	13 (34.2)
Waterproofclothing	10 (26.3)
Usageguidance	
Yes	29 (40.3)
Who guided?	
Company	23 (79.3)
Publicdepartments	4 (13.8)
Others	2 (6.9)
Equipment used in the application	
Coastalsprayer	40 (55.6)
Coastalsprayerandtractor	11 (15.3)
Manual	11 (15.3)
Others	10 (13.8)
Pesticidepoisoning	
Yes	26 (36.1)
Discomfortafterpesticide use	

Yes 29 (40.3)

What?

Weakness / dizziness / tremor / headache 25 (86.2)

Gastrointestinal discomfort 18 (65.1)

Muscle aches 9 (31.0)

Sleep disorders 7 (24.1)

** PPE: personal protective equipment; a: 11 missing

Regarding the clinical profile of farmers, in relation to clinical diagnoses, the types of neoplasm were Lymphoma-Hodgkin (32%); Multiple myeloma (27.8%); Lymphoid leukemia (16.6%); Lymphoid leukemia (15.2%); Hodgkin's lymphoma (5.6%) and 2.8% corresponded to other types of leukemia. Most farmers were diagnosed between 1 and 5 years (58.6%). 39 (54.2%) of them had a family history of neoplasm, 30 (41.47) of first degree of kinship. The previous comorbidities presented that had the highest prevalence were

systemic arterial hypertension (44.4%) and depression (22.2%). Regarding the use of medicines for continuous use, 91.7% used them.

When the relation between the social demographic variables and the lifestyle of the farmers was carried out with the presence of hematological neoplasm, it was possible to identify a positive association with the health region and the cultivation of tobacco, according to data in Table 3.

Table 3. Relationship between social demographic variables and farmers' lifestyle with hematological neoplasm

Variável	HL* (n=4) n (%)	NHL* (n=23) n (%)	MM* (n=20) n (%)	Leukemias (n=25) n (%)	P
Age*	60,7±14,6	63,4±11,4	66,9±9,3	60,0±15,7	0.340
Breed					
White	3 (5)	19 (30)	18 (29)	23 (36)	0.767
Brown	1 (14)	3 (43)	1 (14)	2 (29)	
Black	0 (0)	1 (50)	1 (50)	0 (0)	
Health Region					
8th	4 (33)	5 (42)	1 (8)	2 (17)	<0.001
13th	0 (0)	4 (20)	8 (40)	8 (40)	
16th	0 (0)	13 (33)	11 (28)	15 (39)	
AreaofResidence					
Rural	3 (8)	8 (22)	9 (25)	16 (45)	0.188
Urban	1 (3)	14 (40)	11 (31)	9 (26)	
Education					
Illiterate	0 (0)	2 (25)	4 (50)	2 (25)	0.126
Incompleteelementaryschool	2 (4)	18 (35)	14 (26)	18 (35)	
Complete elementaryschool	2 (29)	1 (14)	0 (0)	4 (57)	
Complete high school	0 (0)	2 (40)	2 (40)	1 (20)	
History Family ofNeoplasm					
Yes	4 (10)	12 (31)	12 (31)	11 (28)	0.192
No	0 (0)	11 (33)	8 (24)	14 (43)	
Which Family Member					

First Grade	2 (6)	12 (39)	10 (32)	7 (23)	0.082
SecondDegree	2 (25)	0 (0)	2 (25)	4 (50)	
Third Grade	0 (0)	1 (100)	0 (0)	0 (0)	
Physicalactivity					
Yes	3 (9)	9 (28)	11 (35)	9 (28)	0.132
No	0 (0)	14 (36)	9 (23)	16 (41)	
Consumptionofalcoholicbeverage					
Never	3 (6)	16 (31)	17 (33)	15 (30)	0.447
Daily	0 (0)	2 (100)	0 (0)	0 (0)	
From 1 to 2 times a week	0 (0)	1 (50)	0 (0)	1 (50)	
Sporadically	1 (6)	4 (23)	3 (18)	9 (53)	
Smoking					
Never smoked	0 (0)	8 (28)	9 (33)	11 (39)	0.676
Smoker	0 (0)	2 (50)	0 (0)	2 (50)	
Ex-smoker	2 (8)	9 (38)	6 (25)	7 (29)	
Passive smoking	2 (12)	4 (24)	5 (32)	5 (32)	

*HL: Hodgkin's lymphoma; NHL: Non-Hodgkin's Lymphoma; MM: Multiple Myeloma

Table 4 shows the relation between occupational variables and exposure to pesticides in farmers with hematological neoplasm.

Table 4. Relation between occupational variables and exposure to pesticides in farmers with hematological neoplasm

Variable	HL* (n=4) n (%)	NHL* (n=23) n (%)	MM* (n=20) n (%)	Leukemias (n=25) n (%)	p
Professional activity					
Retired / aid	3 (5)	17 (31)	18 (33)	18 (33)	0.884
Unemployed	1 (14)	2 (29)	1 (14)	3 (43)	
Farmer	0 (0)	3 (43)	1 (14)	3 (43)	
Formal employee	0 (0)	1 (50)	0 (0)	1 (50)	
Starting age in agriculture					
<10 anos	4 (10)	12 (28)	11 (26)	(36)	0.343
>11 anos	0 (0)	11 (37)	9 (30)	10 (33)	
Graincultivation					
Yes	4 (6)	22 (32)	20 (29)	23 (33)	0.580
No	0 (0)	1 (33)	0 (0)	2 (67)	
GrowingVegetables					
Yes	2 (4)	20 (37)	16 (29)	17 (31)	0.252
No	2 (12)	3 (18)	4 (23)	8 (47)	
TobaccoGrowing					
Yes	1 (2)	14 (27)	17 (33)	20 (38)	0.040
No	3 (15)	9 (45)	3 (15)	5 (25)	

Yerba Mate cultivation					
Yes	0 (0)	3 (30)	5 (50)	2 (20)	0.328
No	4 (7)	20 (32)	15 (24)	23 (36)	
Pesticideused					
Formicide	2 (15)	7 (35)	2 (15)	2 (15)	0.258
Fungicide	0 (0)	0 (0)	1 (50)	1 (50)	
Herbicide	1 (11)	3 (33)	1 (11)	4 (45)	
All	1 (11)	13 (27)	16 (34)	18 (38)	
Disposalofpackaging					
Suitable	0 (0)	9 (32)	7 (25)	12 (43)	0.315
Inappropriate	4 (10)	14 (32)	13 (29)	13 (29)	
Use of PPE*					
Yes	1 (2)	13 (34)	8 (21)	16 (43)	0.268
No	3 (9)	10 (29)	12 (35)	9 (27)	

*HL: Hodgkin's lymphoma; NHL: Non-Hodgkin's Lymphoma; MM: Multiple Myeloma; PPE: Personal Protective Equipment

When related to previous co-morbidities with hematological neoplasm, depression showed a significant difference ($p=0.026$). The use of the types of pesticides was also compared and a significant difference was observed regarding the initial age in agriculture ($p=0.027$), the daily work ($p=0.035$), tobacco cultivation ($p\leq 0.01$) and not Significance was observed in the area of residence ($p=0.055$), in the health region ($p=0.133$), between genders ($p=0.133$), education ($p=0.422$), referring to smoking ($p=0.432$), consumption alcoholic beverages ($p=0.371$), agricultural activity time ($p=0.371$), grain cultivation

($p=0.83$), vegetables ($p=0.724$) and yerba mate (0.083) and use of PPE ($p = 0.368$).

Multinomial logistic regression analysis was used to determine the odds ratio. In the association between different hematological neoplasm and smoking, consumption of alcoholic beverages, used pesticides, cultivation of vegetables, tobacco and yerba mate, no differences in the odds ratio were observed, since between the presence of leukemia and MM, the use of PPE showed as a protective factor (OR: 0.26; CI: 0.07-0.99), according to data in table 5.

Table 5. Association between hematological cancer groups and characteristics of work and lifestyle

Variable	OR (95% CI)	
		Leukemias
Smoking	LNH	1.12 (0.21–5.91)
	MM	1.12 (0.21–5.91)
Consumptionofalcoholicbeverage	LNH	1.48 (0.41–5.40)
	MM	4.35 (0.95-20.03)
Type of pesticide used	LNH	4.75 (0.81-28.04)
	MM	0.94 (0.11-7.97)
Cultivation of Vegetables	LNH	2.92 (0.63-13.57)
	MM	2.31 (0.51-10.57)
TobaccoCultivation	LNH	0.41 (0.10-1.72)
	MM	1.57 (0.28-8.76)
CultivationofYerba Mate	LNH	1.42 (0.20-10.15)

Use of PPE	MM	3.92 (0.61-25.10)
	LNH	0.76 (0.21-2.75)
	MM	0.26 (0.07-0.99)

NHL: Non-Hodgkin's Lymphoma; MM: Multiple Myeloma, OR: odds ratio; CI: confidence interval, PPE: personal protective equipment.

IV. DISCUSSION

The average age found in the study population characterizes the sample as elderly, which coincides with data from the literature indicate that hematological neoplasm usually affect patients older than 59 years.^{15,27} However, after relating this variable to the presence of the neoplasm, it was not statistically significant ($p=0.340$), suggesting that there is no implication of age in presenting or not the disease.

The female sex was predominant among farmers being treated for hematological neoplasm. In the Brazilian state of Piauí, the findings of a survey that investigated the socio-demographic data of rural workers, 63% of the participants were also women²⁸, contradicting some studies that claim that a large part of the population of active farmers is male.^{29,30} However, it should be considered that the population investigated in the present research, for the most part, was not in professional practice and the entire sample was being treated for a malignant disease, whose female life expectancy is higher than that of the male.⁹ Still, it is emphasized that the participation of women in agricultural activities, in the territories where agricultural cultivation is characterized for purposes of family subsistence is greater.²⁸

Some authors^{31, 32} have also shown that there has been an increase in the number of neoplasm in women farmers, particularly in ovarian, pancreatic, breast and acute myeloid leukemia. Thus, it is assumed that the data found in the present study are in line with those found in the literature and although they have not shown statistical significance ($p=0.281$) when sex is related to the prevalence of the disease, it is an important data since it assumes that female farmers have a better survival prognosis when compared to male farmers.

The education indexes identified reveal that the most of them do not have complete elementary school and some did not even attend school. The education level of farmers in general is low, which could be observed in other studies carried out in Brazil.^{15, 28,30,33,34} It thus becomes an aggravating factor for the occurrence of poisoning and death from pesticides, which can be revealed through the notification indicators. In addition, in farmers with low education, the refusal to use Individual Safety Equipment (PPE) is greater than in those with a higher level of education.^{30, 35-37} It is important to note that, not only in the

health area, education is also a determining factor in people's well-being conditions, acting as a protective factor against poisoning by agrochemicals.¹⁷

Although education was not shown to be a variable with a significant result ($p=0.126$) and there was no difference in the analysis of the odds ratio of this variable with the presence of hematological neoplasm (table 5), the low level of education of the sample farmers is an important piece of data, as the lower educational level of farmers can lead to misunderstanding of the guidelines regarding the use of pesticides. The difficulty in reading the labels of the containers of these products can cause mixing and inadequate preparation of the syrups, causing risks of contamination and damage to the health of the handler.^{15, 29}

The present study was carried out in a reference center in oncology, which serves a population of a region formed by several ethnic groups, of which those of German, Italian and Azorean origin stand out.³⁸ The study patients came, in their totality, from municipalities located in these regions and were mostly called white (87.5%). In other studies, in which the presence of hematological neoplasm in farmers was investigated, there was also a predominance of white skin color.¹⁵ In addition, it is highlighted that the majority of farmers came from municipalities of the 16th CRS, in which European colonization is predominant, mainly of German origin.

According to the report of patients in the study, the majority no longer had an occupational activity in agriculture, but a representative part of them still resided in the rural area, a common characteristic of the municipalities in the region where the study was conducted.³⁹ Thus, even though this variable has not shown a significant relationship with the disease ($p=0.188$), it is suggested that even without direct contact with pesticides, they could still be exposed to its harmful effects, as they are found in the rural area where these products are more used.³ A study carried out in Greece, with patients undergoing treatment for myelo-dysplastic syndromes, the findings corroborate those of the present study, in which the majority of the population remained residing in the countryside.³⁵

Regarding lifestyle, it was observed that farmers had healthy lifestyle habits, with the exception of physical activity. However, despite the low frequency of alcoholic

beverages and daily consumption of fruits and vegetables prevalent among the participants, the presence of smoking was found in most participants. These data can be considered as protective factors for cardiovascular diseases and cancer, except for the recent or old presence of smoking.¹⁵ Even so, there are studies in the literature that suggest that the rural population has a higher risk for the development of some types of neoplasm, such as hematological ones¹⁰⁻¹³, with the greatest risk factor being overexposure to pesticides and the relationship with tobacco¹⁵, already investigated in this study. Another fact that is important is the prevalence of overweight among farmers, which despite not being significant ($p=0.140$). Studies assess the presence of obesity with the development of cancers. In the present study, it is not possible to say whether this excess weight may or may not be related to the disease or chemotherapy treatment, since these data were not collected prior to the diagnosis of the neoplasia.

Analyzing the data of the occupational profile, the extensive period of exposure to pesticides of the farmers is verified, which corroborates with other studies and also with statistics about the work activities in the field.^{6, 28, 40} Another relevant fact is that 62.5% of the farmers owned the workplaces, which may justify the premature start in the activity, as well as the long period of professional practice in agriculture.

The finding of child labor in agriculture was also highlighted, since it was observed, in this study, that 95.8% of the interviewees started their activities in the sector before the age of 18 years. In the past, it was a very common practice, but a recent study still identified child labor in these places, mainly associated with tobacco cultivation.⁴¹ The International Labor Organization reported that there are still 11% of minors in employment and 59% of them are in agriculture.⁴² Since the consequences of these activities as children, they will probably only be seen as adults, when there are manifestations of neoplasms, infertility problems, respiratory, among others.

In the study by Pignati⁵, the authors found that in 76% of the planted area in Brazil in 2015, agricultural production of soy, corn and sugarcane prevailed. In addition, tobacco is one of the products that represents a high percentage in the number of total exports of agricultural products in the South Region.⁴³ Similar data were found in the present study, in which grain cultivation predominated among farmers, followed by vegetables and tobacco. Still, it is worth mentioning the low percentage of yerba mate producers among the sample farmers, due to the lower number of resident patients in the health region where the cultivation of this product is characteristic.

According to a survey presented by Friedrich⁴⁴, the most used pesticides in agricultural activity in Brazil, are herbicides, fungicides and insecticides. It was evidenced in the present research that these were also the types of pesticides used by the sample farmers. In a study by Chagas⁴⁵, farmers with exposure to pesticides classified as herbicides and fungicides, embraced a high risk for the rise of NHL and MM.

A systematic review by Schinasi and Leon⁸ evaluated the relationship between NHL and exposure of rural workers to pesticides, gathering studies, of which twenty of them indicated an association between the disease and exposure to herbicides, four with fungicides and seventeen with insecticides. Research by Rapisarda⁴⁶ also suggested the association of hematological neoplasm with exposure to these products. In a study by Avgerinou³⁵ it was found that patients affected by hematological neoplasm exposed to insecticides and herbicides were more numerous than those patients who had no contact with these products. Those who plant yerba mate can also plant tobacco, so a high prevalence in the use of all the types of pesticides (fungicides, herbicides and insecticides), although not significant ($p=0.083$). Through the results found, it is suggested that those who had a longer daily workday, used more all types of pesticides, since there was significance when related to the variables ($p=0.035$).

In another study, the exposure to pesticides of more than 300 thousand rural workers registered in cohort studies in France, Norway and the United States with the presence of hematological neoplasm was analyzed. And the authors' suggestion was that the associations between these variables will depend on the subtype of the pathology and the pesticide used.⁴⁷

In the present study, when the variables health region and tobacco cultivation were related, there was statistical significance ($p \leq 0.001$ and $p = 0.040$, respectively), suggesting a possible relationship between tobacco plantation and the health region belonging to the farmer and the presence of neoplasm. The health region with the highest number of cases was from the municipalities belonging to the 16th CRS. In this region, family farming is the main means of production and there are municipalities that are among the largest tobacco producers in the country, which may justify these relationships, suggesting that tobacco cultivation may be related to the presence of the disease.⁴⁸ This possible relationship has not yet been pointed out in other studies, as there were no studies on the topic in the region, only in the state and country, in which there is a concern about the excessive use of pesticides in tobacco production, as well

as a high index smoking among farmers and the relationship with the development of cancer.^{15, 30, 33}

The inappropriate disposal of pesticide packaging is considered to be another public health problem, since it is waste of highly toxic chemical products, which can harm the environment. Through a survey of the socioeconomic characteristics of tobacco producers in the South, researchers from the Federal University of Rio Grande do Sul found that 52.2% of respondents performed inappropriate waste disposal, including the packaging of pesticides.⁴⁰ Similar data were observed in this study, in which 59.7% of farmers also did not correctly dispose of the packaging of the products they used as pesticides and, even though there was no statistical relationship ($p=0.315$) with the presence of the disease, this data it is relevant, as it points out that education and awareness measures should be carried out with this population.

Regarding the use of PPE, 52.8% responded that they used them, corroborating with data from the literature.²⁸ However, in relation to the frequency of use of PPE, only 28.9% reported using them always. As for the type of equipment, the most cited were closed shoes (86.9%) and hats (78.9%). It is evident that even having knowledge about the health problems that can be caused by not using PPE, farmers do not seem to perceive the risk, in addition to not being concerned with practices aimed at safety at work.^{30,34,49} In the research by Riquinho and Hennington³⁴ it was also found that most farmers did not adhere to PPE, which is justified because it makes the harvesting process difficult and due to the very hot climate. It is important to note that when comparing leukemia with MM it was observed that farmers who do not use PPE have a higher risk of developing MM among those who use PPE and those who have leukemia.

In this study, more than half of the farmers (55.6%) used the spray sprayer as a tool for applying pesticides, as well as in other studies that assessed the occupational risk of these workers.^{50,51} When using this instrument, the applicator is more vulnerable to risks of intoxication or accident, as it is fragile material, being in direct contact with the worker.⁵²

Acute intoxications in farmers caused by pesticides are also reported in studies worldwide, but it is known that there is an underreporting of cases, since these workers often do not identify these diseases as related to the use of these products, they often do not seek specialized care for the treatment of symptoms.^{34,36,51,53} In our study, part of the sample (36.1%) reported intoxication due to the use of pesticides and 40.3% reported feeling discomfort after applying the products, mainly related to neurological symptoms, such as weakness, dizziness, tremor and headache, corroborating with other research

findings.^{11,45} Despite these symptoms, the majority reported feeling good after the workday.

In this sense, it is important to intervene by the health teams of the municipalities in guiding farmers about the importance of using PPE, in addition to alerting them about the symptoms of intoxication and about the necessary procedures in cases of intoxication. It is also important that these teams are trained to provide adequate care for these situations, in addition to emphasizing the need for notification of these events in the Notified Diseases Information System (SINAN), which is a very important tool in the health field. , guiding teams in the formulation of strategies that prevent recurrence of injuries and the assessment of actions through indicators that demonstrate the impact of interventions.²⁸

The most frequent hematological cancers are leukemia, lymphomas and myelo-dysplastic syndromes.⁵⁴ According to the findings of the literature, in the present study, these were also the most representative among the farmers in the sample.

In Thailand, a survey was conducted with orchid producers, which evaluated the effect of exposure to pesticides on immunological, hematological and biochemical parameters. The findings showed that some results pointed to a decrease in the production of B lymphocytes in humans.⁵⁰ Other studies have also found hematological changes in pesticide applicators, in which the dependent factors were exposure time, product used and non-use of PPE.⁵⁵⁻⁵⁷ In the present study, patients also presented these changes, since they were diagnosed with some type of hematological malignancy, which may also be related to the findings of these studies.

Regarding the diagnosis of the disease, 55 (76.4%) of the farmers were due to specific symptoms or because they felt bad due to some clinical manifestation of the disease, while 17 (23.6%) reported that they were undergoing routine. These results may suggest that this population does not have easy access to health or, even, it may be an indicator of the farmer's own disregard for their health. Generally, in rural communities, admission to public health is not as accessible as in other locations, making it an obstacle for these workers to seek medical assistance.³⁴ In addition, they usually seek health care only when symptoms are already evident and not through routine or preventive exams.

There was a statistical relationship between patients who reported having depression with the presence of hematological neoplasm. This data can be justified by the fact that depression is manifested in greater numbers in patients with NHL (47%) and MM (47%), while only 6% of patients with leukemia and in no case of Hodgkin's lymphoma. There is no way to say whether the disease

manifested itself before or after chemotherapy, but studies suggest the relationship between depression in cancer patients^{58, 59} and with the use of pesticides.^{37,60,61}

The number of farmers who reported a family history of neoplasm was greater (54.2%) and, of these, in relation to the degree of kinship, 41.47% was first degree. In a case-control study carried out in Greece, it was found that in patients with myelo-dysplastic syndrome, the frequency of reporting a history of hematological neoplasm was higher when compared to controls.³⁵ It is known that genetic predisposition is a collaborative factor for the development of some diseases, including cancer and, when associated with exposure to pesticides, can contribute to its development.^{11,45,62} In the present study, it is suggested that the genetic factor associated with pesticide exposure may have contributed to the development of hematological neoplasm, but not in all cases.

When comparing the use of pesticides with diseases, a significant difference was observed regarding the initial age in agriculture and in the daily work shift, suggesting that these factors may indicate that there was a greater use of all types of pesticides in those farmers who started early on agricultural activity and that fulfilled a greater daily working day, that is, the younger the age and the longer the working day, the greater the use of different types of pesticides.

There was also a significant association in those who grew tobacco, suggesting that farmers who grew tobacco used more types of pesticides than those who did not. In addition, it can be suggested that those who planted yerba mate could also grow tobacco and, therefore, a high prevalence in the use of all pesticides, despite not having statistical significance ($p=0.083$). These findings may suggest that the early initial age in agriculture, the amount of daily hours worked and the cultivation of tobacco are related to greater exposure to pesticides and consequently becoming risk factors for the development of hematological neoplasm, as evidenced in other studies.³⁰

The use of PPE in our study was considered reasonable, but when asked about the frequency, most did not always use the equipment. Even so, when analyzing of the odds ratio between the presence of leukemia and MM, the use of PPE was a protective factor. Other studies⁶³⁻⁶⁵ report on the importance of using these devices in an attempt to control farmers' exposure to pesticides, but as in this research, their adherence and frequency of use was low.

Among the findings of the study, the association between tobacco cultivation, health region of the farmers' residence and the existence of the disease stands out, suggesting a possible relationship between them. In this region are located municipalities that are among the largest tobacco producers in the country, which may justify these relationships, suggesting that tobacco cultivation may be related to the presence of the disease.

The study also pointed out an association between the age of beginning work in agriculture, daily working hours and the use of different types of pesticides, suggesting that the earlier the start of work in agriculture and the longer the working day, the greater exposure to different types pesticides, due to the greater concomitant use of fungicides, herbicides and insecticides.

It is noteworthy that all individuals in the research were farmers diagnosed with hematological neoplasms and direct exposure to pesticides. In addition, even though there was no association between the other variables studied, there was evidence that they could be related to the presence of hematologic neoplasia. Since it was evidenced the low level of education of the participants, the long period of exposure to pesticides, as well as the early start in agricultural activities, the non-use of PPE frequently and the concomitant exposure to different types of pesticides.

Regarding the two agricultural products grown in the study region, a large proportion of tobacco producers were found to be affected by hematological neoplasms, in contrast to the small number of producers of yerba mate with the disease. This may suggest that the cultivation of yerba mate affects and exposes farmers less to hematological neoplasms.

It is important to note that the study did not intend to prove the direct relationship between use and exposure to pesticides with the presence of hematological neoplasms among farmers. The multiple genetic, environmental and lifestyle factors need to be considered in the origin of the disease, however, it is important to pay attention to the research results, which point out work factors that can contribute to the presence of these pathologies.

Health promotion strategies are suggested that may include education actions, with the objective of stimulating changes in the lifestyle and work of farmers, greater quality of life, less exposure to pesticides and, consequently, a decrease in the presence of hematological neoplasms.

V. CONCLUSION

ACKNOWLEDGEMENT

To Coordination of the Improvement of Higher Education Personnel (Capes) for granting a scholarship to Master's degree

REFERENCES

- [1] Bombardi LM. Intoxicação e morte por agrotóxicos no Brasil: a nova versão do capitalismo oligopolizado. *Boletim Data Luta* [Internet]. 2011 [acesso em 25 set 2018]; 45:1-21. Disponível em: http://docs.fct.unesp.br/grupos/nera/artigodomes/9artigodomes_2011.pdf
- [2] Costa C, Gangemi S, Giambò F, Rapisarda V, Caccamo D, Fenga C. Oxidative stress biomarkers and paraoxonase 1 polymorphism frequency in farmers occupationally exposed to pesticides. *Mol Med Rep*. 2015;12(4):6353-7. doi:10.3892/mmr.2015.4196.
- [3] Bombardi LM. Geografia do uso de agrotóxicos no Brasil e conexões com a União Europeia. 1. ed. São Paulo: Laboratório de Geografia Agrária [Internet]. 2019 [cited 2020 Jan 06]. Available from: <https://www.larissabombardi.blog.br/atlas2017>
- [4] Brasil. Ministério da saúde. Secretaria de vigilância em saúde. Departamento de vigilância em saúde ambiental e saúde do trabalhador. Relatório Nacional de Vigilância em Saúde de Populações Expostas a Agrotóxicos [Internet]. Brasília, 2016 [cited 2019 Nov 16]. Disponível em: <http://portal.arquivos2.saude.gov.br/images/pdf/2016/dezembro/05/Relatorio-Nacional-de-VSPEA-vol-1.pdf>
- [5] Pignati WA, Lima FANS, Lara SS, Correa MLM, Barbosa JR, Leão LHC, et al. Distribuição espacial do uso de agrotóxicos no Brasil: uma ferramenta para a Vigilância em Saúde. *Ciênc. saúde coletiva*. 2017;22(10):3281-3293. doi:10.1590/1413-812320172210.17742017.
- [6] WHO. World Health Organization. Apresenta informações gerais sobre a instituição [Internet]. 2018 [cited 2020 Jan 06]. Available in: <http://www.who.int/en/news-room/detail/03-02-2017-early-cancer-diagnosis-saves-lives-cuts-treatment-costs>
- [7] INCA. Instituto Nacional de Câncer José Alencar Gomes da Silva. ABC do câncer: abordagens básicas para o controle do câncer / Instituto Nacional de Câncer José Alencar Gomes da Silva; organização Mario Jorge Sobreira da Silva – 5. Ed. Ver. Atual – Rio de Janeiro: Inca [Internet]. 2019 [cited 2019 Nov 23]. Available in: http://www1.inca.gov.br/inca/Arquivos/comunicacao/livro_abc_3ed_8a_prova_final.pdf
- [8] Schinasi LH, Leon ME. Non-hodgkin lymphoma and occupational exposure to agricultural pesticide chemical groups and active ingredients: a systematic review and meta-analysis. *Int J Environ Res Public Health*. 2014;11(4):4449-4527. doi: 10.3390/ijerph110404449.
- [9] INCA. Instituto Nacional de Câncer José Alencar Gomes da Silva. Estimativas 2020: incidência de câncer no Brasil. Rio de Janeiro [Internet]. 2020 [cited 2019 Nov 23]. Available in: <https://www.inca.gov.br/sites/ufu.sti.inca.local/files//media/document/estimativa-2020-incidencia-de-cancer-no-brasil.pdf>
- [10] Alavanja MC, Ross MK, Bonner MR. Increased cancer burden among pesticide applicators and others due to pesticide exposure. *CA Cancer J Clin*. 2013;63(2):120-42. doi: 10.3322/caac.21170.
- [11] Bonner MR, Freeman LE, Hoppin JA, Koutros S, Sandler DP, Lynch CF, et al. Occupational exposure to pesticides and the incidence of lung cancer in the Agricultural Health Study. *Environ Health Perspect*. 2017;125(4):544-551. doi: 10.1289/EHP456.
- [12] Cocco P, Satta G, Dubois S, Pili C, Pilleri M, Zucca M, et al. Lymphoma risk and occupational exposure to pesticides: results of the Epilymph study. *Occup Environ Med*. 2012;70:91-98. doi: 10.1136/oemed-2012-100845.
- [13] Lerro CC, Andreotti G, Koutros S, Lee WJ, Hofmann JN, Sandler DP, et al. Alachlor use and cancer incidence in the Agricultural Health Study: an updated analysis. *J Natl Cancer Inst*. 2018;110(9):950-958. doi: 10.1093/jnci/djy005.
- [14] Carvalho LVB, Costa-Amaral IC, Mattos RCOC, Larentis AL. Exposição ocupacional a substâncias químicas, fatores socioeconômicos e Saúde do Trabalhador: uma visão integrada. *Saúde debate*. 2017;41(spe2):313-326. doi: 10.1590/0103-11042017s226.
- [15] Boccolini PM, Boccolini CS, Chrisman JR, Koifman RJ, Meyer A. Non-Hodgkin lymphoma among brazilian agricultural workers: a death certificate case control study. *Arch Environ Occup Health*. 2017;7(42):139-144. doi: 10.1080/19338244.2016.1179167
- [16] Alavanja MC, Hofmann JN, Lynch CF, Hines CJ, Barry KH, Barker J, et al. Non-Hodgkin lymphoma risk and insecticide, fungicide and fumigant use in the agricultural health study. *PloSOne*. 2014;9(10e109332):1-17. doi: 10.1371/journal.pone.0109332.
- [17] Faria NMX, Fassa AG, Facchini LA. Intoxicação por agrotóxicos no Brasil: os sistemas oficiais de informação e desafios para realização de estudos epidemiológicos. *Ciênc. saúde coletiva*. 2007;12(1):25-38. doi: 10.1590/S1413-81232007000100008.
- [18] Brasil. Ministério da saúde. Secretaria de vigilância em saúde. Boletim epidemiológico, v. 47, n. 16 [Internet]. Brasília, 2016 [cited 2020 Jan 30]. Available in: <http://portal.arquivos2.saude.gov.br/images/pdf/2016/marco/23/2015-052---Agrot--xicos-publica---o.pdf>
- [19] Brasil. Ministério da saúde. Secretaria de vigilância em saúde. Departamento de vigilância em saúde ambiental e saúde do trabalhador. Relatório Nacional de Vigilância em Saúde de Populações Expostas a Agrotóxicos [Internet]. Brasília, 2016 [cited 2019 Nov 2019]. Available in: <http://portal.arquivos2.saude.gov.br/images/pdf/2016/dezembro/05/Relatorio-Nacional-de-VSPEA-vol-1.pdf>
- [20] SES RS. Developed by the State Department of Health of Rio Grande do Sul. Provides general information about the institution [Internet]. 2020 [cited 2020 Jan 11]. Available in: <http://www.saude.rs.gov.br>
- [21] Agostini C. Plano estratégico de desenvolvimento do Vale do Taquari 2015 - 2030. Lajeado: Ed. da Univates

- [Internet], 2017 [cited 2020 Jan 07]. Available in: <https://governanca.rs.gov.br/upload/arquivos/201710/11104740-plano-valedotaquari.pdf>
- [22] Extraordinary Secretariat for Federative and International Relations of Rio Grande do Sul. Provides general information about the institution [Internet]. 2020 [cited 2020 Jan 11]. Available in: <https://estado.rs.gov.br/serfi>
- [23] Datasus. Computer Science Department of SUS. Malignant neoplasms (tumors), declared or presumed to be primary, of lymphatic, hematopoietic and related tissues [Internet]. 2008 [cited 2019 Jul 25]. Available in: http://www.datasus.gov.br/cid10/V2008/WebHelp/c81_c96.htm Acesso em 25 julho 2018.
- [24] Rocha, LFS. Fatores associados com não adesão ao tratamento com tamoxifeno em paciente com câncer de mama: um estudo de intervenção da atividade farmacêutica [dissertação]. Santa Cruz do Sul: Universidade de Santa Cruz do Sul, 2017.
- [25] Martins VA. Doença da folha verde do tabaco: uma análise por FT – IR da metabólômica da saúde dos fumicultores [dissertação]. Santa Cruz do Sul: Universidade de Santa Cruz do Sul, 2017.
- [26] AHS. Agricultural Health Study. Provides general information about the institution [Internet]. 2020 [cited 2020 Jan 11]. Available in: <https://www.aghealth.nih.gov/>
- [27] NIH. National Cancer Institute. Understanding Cancer [Internet]. 2017 [cited 2019 Nov. 20]. Available in: <https://www.cancer.gov/>
- [28] Santana CM, Costa AR, Nunes RMP, Nunes NMF, Peron AP, Melo-Cavalcante AAC, et al. Exposição ocupacional de trabalhadores rurais a agrotóxicos. *Cad. saúde colet.* 2016;24(3):301-307. doi: 10.1590/1414-462x201600030199.
- [29] Mori NC, Horn RC, Oliveira C, Leal PAP, Golle DPK, Koefender J, et al. Alterações bioquímicas e toxicológicas de agricultores familiares da região do Alto Jacuí, Rio Grande do Sul. *Sci Med.* 2015;25(3):1-7. doi:10.15448/1980-6108.2015.3.20999.
- [30] Corcino CO, Teles RBA, Almeida JRGS, Lirani LS, Araújo CRM, Gonsalves AA, et al. Avaliação do efeito do uso de agrotóxicos sobre a saúde de trabalhadores rurais da fruticultura irrigada. *Ciênc. saúdecoletiva.* 2019;24(8):3117-3128. doi: 10.1590/1413-81232018248.14422017.
- [31] Ghafari M, Cheraghi Z, Doosti-Irani A. Occupational risk factors among Iranian farmworkers: a review of the available evidence. *Epidemiol Health.* 2017;2(39):e2017027. doi: 10.4178/epih.e2017027.
- [32] Kachuri L, Harris MA, MacLeod JS, Tjepkema M, Peters PA, Demers PA. Cancer risks in a population-based study of 70,570 agricultural workers: results from the Canadian census health and Environment cohort (CanCHEC). *BMC cancer.* 2017;17(1):343. doi: 10.1186/s12885-017-3346-x.
- [33] Almeida EA, Zimmermann MH, Gonçalves CS, Grden CRB, Maciel MAS, Bail L, Ito CAS. Agrotóxicos e o risco à saúde entre fumicultores. *Publ. UEPG Ci. Biol. Saúde.* 2011;17(2):133-139. doi: 10.5212/publicatio%20uepg.v17i2.4055.
- [34] Riquinho DL, Hennington EA. Cultivo do tabaco no sul do Brasil: doença da folha verde e outros agravos à saúde. *Ciênc. saúde coletiva.* 2014;19(12):4797-4808. doi: 10.1590/1413-812320141912.19372013.
- [35] Avgerinou C, Giannezi I, Theodoropoulou S, Lazaris V, Kolliopoulou G, Zikos P, et al. Occupational, dietary, and other risk factors for myelodysplastic syndromes in Western Greece. *Hematology.* 2017;22(7):419-429. doi: 10.1080/10245332.2016.1277006
- [36] Varona ME, Díaz SM, Briceño L, Sánchez-Infante CI, Torres CH, Palma RM, et al. Determinantes sociales de la intoxicación por plaguicidas entre cultivadores de arroz en Colombia. *Rev. salud pública.* 2016;18(4):617-629. doi: 10.15446/rsap.v18n4.52617.
- [37] Zhang X, Wu M, Yao H, Yang Y, Cui M, Tu Z, et al. Pesticide poisoning and neurobehavioral function among farm workers in Jiangsu, People's Republic of China. *Cortex.* 2016;74:396-404. doi: 10.1016/j.cortex.2015.09.006
- [38] Santos MO. Reescrevendo a história: imigrantes italianos, colonos alemães, portugueses e a população brasileira no sul do Brasil. *Rev.Tempo e Argumento.* 2017;9(20):230 - 246. doi: 10.5965/2175180309202017230.
- [39] Siebeneichler TJ, Kolchinski EM, Sant'Anna V, Biondo E. Caracterização do arranjo produtivo local das agroindústrias familiares do Vale do Taquari, no estado do Rio Grande do Sul. *Cad. Ciência & Tecnologia.* 2017;36(2e26517):1-12. doi: 10.35977/0104-1096.cct2019.v36.26517.
- [40] Slongo LA, Santos LO, Lionello RL. Produtor de Tabaco da Região Sul do Brasil: Perfil Socioeconômico. Porto Alegre: Centro de Estudos e Pesquisas em Administração - Universidade Federal do Rio Grande do Sul [Internet]. 2016 [cited 2019 Nov. 2019]. Available in: http://www.agricultura.gov.br/assuntos/camaras-setoriais-tematicas/documentos/camarassetoriais/tabaco/2017/55aro/app_pesquisa_perfil_socioeconomico_55ro_atabco.pdf
- [41] Riquinho DL, Hennington EA. Sistema integrado de produção do tabaco: saúde, trabalho e condições de vida de trabalhadores rurais no Sul do Brasil. *Cad. Saúde Pública.* 2016;32(12):e00072415. doi:10.1590/0102-311x00072415.
- [42] Organização Internacional do Trabalho (OIT). Medir o progresso na luta contra o trabalho infantil: estimativas e tendências mundiais 2000-2012. Genebra: Organização Internacional do Trabalho [Internet]. 2013 [cited 2020 Jan. 31]. Available in: https://www.ilo.org/wcmsp5/groups/public/---ed_norm/---ipecc/documents/publication/wcms_221799.pdf
- [43] Silveira DC, Feistel PR, Brum AL. As Exportações da Região Sul -do Brasil: Uma Análise do Setor Agropecuário. *Redes.* 2019;24(3):272-294. doi: 10.17058/redes.v24i3.12330
- [44] Friedrich K, Souza MMO, Carneiro FF. Dossiê ABRASCO ABA: contra o PL do Veneno e a favor da Política Nacional de Redução de Agrotóxicos – PNRA. Associação Brasileira de Saúde Coletiva e Associação Brasileira de Agroecologia. [Internet]. 2018 [cited 2019 Nov. 10]. Available in: <https://www.abrasco.org.br/site/wp->

- content/uploads/2018/07/Dossie_comcapanova_2018_V-Reduzida.pdf
- [45] Chagas CC, Guimarães RM, Boccolini PMM. Câncer relacionado ao trabalho: uma revisão sistemática. *Cad. saúde colet.* 2013;21(2):209-223. doi: 10.1590/S1414-462X2013000200017.
- [46] Rapisarda V, Ledda C, Matera S, Fago L, Arrabito G, Falzone L, et al. Absence of t (14;18) chromosome translocation in agricultural workers after short-term exposure to pesticides. *Mol Med Rep.* 2017;15(5):3379-3382. doi: 10.3892 / mmr.2017.6385.
- [47] Leon ME, Schinasi LH, Lebaillly P, Beane Freeman LE, Nordby KC, Ferro G, et al. Pesticide use and risk of non-Hodgkin lymphoid malignancies in agricultural cohorts from France, Norway and the USA: a pooled analysis from the AGRICOH consortium. *Int J Epidemiol.* 2019;48(5):1519-1535. doi: 10.1093/ije/dyz017.
- [48] Silveira KRK, Machado CD, Arend SC. O índice de diversificação e o grau de exposição ao mercado dos agricultores produtores de tabaco da microrregião geográfica de Santa Cruz do Sul. *Rev. Desenv. Econômico.* 2015;17(32):860-871. doi: /10.21452/rde.v17i32.3784.
- [49] Ribeiro MG, Colasso CG, Monteiro PP, PedreiraFilho WR, Yonamine M. Occupational safety and health practices among flower greenhouses workers from Alto Tiete region (Brazil). *Sci Total Environ.* 2012;416:121-6. doi: 10.1016 / j.scitotenv.2011.11.002.
- [50] Aroonvilairat S, Kespichayawattana W, Sornprachum T, Chaisuriya P, Siwadune T, Ratanabanangkoon K. Effect of pesticide exposure on immunological, hematological and biochemical parameters in Thai orchid farmers-across-sectional study. *Int J Environ Res Public Health.* 2015;12(6):5846-5861. doi: 10.3390/ijerph120605846.
- [51] Sankoh AI, Whittle R, Semple KT, Jones KC, Sweetman AJ. An assessment of the impacts of pesticide use on the environment and health of rice farmers in Sierra Leone. *Environ Int.* 2016;94:458-466. doi: 10.1016/j.envint.2016.05.034.
- [52] Mazon LM, Ruthes B, Dombroski D, Moro A. Determinação dos sintomas físicos e psicoemocionais de trabalhadores rurais expostos ocupacionalmente aos agrotóxicos. *Saude e MeioAmbiente - RevistaInterdisciplinar.* 2018;7(2):124-136.
- [53] Gesesew HA, Woldemichael K, Massa D, Mwanri L. Farmers Knowledge, Attitudes, Practices and Health Problems Associated with Pesticide Use in Rural Irrigation Villages, Southwest Ethiopia. *PLoSOne.* 2016;11(9):e0162527. doi: 10.1371/journal.pone.0162527.
- [54] Costa VIB, Mello MSC, Friedrich K. Exposição ambiental e ocupacional a agrotóxicos e o linfoma não Hodgkin. *Saúde debate.* 2017;41(112):49-62. doi: 10.1590/0103-1104201711205.
- [55] Fareed M, Pathak MK, Bihari V, Kamal R, Srivastava AK, Kesavachandran CN. Adverse respiratory health and hematological alterations among agricultural workers occupationally exposed to organophosphate pesticides: a cross-sectional study in North India. *PLoS One.* 2013;8(7):e69755. doi: 10.1371/journal.pone.0069755.
- [56] Freire C, Koifman RJ, Koifman, S. Hematological and Hepatic Alterations in Brazilian Population Heavily Exposed to Organochlorine Pesticides. *J Toxicol Environ Health A.* 2015;78(8):534-48. doi: 10.1080 / 15287394.2014.999396.
- [57] García-García CR, Parrón T, Requena M, Alarcón R, Tsatsakis AM, Hernández AF. Occupational pesticide exposure and adverse health effects at the clinical, hematological and biochemical level. *Life Sci.* 2016;145:274-83. doi: 10.1016/j.lfs.2015.10.013.
- [58] Antonechen AC, DÓRO MP. Qualidade de vida, ansiedade e depressão em pacientes da hemato-onco com dor crônica. *Revista Saúde (Santa Maria).* 2016;42(1):225-234. doi: 10.5902/2236583419001.
- [59] Arantes TC, Martins VE, Mendes AS, Silva AMB, Nicolusset AC. Fatores associados à depressão em pacientes oncológicos durante quimioterapia. *Rev. Rene.* 2019;20(e41647). doi: 10.15253/2175-6783.20192041647
- [60] Koh SB, Kim TH, Min S, Lee K, Kang DR, Choi JR. Exposure to pesticide as a risk factor for depression: A population-based longitudinal study in Korea. *Neurotoxicology.* 2017;62:181-185. doi: 10.1016/j.neuro.2017.07.005.
- [61] Murakami Y, Pinto NF, Albuquerque GSC, Perna PO, Lacerda A. Intoxicação crônica por agrotóxicos em fumicultores. *Saúde debate.* 2017;41(113):563-576. doi: 10.1590/0103-1104201711317.
- [62] Martin FL, Martinez EZ, Rolha H, Garcia SB, Uyemura SA, Kannen V. Increased exposure to pesticides and colon cancer: early evidence in Brazil. *Chemosphere.* 2018;209:623-631. doi: 10.1016/j.chemosphere.2018.06.118.
- [63] Öztaş D, Kurt B, Koç A, Akbaba M, İlter H. Knowledge Level, Attitude, and Behaviors of Farmers in Çukurova Region regarding the Use of Pesticides. *Biomed Res Int.* 2018;2018:6146509. doi: 10.1155/2018/6146509.
- [64] Shin J, ROH S. A study of risk factors for the possible cases of acute occupational pesticide poisoning of orchard farmers in some parts of south Chungcheong province. *Ann Occup Environ Med.* 2019; 31:e35. doi: 10.35371/aoem.2019.31.e35.
- [65] Wumbi A, Houbraken M, Spanoghe P. Pesticides use and exposure among yam farmers in the Nanumba traditional area of Ghana. *EnvironMonitAssess.* 2019;191(5):307. doi: 10.1007/s10661-019-7449-5.

Neurological Evaluation in Quilombolas Individuals Exposed to Organophosphorus Pesticides in the Brazilian Amazon Population

Núbia Rocha Marques¹, Izabelle Cristine Melo de Lima¹, Amanda Cavalcante Lopes², Rosivaldo de Alcântara Mendes³, Kleber Raimundo Freitas Faial³, Antônio Marcos Mota Miranda³, Fernando Paschoal-Jr¹

¹ Federal University of Pará, Brazil.

² University of the State of Pará, Brazil.

³ Instituto Evandro Chagas, Pará, Brazil.

Received: 21 Jun 2022,

Received in revised form: 19 Jul 2022,

Accepted: 23 July 2022,

Available online: 29 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords—Pesticides, Organophosphorus, Neurology, Quilombolas.

Abstract—The aim of the present study was to investigate the relationship between the biochemical changes of this enzyme and the occurrence of neurological symptoms. In addition, an attempt is made to link the neurocognitive damage to environmental and human pollution near oil palm monocultures in the Amazon. This is a descriptive cross-sectional study in a quilombola community in the state of Pará exposed to pesticides from 2017 to 2019 through epidemiological, clinical, biochemical, and toxicological investigations. Clinical, epidemiological, and laboratory data of the subjects were used for the study, as well as a neurological examination using a pesticide poisoning examination form from the Instituto Evandro Chagas. The sample of the study includes 195 people. Of these, more than half (54.9%) were male and the rest were female. As for the age group of the participants, 28.7% were children and adolescents, 58% of the subjects were between 20 and 59 years old, and another 13.3% were elderly. It was found that the reduced AChE levels were significantly lower in individuals with neurological complaints. In addition, the most frequently expressed signs and symptoms were weakness in 28.7%, memory impairment in another 24.6%, insomnia in 21%, and motor disorders in 15%. And it was found that the female gender manifested the neurological clinical picture the most and showed the greatest reduction in AChE enzyme. Therefore, it is necessary to biologically monitor populations exposed to the environment OP.

I. INTRODUCTION

The main effect of organophosphates (OP) in the human body is the inhibition of the enzyme cholinesterase in nerve endings. Therefore, measurement of acetylcholinesterase activity (AChE) in blood is often used as a biomarker of effect to characterize exposure to pesticides. Neurodegeneration can occur from exposure to

OP at small subclinical doses and may be referred to as organophosphate-induced chronic neurotoxicity. [1]

Incidence rates of pesticide poisoning have increased in recent years. At the same time, the use of pesticides in agriculture is expanding. At the global level, the use of these agents has gradually increased in recent years, with about 4 million tons of pesticides used or sold in agriculture.[2] In the world ranking, Brazil has been the

largest consumer of pesticides on the planet since 2009, followed by the United States, China and Japan. [3]

According to SINAN (Sistema Nacional de Agravos de Notificação Compulsória), from 2007 to 2021, 157,382 cases of agricultural and household pesticides were registered in the country, resulting in 2639 cases of poisoning. And in the state of Pará, there were 1801 reports of exogenous poisoning by these agentes. [4]

It is worth noting, however, that the World Health Organization - WHO - estimates that for every reported case, there are 50 unreported cases, which ends up being about 500,000 new cases.[5] Thus, it is believed that the epidemiological profile does not match the reality of pesticide use and human exposure. This makes it difficult to scale the problem and make the public sector more visible in dealing with these problems and diseases in exposed communities.[6, 7]

Oil palm is the main oilseed production chain in the world, occupying 20% of permanent cropland. [8] Brazil ranks ninth in the world and is responsible for the production of 395 thousand tons per year. Pará is the largest national producer with 98.47%, followed by Bahia. In the northeast of the state, the municipality of Concórdia do Pará ranks third in the microregion with an annual production of 276 thousand tons.[9]

The Santo Antônio Community, in the municipality of Concórdia do Pará, there are agricultural activities related both to family farms, where pesticides are not used, and to large-scale projects such as the monoculture of “dendê”, where the use of pesticides is quite common. Therefore, a strong epidemiological link between occupational and environmental exposure is suspected. The study aims to gain knowledge about the coexistence of individuals of a traditional population with organophosphate pesticides used in the monoculture of “dendê” in the northeastern region of Pará State in the Brazilian Amazon.

II. METHOD

This is a descriptive cross-sectional study with a quantitative approach conducted between 2018 and 2019 in the Quilombola municipality of Santo Antônio, in the municipality of Concórdia do Pará/Brazil. This study was approved by the local research ethics committee. The municipality belongs to the northeastern mesoregion of the state of Pará and is located at latitude 02° 00' 06" South and longitude 47° 56'59" West, at an altitude of 440 meters above sea level.

This municipality is located about 150 km from the capital, Pará State, and has the privilege of being located in an easily accessible region that is economically linked to

the capital. The main economic activities are black pepper and subsistence agriculture with cassava flour as the main product. Currently, the introduction of large-scale projects with oil palm monocultures is intensifying, aiming at the production of biodiesel.[10]

The Quilombola community of Santo Antônio lives in the vicinity of this oil palm monoculture, where the use of pesticides is widespread, so there is a strong epidemiological link between occupational and environmental exposure. The selection of study participants was based on the criteria of duration of residence (at least one year) and complaints transmitted by indicating the local management. Thus, the demographic epidemiology of the sample was characterized by sex (male and female) and age group (2-19 years; 20-39 years; 40-59 years and over 60 years), giving a total number of n - 195 (100%).

Factors influencing the occurrence of neurologic signs and symptoms, such as previous neurologic disease and clinical and/or drug conditions (diabetes associated with peripheral neuropathy), hypothyroidism or hyperthyroidism, hypovitaminosis B12, alcoholism, HIV/AIDS, syphilis, and leprosy) were used as exclusion criteria.

Study Design

Neurological Examination and Medical Examination

The study of neurotoxic effects was based on the neurological examination using the Evandro Chagas Institute (IEC) Pesticide Poisoning Examination Form, which includes epidemiological and clinical questions and a medical examination. The standardized neurological questionnaire used during the medical interview assessed the clinical tremor scale, sleep disturbances (insomnia), fatigue, memory difficulties, tingling in the hands, upper and lower limbs, hand and eyelid tremor, where single investigator observed and assessed tremor. The parameter of presence or absence of involvement was used for statistical analysis of all clinical data.

Enzymatic Activity of Erythrocyte Acetylcholinesterase

As for the toxicological analysis, the AChE densitometry values were processed in the chromatography laboratory of the Environmental Department (SEAMB) of the IEC using the modified Elmann method. The reference values used in the data analysis correspond to the assessment method for AChE (2.6-4.1 IU/mL).

Statistical analysis

All tests were performed using Bioestat 5.5 software. Quantitative variables and AChE enzyme activity were described by mean and standard deviation, and qualitative variables were described by frequency and percentage.

The Mann-Whitney test was used, as in the correlations between sex and average cholinesterase activity and the presence or absence of signs and symptoms with the community enzymatic average. The Kruskal-Wallis test was used, as in the division of age groups with respect to enzyme means. To determine the number of individuals with enzymatic inhibition (below 2.6 IU/ml) correlated with the variables sex and age and neurological signs and symptoms by sex, frequency and percentage by test. of chi-square was used to test independence or association between two categorical variables.

The significant result was detailed by multiple comparisons between two groups with adjustment of p value. Results with $p \leq 0.05$ (two-sided) were considered statistically significant.

III. RESULTS

The study includes a representative sample with the inclusion of 195 individuals. Of these, more than half (54.9%) were male and (45.1%) were female. As for the age characterization of the participants, 28.7% were in the

age group of 2-19 years, 58% of the subjects were between 20 and 59 years old, and another 13.3% belonged to the elderly population. The mean AChE value was 5.8 ± 3.3 IU/mL.

In the female subjects, the mean AChE level was 5.1 ± 3.1 IU/mL, and in the male group, it was 6.1 ± 3.5 IU/mL. There was a significant difference between these groups ($p=0.0266$). It was found that, taking the modified Ellmann method as a reference value for erythrocyte AChE (2.6-4.1 IU/mL), the inhibition of acetylcholinesterase occurred in 75 quilombola subjects. In addition, it seems that 55 individuals with reduced AChE values were under 39 years of age, and the age group with the greatest change was between 20 and 39 years. On the other hand, there was a greater balance of occurrence of the data among the sexes, as shown in Table 1.

Despite the correlation between the age group and the AChE classification (lower or higher than the reference level), the indication of a p-value ($p=0.054$) is considered relevant because the significance value is in a large proximity. This is different with respect to gender ($p=0.847$) (Table 2):.

Table 1. Acetylcholinesterase levels in the Quilombola population of the municipality of Santo Antônio, Concórdia do Pará.

Variable	Mean AchE \pm SD	p-value	FIND >2.6	THINK <2.6	p-value ²
community population	5.4 \pm 3.3	-	120	75	-
GENRE					
Feminine	5.1 \pm 3.1	0.0266 ¹	53 (44.2)	35 (46.7)	0.0847 ³
Male	6.1 \pm 3.5		67 (55.8)	40 (53.3)	
AGE GROUP					
2-19 years old	5.5 \pm 3.0	0.0502 ²	34 (28.3)	22 (29.3)	0.054 ³
20-39 years old	5.2 \pm 3.4		34 (28.3)	33 (44)	
40-59 years old	7.0 \pm 3.6		34 (28.3)	12 (16)	
>60 years	5.6 \pm 2.9		18 (55.8)	8 (10.7)	

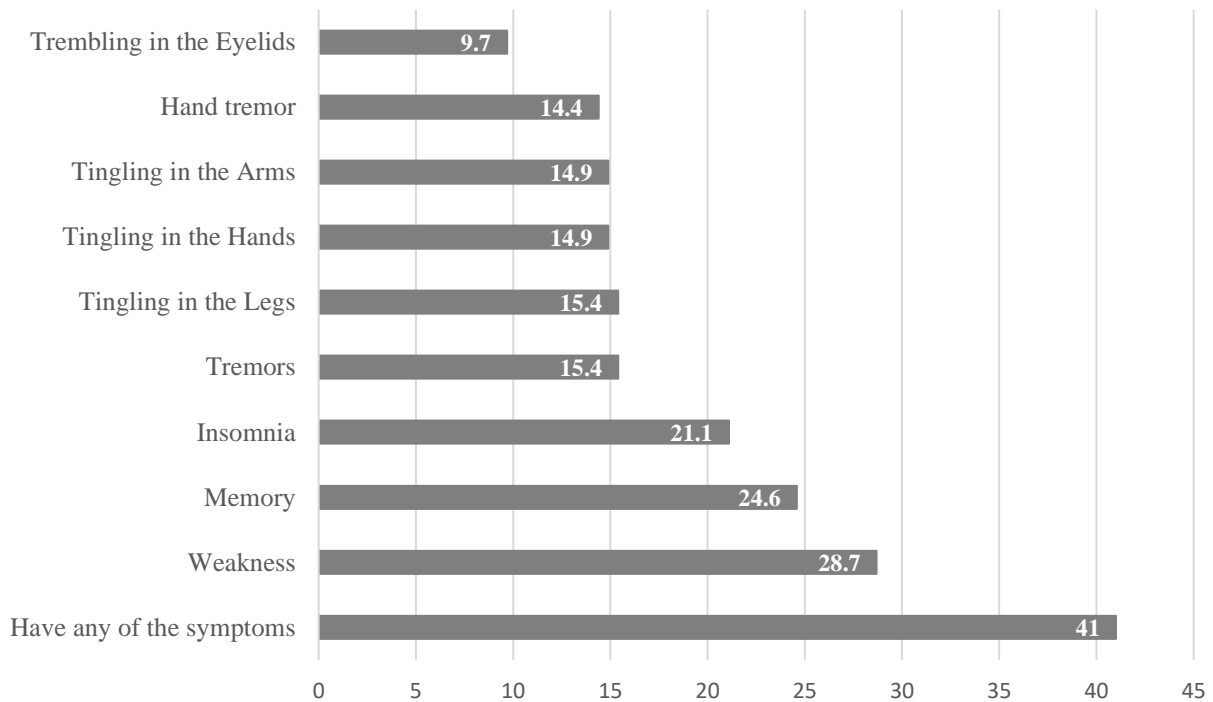
¹ Numerical variables of AchE are represented as mean \pm standard deviation. The Mann-Whitney test was used. ² Numerical variables of AchE by age group are represented as mean \pm standard deviation. The Kruskal-Wallis test was used. ³ Categorical variables are displayed as n (%). The percentages are relative to the total of each column. The chi-square test was used.

Source: Author's research. Instituto Evandro Chagas, Environment Section.

Neurological Clinical Manifestations

The signs and symptoms were shown in Figure 1. It is noted that 56 subjects (28.7%) complained of weakness, another 48 subjects (24.6%) had a memory problem, 21% suffered from insomnia, which were the most common symptoms. In addition, 80 (41%) of the respondents had one of the symptoms studied (at least 1 or more).

Fig.1 - Presence of neurological signs and symptoms in the quilombola community, in the municipality of Concórdia do Pará.



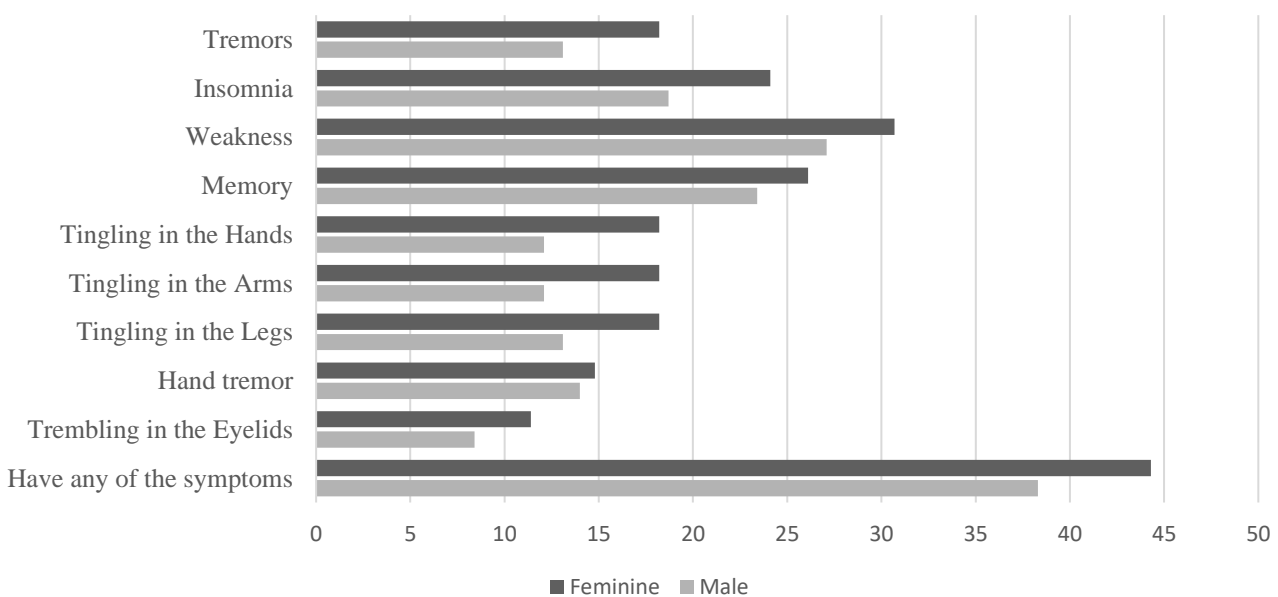
The percentages are relative to the total number of participants (n=195).

Source: Author's research. Instituto Evandro Chagas, Environment Section.

Relating these signs and symptoms to gender, we find that tremor, insomnia, weakness, memory impairment, tingling in the hands, tingling in the arms and legs, and tremor of the hands and eyelids were more common in

women (Figure 2). However, there was no significant association between gender and symptoms (non-significant p-values) based on the Chi-Square Test.

Fig.2 - Association between the presence of signs and symptoms and gender.



Source: Author's research. Instituto Evandro Chagas, Environment Section.

The results of the comparison between the mean values of AChE activity and the presence or absence of signs and symptoms are shown in Table 4. In the subjects who did not have weakness, the mean AChE value was 6.6 ± 3.3 and in the group with weakness, 5.4 ± 3.3 , differing significantly ($p=0.017$), i.e., AChE values were significantly lower in subjects with weakness. Thus, it was found that in subjects without memory problems the average AChE was 6.8 ± 3.1 and in the group with problems it was 5.1 ± 3.3 , with significant significance

($p=0.0007$). Regarding the symptom insomnia, the mean score of AChE was 5.4 in those who had this symptom, differing from those without this symptom, in whom the mean score was 6.1, also showing significance ($p= 0.032$) between groups. In the participants who did not have symptoms, the mean AChE was 6.6 ± 3.3 and in the group with symptoms it was 5.2 ± 3.2 , with a significant difference between the groups ($p= 0.003$) (Table 2). The other symptoms previously reported in this study had no significant correlation.

Table 2 - AChE levels in relation to the presence of signs and symptoms in quilombola patients in the municipality of Concórdia do Pará.

Variable	Absence	Presence	p-value
tremors	5.8 ± 3.3	5.8 ± 3.3	0.890
Insomnia	6.1 ± 3.2	5.4 ± 3.4	0.032
Weakness	6.6 ± 3.3	5.4 ± 3.3	0.017
Memory	6.8 ± 3.3	5.1 ± 3.3	0.0007
Tingling in the Hands	5.8 ± 3.3	5.6 ± 3.3	0.733
Tingling in the Arms	5.8 ± 3.3	5.6 ± 3.3	0.790
Tingling in the Legs	5.8 ± 3.3	5.6 ± 3.2	0.753
hand tremor	5.7 ± 3.3	6.0 ± 3.5	0.728
Trembling in the Eyelids	5.8 ± 3.3	5.7 ± 3.3	0.981
Have any of the symptoms	6.6 ± 3.3	5.2 ± 3.2	0.003

Numerical variables are represented as mean \pm standard deviation. In all cases, the Mann-Whitney test was used. Source: Author's research. Instituto Evandro Chagas, Environment Section.

IV. DISCUSSION

There are few data in the literature that shed light on this problem, especially in traditional Brazilian populations. However, this study allows us to establish a possible association between neurological signs and symptoms and changes in the AChE biomarker with the general use of pesticides in the quilombola population living with the practice of palm oil cultivation in the Amazon. The chronic manifestations presented can be attributed to a strong and long association with environmental exposure and low levels of organophosphates applied seasonally, at least once a month, by spraying.

Much is known about the acute clinical consequences associated with occupational use of pesticides or direct handling of them. However, data are still lacking on the chronic manifestations. The main mechanism of action of OPs in the human body is the inhibition of the enzyme cholinesterase in the nerve endings, resulting in the accumulation of the neurotransmitter acetylcholine in the

neuromuscular junctions, which triggers the occurrence of the cholinergic syndrome, nicotinic and muscarinic symptoms with CNS involvement.[1] Measurement of erythrocyte AChE activity in blood is commonly used as a biomarker for pesticide effects.[11]

In this study, the mean values of enzymatic activity are in the normal range, but it was observed that 38% of the participants showed enzymatic inhibition of AChE (< 2.6 IU/mL). Regarding gender, there was a significant difference between these data (p -value=0.0266), with the highest enzymatic inhibition occurring in females. In addition, the age group with the lowest mean enzymatic value was 20-39 years old, economically active, and moved around the area the most and generally engaged in extractive activities.

This result is like that of Farahat et al. (2003),[12] who studied a cohort of young people exposed to OP in Egypt. They showed that there was a reasonable proportion of individuals with enzymatic inhibition, but they were still within the normal range. This contrasts with the study

conducted in Nova Friburgo (RJ) in an agricultural community, where an extreme decrease in acetylcholinesterase levels was found in 102 farmers. However, there was no significant difference between the sexes in terms of the mean value of enzyme activity. The age group with the greatest change was under 40 years old, a similar result to this work

When Ramírez-Santana et al. (2020) [13] compared two groups from the same agricultural region exposed both environmentally and occupationally to OP, they found that the frequency of inhibition of AChE was 25-30% and that there was little difference in the mean enzyme between these groups. They therefore concluded that environmental exposure OP was as high as occupational exposure.

To make matters worse, workers know the health risk and use biosafety equipment. Surrounding populations may not have this knowledge and are therefore more exposed to the effects of pesticide exposure. This observation was also made in the municipality of this study, where houses were built near the monocultures during territorialization, which can lead to direct and indirect risk to the population without any protection on a seasonal basis.

As in studies conducted in other populations, the most common general and cognitive signs and symptoms noted in this study were: weakness in 28.7% of subjects, followed by memory impairment in another 24.6%, and insomnia in 21%. In addition, symptoms indicative of motor changes, such as hand and eyelid tremors and tingling in the extremities, were noted in a percentage of about 15%; and 41% of those affected experienced at least one of these symptoms.

In addition, it was found that these complaints occurred mainly in women, a gender that also has a greater decrease in the enzyme AchE, which is due to the fact that they stay longer near the oil palm plantation, as few work outside the community.

Exposure to OP causes biochemical changes and clinical syndromes in humans. OP-induced chronic neuropsychiatric disorders may be caused by repeated exposure to low doses, which may be associated with alterations in the axonal transport system. Clinical effects with the most common signs include memory impairment, concentration and learning difficulties, anxiety, depression, and extrapyramidal symptoms such as tremor.[14, 15, 16]

When these neurological complaints were related to cholinesterase levels, it was found that AChE levels were significantly lower in individuals with weakness, as well as problems with insomnia, which was a significant value in those affected ($p=0.032$), and memory problems, where

not only were lower AChE levels found in individuals with this symptom, but also showed important significance in this relationship ($p=0.0007$). In relation to the other manifestations, the mean value of esterase is lower in individuals with neurological changes, although there are no significant correlations.

These findings are consistent with recent publications linking clinical neurological findings to AChE enzyme dosing in developing countries. The increased prevalence of neurological symptoms has been associated with inhibition of cholinesterase enzymes in erythrocytes in 03 studies.[13, 17, 18]

The above data indicate that it is necessary to monitor populations exposed to pesticides because clinical signs and symptoms of enzymatic alteration of the biomarker may precede the effect. In addition, the use of validated tests that assess cognitive, motor, and behavioral functions could provide the study with greater consistency in the data observed in recent work. For example, the use of psychometric tests used in previous studies is an effective method to track chronic neurotoxic effects with moderate exposure over time. [13, 17, 12]

For the development of this study, instruments such as questionnaires within a survey were used, which made it possible to obtain epidemiological data and general health conditions; tests of neurosensory functions; laboratory tests to measure AChE enzyme levels. However, there was some limitation to better characterize the community, which could be improved by using other tools discussed in other articles. For example, a survey to complete profile of pesticide exposure at work, home, and family members; use of tests such as the Mini Mental State Examination (MMSE), Wechsler adult intelligence Scale-Revised (WAIS-R) to assess neurological functioning.[17]

In addition, there are other limitations as the only measurement of AChE activity is without consideration of spray times. Therefore, the need for biomonitoring of this quilombola population, which is susceptible to chronic intoxication by low doses of OP, is emphasized to understand the progression of neurological sequelae and to verify the relationships between enzyme dose and clinical changes over a long period of time.

V. CONCLUSION

The present study is a contribution to knowledge as it attempts to link neurological clinical manifestations to environmental exposure of OP in monoculture areas in the Amazon, in a Quilombola population living near these agricultural areas. The average activity of the effect biomarker is within the normal range. However, in relation

to the presence of neurological clinical symptoms, these dosages show reduced values. It is worth noting that these results are the result of a cross-sectional study, so it is important to conduct longitudinal studies to establish the causal relationship.

Therefore, the implementation of biomonitoring in the region is useful for early detection of possible greater participation in this Quilombola community. Therefore, publicizing and recognizing this possible association through the environmental health surveillance program is essential, which must pay attention to the risks from environmental and occupational contamination, especially at low doses and over a long period of time.

REFERENCES

- [1] Uwaifo, F.; John-Ohimai, F. Human health hazards of exposure to organophosphate pesticides. *Matrix Sci Med.* v. 4, p. 27 -31.2020.
- [2] Faostat, 2020. Available:<http://www.fao.org/faostat/en/#data/RP/visualize> , last accessed 31 April 2022.
- [3] FAO.Food and Agriculture Organization. (2019). Preventing suicide: a resource for pesticide registrars and regulators.
- [4] Brazil. Department of Informatics of the Unified Health System (DATASUS).2021. Exogenous Poisoning - Notifications registered on SINAN NET.
- [5] World Health Organization (WHO). In: Poisoning prevention and management. World Health Organization. 2018.
- [6] Queiroz, R.P., et al. Notifiable diseases Information System and human poisoning by pesticides in Brazil Notifiable Diseases Information System and human poisoning by pesticides in Brazil. 2019.
- [7] Brazil. Ministry of Health. Health Surveillance Department. Department of Environmental Health Surveillance and Occupational Health. Pesticides from the perspective of the Unified Health System. Brasilia: Ministry of Health.2018.
- [8] United States Department Of Agriculture (USDA). Palm oil production by country in 1000 MT. Washington, 2018. Available: <https://www.indexmundi.com/agriculture/?commodity=palm-oil> . Accessed on: 17 jun. 2018
- [9] Pará. Secretaria de Desenvolvimento do Pará 2015/2019. Dendê: Cachos de coco. Disponível em: <http://www.sedap.pa.gov.br/content/dend%C3%AA>. Acessado em 01 de junho de 2022.
- [10] IBGE, Brazilian Institute of Geography and Statistics. 2017 Census. Population Estimates for Municipalities and Brazilian Federation Units. <https://cidades.ibge.gov.br/brasil/pa/concordia-do-para/panorama> . Accessed June 20 , 2022.
- [11] Crane,A.L. et al. Longitudinal assessment of chlorpyrifos exposure and effect biomarkers in adolescent Egyptian agricultural workers. *Journal of Exposure Science & Environmental Epidemiology.* V. 23, n. 4, p. 356-62.2013.
- [12] Farahat,T.M. et al. Neurobehavioral effects in workers occupationally exposed to organophosphate pesticides. *Occup Environ Med* v. 60, p. 279–286. 2003.
- [13] Ramírez-Santana, M. et al. Association between cholinesterase's inhibition and cognitive impairment: a basis for prevention policies of environmental pollution by organophosphate and carbamate pesticides in Chile. *Environmental research,* v. 186, p. 109539, 2020.
- [14] Prendergast, M.A. et al. Microtubule-associated targets in chlorpyrifos oxon hippocampal neurotoxicity. *Neuroscience,* v. 146, no. 1, p. 330-9, Apr 25 2007.
- [15] Terry, A.V.; et al. Chronic, intermittent exposure to chlorpyrifos in rats: protracted effects on axonal transport, neurotrophin receptors, cholinergic markers, and information processing. *J Pharmacol exp Ther,* v. 322, no. 3, p. 1117-28, Sep 2007.
- [16] Rishal, I. et al. axoplasm isolation from peripheral nerve. *dev Neurobiol,* v. 70, no. 2, p. 126-33, Feb 2010.
- [17] Ismail, A.A., et al. Comparison of neurological health outcomes between two cohorts of adolescents exposed to pesticides in Egypt. *PloS one,* v.12, n. 2, e0172696. 2017.
- [18] Araújo, A.J. et al. Multiple exposure to pesticides and health effects: cross-sectional study in a sample of 102 rural workers, Nova Friburgo, RJ. *Science & Public Health [online].* 2007, v. 12, no. 1 [Accessed 10 May 2022], pp. 115-130. Available: <<https://doi.org/10.1590/S1413-81232007000100015>>. Epub 18 Jan 2007.

Development of a Smartphone Application for Dental Biofilm Control for Adolescents undergoing Fixed Orthodontic Treatment

Ms. Cristiane Caram Borgas Alves

Master in Dentistry UNIP, European Master's in Aesthetic Medicine, Doctoral Student in Dentistry UNIP, Coordinator and teacher of the Facial Harmonization Specialization course at the Facial Harmony Institute, Coordinator and teacher of the Santa Rosa Poços de Caldas School Specialization course
Email : dracristiaecaram@gmail.com

Received: 19 Jun 2022,

Received in revised form: 09 Jul 2022,

Accepted: 15 July 2022,

Available online: 29 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords — *Biofilms, Orthodontic Brackets, Dental Informatics, Oral Hygiene, Health Education.*

Abstract— *This work is aimed at the development of an electronic quiz-style game, available as an application for smartphones. The game was developed by a multidisciplinary team composed of dentistry and information technology professionals, who created a method of education compatible with the adolescent public, aiming to reduce oral problems arising from the prolonged use of fixed orthodontic appliances. As a result, a game was available free of charge at the smartphone application store, firstly tested by a team of orthodontics and periodontics clinicians, as well as computer professionals, who approved the quality and quantity of information provided to users as well as the usability of the application and clarity in the functions for the target audience.*

I. INTRODUCTION

During adolescence, the individual is amid biological and psychosocial changes¹. This phase is also marked by a decrease in care by parents and sometimes negative influence from the media and their social groups, resulting in conditions that are unfavourable to the teenager's general and oral health^{2,3}. The adolescent population represents 29% of the world population, 80% of which are in developing countries like Brazil, which, in 2019, had about 21 million young people⁴. As observed in clinical practice and reported in other studies, adolescent patients have a high rate of oral diseases, such as periodontal disease, caries, and halitosis⁵⁻⁷.

According to Souza *et al.*^{8,9}, health education is the most effective strategy to combat and prevent oral pathologies, considering that adolescents can acquire habits for the promotion, recovery, and maintenance of their health through information and learning activities.

Teenagers have access to a variety of digital media, through which they seek communication and entertainment. These digital resources can also be presented as electronic games and are part of their lives; therefore, their potential as a teaching and learning tool that could be explored^{10,11}.

Often, the oral hygiene of patients undergoing fixed orthodontic appliance is deficient, and clinical practice shows that teenagers are the most affected group. Therefore, the development of a tool was necessary to assist in oral hygiene habits and avoid the formation of bacterial plaque on the teeth and around the brackets, which is the leading cause of gingival inflammation and carious lesions. Also, the application was programmed to give specific advice and tips to adolescent patients on the correct use, care, and maintenance of the device.

Hygiene habits should be carried out according to the professionals' instructions, considering that biofilm control strategies must be adapted to individual needs.

However, not all patients have proper access to information, and when they do, many of them do not follow the recommendations due to the difficulties of daily life. Thus, the need for the creation and clinical trial of a smartphone application for correct orthodontic appliance and oral cavity hygiene guidance, with notification functions so that patients have better control of the distribution of the oral care measures throughout their day.

II. MATERIAL AND METHOD

This paper describes the creation and evaluation of an application for smartphones to improve the oral hygiene of adolescent patients undergoing orthodontic treatment using fixed braces. The purpose of creating the device was to strengthen its users' engagement towards the treatment to improve their oral hygiene.

The present work is a laboratorial research based on enhancing teaching and learning from the use of electronic games. The Research Ethics Committee approved this research of Paulista University (UNIP), São Paulo/Brazil, under protocol number 86135318.6.0000.5512.

The oral health electronic game entitled ORTODONTECH was developed by a multidisciplinary team of professionals from dentistry, computer engineering, and information technology.

The smartphone application containing the quiz-style game was developed in several stages, as described below.

1. DEVELOPMENT

Since the development of a game requires several areas of knowledge, a multidisciplinary team of developers has been made necessary. The team was composed of computer

engineering and information technology professionals in, responsible for the computational technical development itself, and dental orthodontics and periodontics professionals, who took the role of developing the theoretical content of the game. The creation process was organized from weekly meetings with all development team members, in which activities were assigned to the developers, pending activities, and difficulties were discussed. The game was developed over 6 months. The process for the development of this application consisted of the following steps:

- 1.1 Need analysis, reported by clinical situations and supported by the literature¹²⁻¹⁷.
- 1.2 Initial project (Mock-ups) and prototype, developed by information technology professionals. (Figure 1).
- 1.3 Design and pre-development, discussed together with the entire team to reach a consensus about language, information, and visual aspects, given the target audience.
- 1.4 Development and implementation of the application, meeting all legal requirements and privacy policies required by Google Play.
- 1.5 Technical evaluation, when dental and information technology professionals used the application to verify the usability, quantity, and quality of information and check how intuitive the features are given the target audience.
- 1.6 Test phase (future step – phase 2 of the project), in which the game will be applied to a clinical sample to test its effectiveness, in contrast to a control group.
- 1.7 Launching phase (future step – phase 3 of the project)

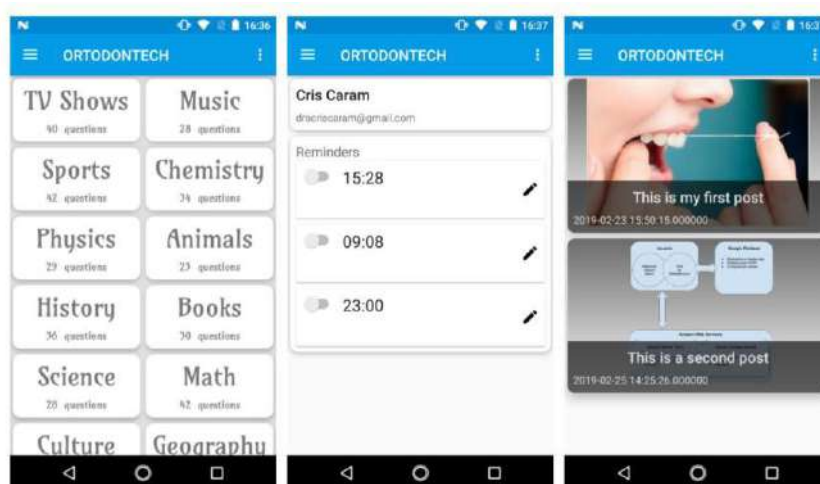


Fig. 1. Ortodontech prototype showing the quiz function, notifications settings, and posts of videos and educational diagrams

An Amazon Web Services (AWS) cloud infrastructure was used to host the services required by the application, such as

Route 53, for Domain Name Server (DNS) Service, EC2 (cloud service that provides secure and scalable computing

capacity in the cloud), and S3 (cloud data storage service). The Firebase Auth service (Google) was used as a user authorization layer.

The application was initially developed in a native environment for Android devices with the Android Studio tool, available for Marshmallow and later versions. The intention is to replicate all actions for IOS devices once the effectiveness of using the application has been clinically tested.

2. TECHNICAL EVALUATION

During this stage, the game was tested by the development team and other volunteer professionals to verify the correct functioning of all the inserted functionalities, usability and gameplay, and the quality and quantity of information made available to the user. For that, a test was applied based on the educational games evaluation method EGameFlow, an evaluative scale to measure the satisfaction and learning of the games¹⁸.

2.1 Sample

The sample consisted of four orthodontists and three periodontists with more than five years of clinical experience, one computer engineer, and two information technologists (n = 10). The computer engineer, two orthodontists, and one periodontist are part of the

Chart 1. EGameFlow: Brief explanation of each of the 56 topics evaluated by the examiners, as published by Fu et al. (2009)

Factor	Item	Content
Concentration	C1	The game grabs my attention
	C2	The game provides content that stimulates my attention
	C3	Most of the gaming activities are related to the learning task
	C4	No distraction from the task is highlighted
	C5	Generally speaking, I can remain concentrated in the game
	C6	I am not distracted from tasks that the player should concentrate on
	C7	I am not burdened with tasks that seem unrelated
	C8	Workload in the game is adequate
Goal clarity	G1	Overall game goals were presented at the beginning of the game
	G2	Overall game goals were presented clearly
	G3	Intermediate goals were presented at the beginning of each scene
	G4	Intermediate goals were presented clearly
	G5	I understand the learning goals through the game
Feedback	F1	I receive feedback on my progress in the game
	F2	I receive immediate feedback on my actions
	F3	I am notified of new tasks immediately

application creation team, while the other professionals participated in the evaluation process voluntarily. Participants should sign the informed consent form and have access to a smartphone with an internet connection and Android operating system to join the assessment team.

2.2 Test

To test the game, examiners received a link via email, which directed them to the application. They were invited to browse the functionalities for 30 minutes to answer an evaluation questionnaire later.

2.2 Questionnaire

EGameFlow¹⁸ is a tool developed for the evaluation of electronic games and applications. The Likert-type scale (which assigns scores from 1 to 7 for each item, with one being the lowest and seven being the highest) has 56 items distributed over eight dimensions. The following are evaluated: (1) concentration (8 items), (2) clarity of objectives (5 items), (3) feedback (6 items), (4) challenge (10 items), (5) autonomy (9 items), (6) immersion (7 items), (7) social interaction (6 items) and (8) knowledge acquisition (5 items), as explained in chart 1. The tool was validated by five different tests and is frequently used by authors in testing new apps and serious games¹⁹⁻²².

	F4	I am notified of new events immediately
	F5	I receive information on my success (or failure) of intermediate goals immediately
	F6	I receive information on my statuses, such as score or level
Challenge	H1	I enjoy the game without feeling bored or anxious
	H2	The challenge is adequate, neither too difficult nor too easy
	H3	The game provides "hints" in text that help me overcome the challenges
	H4	The game provides "online support" that helps me overcome the challenges
	H5	The game provides video or audio auxiliaries that help me overcome the challenges
	H6	My skill gradually improves through the course of overcoming the challenges
	H7	I am encouraged by the improvement of my skills
	H8	The difficulty of challenges increase as my skills improved
	H9	The game provides new challenges with an appropriate pacing
	H10	The game provides different levels of challenges that tailor to different players
Autonomy	A1	I feel a sense of control of the menu (such as start, stop, save, etc.)
	A2	I feel a sense of control over actions of roles or objects
	A3	I feel a sense of control over interactions between roles or objects
	A4	The game does not allow players to make errors to the degree that they cannot progress in the game
	A5	The game supports my recovery from errors
	A6	I feel that I can use strategies freely
	A7	I feel a sense of control and impact over the game
	A8	I know the next step in the game
	A9	I feel a sense of control over the game
Immersion	I1	I forget about time passing while playing the game
	I2	I become unaware of my surroundings while playing the game
	I3	I temporarily forget worries about everyday life while playing the game
	I4	I experience an altered sense of time
	I5	I can become involved in the game
	I6	I feel emotionally involved in the game
	I7	I feel viscerally involved in the game
Social interaction	S1	I feel cooperative toward other classmates
	S2	I strongly collaborate with other classmates
	S3	The cooperation in the game is helpful to the learning
	S4	The game supports social interaction between players (chat, etc.)
	S5	The game supports communities within the game
	S6	The game supports communities outside the game

Knowledge improvement	K1	The game increases my knowledge
	K2	I catch the basic ideas of the knowledge taught
	K3	I try to apply the knowledge in the game
	K4	The game motivates the player to integrate the knowledge taught
	K5	I want to know more about the knowledge taught

III. RESULTS

The scores obtained for EGameFlow questionnaire, attributed by the ten examiners, were recorded on Excel (Microsoft, 2010), and the mean and standard deviations were calculated as shown in Table 1.

Among some evaluation items, proposed by the EGameFlow method, the following were considered for the Ortodontech game:

- Concentration: the game attracted the players' attention, who considered the number of tasks to be adequate. Most of the game's tasks are tied to the educational objective.
- Clarity of Objectives: the player can understand the educational objectives through the game. The general objectives are presented.
- Feedback: the player receives feedback on his or her

progress and performance and is notified of new tasks as soon as he or she fulfils other challenges. The player receives information about scores through positioning in a ranking. (figure 2).

- Challenge: the player experiences the game without feeling too bored or anxious. The difficulty is adequate, without being too easy or too difficult.
- Autonomy: users can control the menu (such as "Start", "Stop", "Save" options), and the game supports the player's errors, clarifying the answers that may be wrong.
- Immersion: the player feels emotionally involved with the game, as it is related to his health.
- Improvement of Knowledge: the game can improve the players' knowledge, allowing them to assimilate the basic ideas of the taught content and apply it in their daily life.

Table 1. Mean and standard deviation (SD) for each item evaluated by the ten professionals through EGameFlow, concerning the Ortodontech application

Factor	Item	Mean	SD
Concentration	C1	4.2	0.6
	C2	4.3	0.6
	C3	4.9	0.7
	C4	5.3	0.5
	C5	5.1	0.5
	C6	4.8	0.4
	C7	6.1	0.7
	C8	4.7	1.1
Goal Clarity	G1	5.1	0.9
	G2	5	0.9
	G3	5.2	0.4
	G4	5.6	0.8
	G5	5.6	0.5
Feedback	F1	5.4	0.5
	F2	5.8	0.6
	F3	5.5	0.5
	F4	5.3	0.5
	F5	5.8	0.7
	F6	4.5	0.7

Challenge	H1	4.8	0.6
	H2	4.9	1.1
	H3	5.3	0.6
	H4	4	0.4
	H5	5.6	0.5
	H6	5.5	0.5
	H7	4.8	0.7
	H8	4.7	0.6
	H9	4.4	0.7
	H10	4.9	1.0
Autonomy	A1	4.3	0.9
	A2	4.5	0.5
	A3	4.4	0.7
	A4	4.7	0.6
	A5	5	0.6
	A6	4.7	0.5
	A7	4.7	0.5
	A8	4.7	0.6
	A9	5	0.8
Immersion	I1	4	0.4
	I2	3.9	0.5
	I3	3.9	0.5
	I4	4.3	0.6
	I5	4.5	0.7
	I6	4	0.8
	I7	3.7	0.5
Social Interaction	S1	3.4	0.8
	S2	3.8	0.4
	S3	4.2	0.7
	S4	3.5	0.5
	S5	3.4	0.5
	S6	3.5	0.5
Knowledge acquisition	K1	5.1	0.5
	K2	5.7	0.6
	K3	5.2	0.6
	K4	5	0.4
	K5	5.2	0.6
Total scale		4.8	0.8

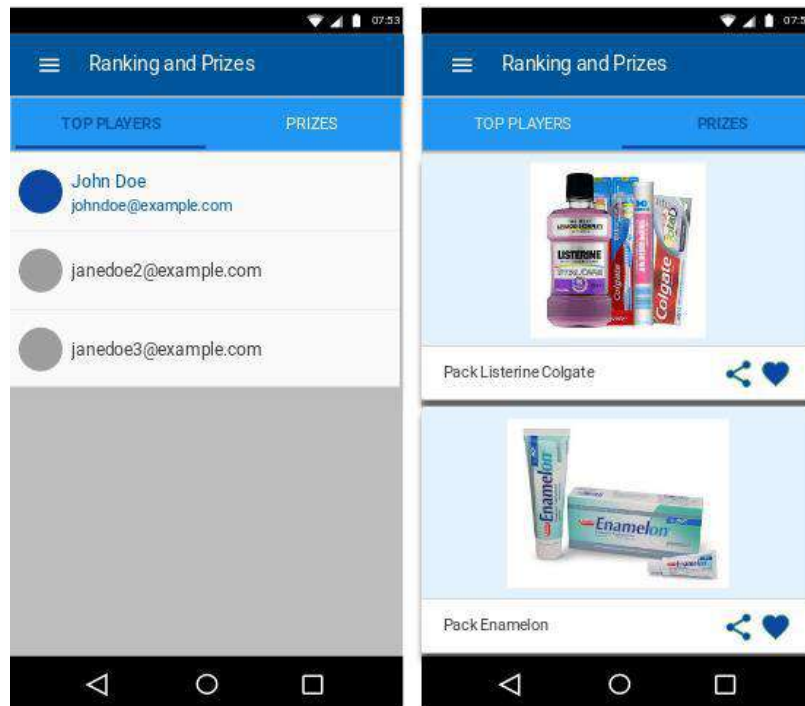


Fig. 2. Player's feedback with ranking position, which may be linked to a reward system

IV. DISCUSSION

The educational potential of electronic games refers to the ability to stimulate a series of fundamental conditions for absorbing information, such as attention, involvement with the educational activity, and cognitive ability. The playful character and the multiplicity of sound and visual stimuli hold the 'players' attention to a particular event occurring in the game, preventing them from diverting their attention. In addition, the effort required to achieve a certain objective of the game promotes engagement with the proposed tasks, leading the player to acquire knowledge^{23,24,26,27}.

When analysing the performance of Ortodontech, one can observe a good general score, but, above all, high scores in terms of knowledge acquisition, clarity of objectives, and feedback. It is understood that a serious game has as main objective to assist in the transmission of educational content or to train the user to perform a particular task with greater precision and autonomy²⁶. Within this context, Ortodontech may be used clinically as a serious game that can positively impact the hygiene habits of adolescents undergoing orthodontic treatment.

There are aspects to be improved in the application, such as social interaction and immersion in the game, although the importance of the user not being so immersed in the game may be debated, as to conflict with his or her daily routine and responsibilities.

Taking this into account, electronic games, especially those

developed as applications for smartphones, can and should be used as educational tools for teenagers since they are used to electronic media. Besides, the entertainment factors that are attributed to games facilitate the learning process. Another point that favours the use of games as an educational medium is the possibility of being continuously used, since its accessibility allows the player to contact the information daily, and without access restrictions. That offers a great advantage for the serious electronic games compared to the traditional means of health education, such as educational lectures, with information reaching the teenagers through annual health actions in schools; thus, the probability of little absorption of what was taught is very high^{25,27,28}.

V. CONCLUSION

Ortodontech is a helpful tool for patient engagement in treatment and greater responsibility awareness for their hygiene since the main objective of the application is to achieve a bond of commitment with the user, aiming to improve their oral hygiene practices. Although clinical applications are necessary, it is safe to say that the application can improve oral hygiene habits in adolescents using fixed appliances.

REFERENCES

- [1] Ferreira MDA. A educação em saúde na adolescência: grupos de discussão como estratégia de pesquisa e cuidado-educação. *Texto & contexto enfermagem*, 15(2), 2006.
- [2] Viero VDSF, de Farias JM, Ferraz F, Simões PW, Martins JA, Ceretta LB. Educação em saúde com adolescentes: análise da aquisição de conhecimentos sobre temas de saúde. *Escola Anna Nery Revista de Enfermagem*, 19(3), 484-490, 2015.
- [3] Natash Y, Santos DDS, Leite IML. Saúde e doença: percepção de adolescentes que vivenciaram o lúdico como estratégia de educação em saúde. *Rev. enferm. UFPE on line*, 10(5), 1822-1827, 2016.
- [4] Unicef Brasil Fundo das Nações Unidas Para Infância. Relatório da situação da adolescência brasileira. Disponível em: http://www.unicef.org/brazil/pt/media_22244.htm acesso em 29 de mar, 2015
- [5] Vieira TR, de Castro, AP, Péret Filho LA. Alterações periodontais associadas às doenças sistêmicas em crianças e adolescentes. *Revista Paulista de Pediatria*, 28(2), 237-243, 2010.
- [6] Fernandes CB, Aquino DR, Jonas Filho C, Cortelli SC, Cortelli JR. Prevalência de microrganismos periodontais intra e extra sulcular em crianças, adolescentes e adultos jovens. *Brazilian Dental Science*, 10(3), 2007.
- [7] SB Brasil 2010: Pesquisa Nacional de Saúde Bucal: resultados principais / Ministério da Saúde. Secretaria de Atenção à Saúde. Secretaria de Vigilância em Saúde. – Brasília: Ministério da Saúde, 2012.
- [8] De Souza IPMA, Jacobinab RR. Educação em saúde e suas versões na história brasileira. *Revista Baiana de Saúde Pública*, 33(4), 618-627, 2009.
- [9] Sousa P, Gaspar P, Fonseca H, Hendricks C, Murdaugh C. Health-promoting behaviors in adolescence: validation of the Portuguese version of the Adolescent Lifestyle Profile. *Jornal de Pediatria*, 91(4), 358-365, 2015.
- [10] Arruda, EP. O papel dos videogames na aprendizagem de conceitos e analogias históricas pelos jovens. *Ensino em Revista*, 2011.
- [11] Da Rocha Seixas L, Gomes AS, Melo Filho IJ, Rodrigues RL. Gamificação como estratégia no engajamento de estudantes do ensino fundamental. In *Brazilian Symposium on Computers in Education (Simpósio Brasileiro de Informática na Educação-SBIE)*, 25(1), 559, 2014.
- [12] Menezes VA, Leal RB, Alcântara CT. Placa dental. In: *Barbosa MBCB, Bruno GB, Souza EHA. Saúde bucal no PSF. Juazeiro do Norte: Refraf Comércio, Serviços e Representações Ltda. Cap.IV. p.95-110, 2004*
- [13] Lindhe J. *Tratado de Periodontia Clínica e Implantologia Oral*. 5ed. Rio de Janeiro: Guanabara Koogan, 2010.
- [14] Newman MG, Takei HH, Klokkevold PR, Carranza Jr. FA. *Periodontia clínica*. 11ed. Rio de Janeiro: Guanabara Koogan, 2012.
- [15] Arweiler NB, Henning G, Reich E, Netuschil L. Effect of an amine-fluoride-triclosan mouth rinse on plaque regrowth and biofilm vitality. *J Clin Periodontol*. 29(4):358-63, 2002
- [16] Lang NP, Schätzle MA, Loe H. Gingivitis as a risk factor in periodontal disease. *J Clin Periodontol*. 2009 Jul;36 Suppl 10:3-8. doi: 10.1111/j.1600-051X.2009.01415.x.
- [17] Peruzzo DC, Gimenes JH, Taiete T, Casarin RC, Feres M, Sallum EA, et al. Impact of smoking on experimental gingivitis. A clinical, microbiological and immunological prospective study. *J Periodontol Res*. 2016 Mar 3. doi: 10.1111/jre.12363.
- [18] Fu FL, Su RC, Yu SC. EGameFlow: a scale to measure 'learners' enjoyment of e-learning games. In: *Computers & Education. Elsevier Educational Research Programme*, 2009.
- [19] Zheng M, Spires HA. Fifth graders' flow experience in a digital game-based science learning environment. *International Journal of Virtual and Personal Learning Environments (IJVPLE)*. 2014; 5(2), 69-86.
- [20] Hwang MY, Hong JC, Hao YW, Jong JT. Elders' usability, dependability, and flow experiences on embodied interactive video games. *Educational Gerontology*. 2011; 37(8), 715-731.
- [21] Dias JD, Mekaro MS, Lu C, Otsuka JL, Fonseca LMM, Zem-Mascarenhas SH. Serious game development as a strategy for health promotion and tackling childhood obesity. *Revista latino-americana de enfermagem*. 2016; 24.
- [22] Tsuda M, Sanches VM, Ferreira TG, Otsuka JL, Beder DM. Análise de métodos de avaliação de jogos educacionais. *Proceedings of XIII SBGames*. 2014; 12-14.
- [23] Lemos LMDC. Games na promoção e educação em saúde: práticas de significação. In: *IV Colóquio Semiótico das Mídias 2015, Alagoas. Anais. Alagoas. Centro Internacional de Semiótica e Comunicação*. 2015 p. 01-15
- [24] Dourado JB, dos Santos AB, da Silva JS, Silva FJM, de Bortoli A, Bezerra A. Desenvolvimento e avaliação de um jogo com tecnologia de RA para auxiliar no ensino de matemática. *XIV Simpósio Brasileiro de Games e Entretenimento Digital SBGames, Trilha da Cultura, Teresina*, 846-853, 2015.
- [25] Jadhav HC, Dodamani AS, Karibasappa GN, Naik RG, Khairnar MR, Deshmukh MA, Vishwakarma P. Effect of reinforcement of oral health education message through short messaging service in mobile phones: a quasi-experimental trial. *International Journal of telemedicine and applications*. 2016; 2.
- [26] Underwood B, Birdsall J, Kay E. The use of a mobile app to motivate evidence-based oral hygiene behaviour. *British dental journal*, 2015; 219(4), E2.
- [27] Sharma R, Hebbal M, Ankola AV, Murugabupathy V (2011) Mobile-phone text messaging (SMS) for providing oral health education to mothers of preschool children in Belgaum City. *J Telemed Telecare* 17: 432-436.
- [28] De Sousa RHA, da Silva AC, de Deus DFL, de Sousa JLRP, de Souza Junior GN, do Nascimento LS. Desenvolvimento de jogo eletrônico como intervenção de educação em saúde para o adolescente. *Renote*, 15(1), 2017

The Use of Technology in Logistics Process Innovation in Industries

O uso da Tecnologia na Inovação do Processo Logístico nas Indústrias

Adriana Maria Miguel Peixe¹, Adriana Berno², Jorge Balsan³, José Simão de Paula Pinto⁴, José Anízio Rocha de Araújo⁵

¹Departamento de Ciências Sociais Aplicadas - Universidade Federal do Paraná, UFPR, Brasil
E-mail: ammp5196@gmail.com; adrianamiguelpeixe@ufpr.br

²Departamento de Ciências Sociais Aplicadas - Universidade Federal do Paraná, UFPR, Brasil
E-mail: adriana.berno76@gmail.com

³Departamento de Ciências Sociais Aplicadas - Universidade Federal do Paraná, UFPR, Brasil
E-mail: balsan@hotmail.com

⁴Departamento de Ciências Sociais Aplicadas - Universidade Federal do Paraná, UFPR, Brasil
E-mail: simao@ufpr.br

⁵Departamento de Ciências Sociais Aplicadas - Universidade Federal Rural do Semi-Árido, UFRSA, Brasil.
E-mail: anizioaraujo@ufersa.edu.br

Received: 30 Jun 2022,

Received in revised form: 15 Jul 2022,

Accepted: 22 July 2022,

Available online: 31 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Industry 4.0; Innovation; Technology; Logistics 4.0; Logistical processes.

Palavras-Chaves— Indústria 4.0; Inovação; Tecnologia; Logística 4.0; Processos logísticos.

Abstract— The present study aimed to elucidate the adoption of technology as a way to innovate logistics processes in industries. Technological innovation is one of the key factors in the competitiveness of organizational/Industry divisions in different regions of the world. In this context, investing in technology is essential for organizations/industries to survive in the market in the face of strong global competition. With a qualitative approach, the research is exploratory in nature with the use of documentary data. Seeking to provide an overview of the problem, of the approximate type through the researcher's understanding of the phenomenon or case that results in the improvement of ideas. From this perspective, it is inferred that the use of digital technology has been widely used, especially in logistics processes adopted by industries. In view of this, the insertion of technology appears as an important ally in the innovation process of logistics processes, configuring the so-called Logistics 4.0, which has been studied by researchers in different countries.

Resumo— O presente estudo teve como objetivo elucidar a adoção da tecnologia como forma de inovar os processos logísticos nas indústrias. A inovação tecnológica é um dos fatores-chave na competitividade das divisões organizacionais/Indústrias em diferentes regiões do mundo. Neste contexto, investir em tecnologia é essencial para que organizações/Indústrias sobrevivam no mercado diante da forte concorrência mundial. Com uma abordagem qualitativa a pesquisa é de

natureza exploratória com uso de dados documental. Buscando aprovisionar uma visão geral do problema, do tipo aproximativa pela compreensão do investigador em relação ao fenômeno ou caso que resulta no aprimoramento de ideias. Nessa perspectiva infere-se que o uso da tecnologia digital tem sido amplamente utilizado, principalmente nos processos logísticos adotados pelas indústrias. Frente a isso, a inserção da tecnologia mostra-se como uma importante aliada no processo de inovação dos processos logísticos, configurando a chamada Logística 4.0 a qual tem sido estudada por pesquisadores em diferentes países.

I. INTRODUÇÃO

No atual cenário mundial organizações e indústrias são afetadas de muitas formas, neste aspecto ocorrem transformações sociais, econômicas e culturais na qual a sociedade acompanha suas adaptações. As organizações e indústrias para fazer frente a uma conjuntura cada vez menos estável frente as novas tecnologias da informação, procuram adotar mecanismos para promover de forma mais eficaz, o desenvolvimento profissional para a necessidade de melhorias contínuas no desempenho do uso da tecnologia na inovação do processo logístico nas indústrias [35].

Para promover o desenvolvimento profissional e a melhoria contínua no uso da tecnologia são usualmente utilizadas como ferramenta a inovação em tecnologias que na atualidade vem a ser um dos principais fatores para a competitividade de setores, sejam estas organizações/indústrias em diferentes lugares do mundo como na Austrália; Brasil; China; Coreia do Sul; Espanha; França; Inglaterra; Japão; Singapura; Taiwan; USA entre outros países. Conforme Miguel Peixe e Pinto[41], em análise de conteúdo efetuada em 30 artigos encontrados em 7 *Clusters* num estudo realizado sobre “acoplamento bibliográfico”, na literatura internacional na base *Web of Science* no ano de 2020, tem-se após análise desses conteúdos evidenciados o avanço tecnológico sendo um assunto atual entre setores organizações/indústrias, considerado neste contexto um dos principais fatores para a competitividade na atualidade e futuro próximo.

Destaca-se ainda nome dos autores nesse estudo realizado por Miguel Peixe e Pinto[41], em cada *Clusters* e afirma-se após leitura dos artigos o quanto é relevante as informações encontradas para basear este estudo intitulado “**O Uso da Tecnologia na Inovação do Processo Logístico nas Indústrias**”. O Cluster 1 possui 6 documentos/artigos: Gao et al., [22]; Liu et al., [38]; Wu et al., [56]; Zhang et al., [65]; Zhang et al. [66]; Zhao et al., [67]. O Clusters 2 possui 6 documentos/artigos: Han et al., [27]; Lei et al., [29]; Liao et al., [34]; Sun et al., [50]; Yao, et al., [60]; Zhang et al., [64]. O Cluster 3 possui 5 documentos/artigos: Chen et al., [10]; Li et al., [32]; Li et al., [33]; Yan et al., [59]; Zhang et

al., [62]. O Cluster 4 possui 4 documentos/artigos: Wang et al., [55]; Wu et al., [57]; Wu et al., [58]; Zhang et al., [63]. O Cluster 5 possui 3 documentos/artigos: Liu et al., [38]; Liu et al., [36]; Nie et al., [42]. O Cluster 6 possui 3 documentos/artigos: Ding et al., [14]; Fu et al., [21]; Liu et al., [37]; e o Clusters 7 possui 3 documentos/artigos: Fang et al., [18]; Li et al., [31]; Yu et al., [61].

Ante deste contexto surge o problema de pesquisa: **Como está evidenciado a adoção da tecnologia como forma de inovar os processos logísticos nas indústrias?** O presente estudo teve como objetivo elucidar referente a adoção da tecnologia como forma de inovar os processos logísticos nas indústrias.

Com uma demanda na logística crescente e em vista do desenvolvimento mundial, mobilidade, destaca-se a importância no papel da logística em assegurar que a indústria cumpra o que foi prometido aos clientes, ofertando tanto um serviço como um produto específico, assim para obter uma boa logística é necessário integrar adequadamente setores da mesma indústria e aliar-se à gestão da informação para tomada de decisões acertadas. Frente a isso, a inserção da tecnologia mostra-se como uma importante aliada no processo de inovação dos processos logísticos, configurando a chamada Logística 4.0, [1].

Diante de tal problemática, os sistemas de logística são construídos, como uma ferramenta primordial para eficiência da promessa de consumo e entrega do produto, o viés se encontrado é visualizado como uma solução de acesso para melhoria tanto na coleta do produto e entrega com qualidade, objetivando assim atingir neste sentido a eficiência e eficácia.

O artigo está estruturado da seguinte forma: Referencial Teórico o qual aborda: A inovação como diferencial no âmbito organizacional; Tecnologia como mecanismo de inovação nas indústrias; Aspectos associados ao processo logístico; Emprego da tecnologia como forma de inovar o processo logístico; na sequência tem-se a metodologia, resultados, considerações finais e as referências.

II. A INOVAÇÃO COMO DIFERENCIAL NO ÂMBITO ORGANIZACIONAL

Peter Drucker[15], vincula o conceito de organização ao conhecimento, para “Drucker” o conhecimento é a base onde a organização deveria ser especializada e as funções definidas pela tarefa para tornar conhecimento em conhecimento produtivo. A função das organizações é tornar produtivos os conhecimentos, e quanto mais especializados forem, mais eficazes serão.

A concepção de inovação entra no contexto do sistema capitalista para a criação de processo movida pelo mundo atual [46]. Reforça a importância da inovação para a adaptação e a sobrevivência das organizações. A inovação é a exploração de novas ideias e a busca constante de criar, modificar e transformar, bens, serviços. Para Peter Drucker[16], a inovação é o ato de atribuir novas capacidades aos recursos sejam pessoas e processos, de uma forma operacional, criatividade = ideia + ação e inovação = criatividade + produtividade.

A capacidade de inovar em uma economia na busca da industrialização depende do respectivo sistema de inovação, dos fatores ambientais que o condicionam e dos níveis de interação entre os diversos componentes que o mundo organizacional se encontra por estar num mundo Industrial competitivo [20]; [51].

Já para Etzioni[17], a base da organização é ser uma unidade social, onde os objetivos organizacionais têm várias funções, entre elas, ser a fonte de legitimidade que justifica suas atividades; padrões para avaliar sua eficiência e rendimento; unidade de medida, para verificar sua produtividade. A razão de ser então da organização é servir a esses objetivos

O termo inovação possui diferentes conceitos, porém, é claro que a ideia de inovação sempre envolve mudanças, novas combinações de diferentes fatores e tecnologias. O conceito de inovação é frequentemente associado a um conceito próximo à criatividade e pode ser visto de diferentes ângulos [43].

Rogers e Shoemaker[45], definem inovação como a percepção do novo, seja a ideia objetivamente nova ou não, se considerado seu tempo de uso ou descoberta. É preciso dizer que os conceitos de inovação interpretados por alguns pesquisadores são divergentes. No entanto, entre as muitas definições que relatam, existem alguns argumentos comuns, como que a inovação é uma atividade intencional; a intenção inovadora é criada para resolver um problema intencionalmente; inovação é mudança e isso implica novidade de produtos ou métodos inovadores, algo novo e inovador [12]; [7].

No mundo dos negócios, existem muitos tipos diferentes de inovação que uma empresa pode buscar. Eles geralmente estão vinculados diretamente a produtos individuais, processos ou fluxos de trabalho internos ou modelos de negócios. Com isso, a inovação configura-se como sendo os processos que as empresas e indústrias colocam em prática na concepção de novos produtos e processos de fabricação [12].

Nessa perspectiva, parece que a inovação dentro da organização traz produtividade, reduz erros e tarefas repetitivas e padroniza serviços, além de reduzir custos [7].

Portanto, a inovação nas organizações cada vez mais se mostra necessária para todas as organizações, que buscam novas alternativas de sucesso. Sendo assim, a inovação atua como propulsora do sucesso de uma organização, conforme cita Machado [39]:

Para prosperar no meio de uma concorrência cada vez mais feroz, as empresas e seus dirigentes precisam reorganizar estratégias, processos, recursos – na verdade, a organização inteira – para focar diretamente na inovação e em um dos elementos-chave para que ela aconteça, a tecnologia [39, p.8].

Neste contexto, a inovação é muito importante para a competitividade de uma organização, pois um dos grandes fatores relacionados à competitividade é a inovação. A maior parte da inovação é direta ou indiretamente impulsionada por novas tecnologias e a forma como essas transformam o mundo e os tipos de vários mercados. Os esforços voltados para ferramentas e métodos inovadores baseados no uso das tecnologias digitais podem garantir a vantagem competitiva de uma organização [26].

A tecnologia digital é um sistema discreto que se baseia em métodos de codificação e transmissão de dados de informação, que permitem resolver diversos problemas em um tempo relativamente curto. Um exemplo comum de tecnologia digital e de fácil acesso as pessoas vêm a ser os *smartphones* que tem se tornado os principais dispositivos dos consumidores em todo o mundo, eles facilitam a maneira como as pessoas se comunicam.

Portanto, a inovação tecnológica é um dos fatores-chave da competitividade das regiões organizacionais em diferentes regiões do mundo [40]. Assim, a inovação é descrita como uma iniciativa, pequena ou revolucionária, que surge como uma novidade para as empresas e mercados e é aplicada na prática, traduzindo-se em resultados,

consequências econômicas para a organização especialmente em relação ao uso de tecnologia [26].

O tema abordado neste tópico tem como finalidade mostrar a inovação em nosso dia a dia para demonstrar posteriormente a importância da tecnologia na digitalização das Indústrias em países em desenvolvimento e desenvolvidos, a construção de um novo pensar, a evolução constante.

2.1 TECNOLOGIA COMO MECANISMO DE INOVAÇÃO NAS INDÚSTRIAS

A tecnologia sempre teve influência no desempenho das organizações, e se faz presente desde o tempo da Revolução Industrial [28]. É possível ressaltar como exemplo a máquina de escrever, o telefone, os automóveis e outros diferentes produtos tecnológicos que impulsionaram o cenário das organizações e possibilitaram a consolidação da globalização como exemplo o uso de *drones* na agricultura e logística. No entanto os ambientes inovadores, desde a invenção do computador, na segunda metade do Século XX, as organizações começaram a demonstrar uma transição para suas atuais características de automatização de atividades [26].

Em pesquisa realizada por Vilhena e Miguel Peixe[54], referente a “AMBIENTE DE INOVAÇÃO: Uma Análise Conceitual dos Elementos que caracterizam o Ambiente Inovador”. Evidencia-se que as organizações desenvolvem estratégias para se manterem competitivas, adequando-se às mudanças que ocorrem no meio em que atuam.

A tecnologia é um dos instrumentos que mais altera o meio organizacional, possui relação direta com os impactos relacionados às funcionalidades dentro de uma empresa e o surgimento do computador possibilitou às organizações a se estruturarem no formato conhecido atualmente. O computador ocasionou a possibilidade de se administrar e controlar com mais facilidade todos os dados importantes de uma organização, facilitando assim a tomada de decisões, tornando-as muitas vezes mais assertivas [28].

O desenvolvimento tecnológico sempre foi um fator essencial para o progresso das organizações. De acordo com Chiavenato[11p.34]: “as empresas precisam utilizar alguma tecnologia para executar operações e realizar suas tarefas”. Sendo assim, toda organização precisa da tecnologia para funcionar e alcançar suas metas seja no passado, presente e futuro.

De acordo com Tenório [52], sobre o conceito de tecnologia voltada para o âmbito organizacional destaca-se que:

É a tecnologia que estabelece o fluxo de trabalho, os métodos e processos operacionais e toda a

máquina utilizada para desempenhá-la. A tarefa de uma empresa é muito variada. Desde que uma empresa desempenha alguma tarefa particular e aplica alguma maneira de executá-la, a tecnologia passa a afetar todos os poros das pessoas e das coisas e eventos existentes na empresa [52 p. 89].

Neste contexto aludido por Tenório[52], as organizações são influenciadas pelas tecnologias, modificando seu cotidiano, afetando seu modo de planejar e tomar decisões. As empresas precisam estar alicerçadas diante de uma forte base de informação e comunicação e os sistemas de tecnologia devem ser acessíveis e abertos. Chiavenato[11] e Schwab[47] afirmam em seus estudos que a tecnologia constitui a necessidade de analisar e aprimorar a organização para seguir e desfrutar dos processos tecnológicos.

Dessa forma, os esforços voltados para incorporação da Indústria 4.0 são constantemente evidenciados nas organizações [7]; [5]; [9]. O tema da Indústria 4.0 foi introduzido inicialmente em 2011 no Hannover Feira na Alemanha [23]; [5].

Conforme Ardito et al. (2019), a Indústria 4.0 tem reflexos positivos na aplicação da tecnologia de informação e comunicação (TIC) nos últimos anos, porque hoje aproximadamente 90% de todos os processos de fabricação industrial já são suportados pelas TICs [5]. Na Indústria 4.0, a inovação é um conceito central, visto que se refere à tendência de aumento do uso de tecnologias de informação e automação no ambiente fabril.

Com a ‘implementação da Indústria 4.0 não será mais necessário lançar mão de programações nas máquinas. As próprias máquinas poderão decidir a hora de aumentar ou reduzir a produção e ligar ou desligar. Nos estudos de Belinski et al.,[5], a formação e o desenvolvimento profissional contínuo na Indústria 4.0 é uma das áreas de ação prioritárias na atualidade com grande avanço.

Este avanço possibilitará o aumento do uso da capacidade, racionalização da produção e redução do consumo de energia [53]. Os impactos da Indústria 4.0 ultrapassam o âmbito dos ganhos de produtividade na fábrica.

Ben-Dayaa[6], mencionam em seus estudos referente a perspectiva industrial que para sobreviver em um ambiente tão complexo, as indústrias precisam ser extremamente ágeis e construir um alto nível de capacidades de resiliência e mitigação de riscos e

flexibilidade estrutural que permitam uma resposta rápida a esses desafios [6].

Sobre essa perspectiva industrial, Carvalho[9], consideram que as tendências defendidas pela quarta revolução industrial fornecem a base para a Indústria 4.0, que se baseia na aplicação de modernas tecnologias de informação e comunicação, que estão conectadas e incorporadas no campo da automação industrial, redes de dados e tecnologias de fabricação, como o uso de impressão 3D, produção inteligente, interação homem-máquina, operações remotas, entre outros. Complementando tal visão, os autores destacam que:

A Indústria 4.0 é um ambiente em que todos os equipamentos estão conectados em uma rede e disponíveis a qualquer momento, de modo instantâneo, trazendo de modo exponencial a capacidade dos computadores visando aumentar a quantidade de informação digitalizada e melhorando a estratégias empresariais de inovação, [9 p. 260].

À vista disso, a implementação da Indústria 4.0 nas organizações contribui para que ocorram potenciais mudanças. Dessa forma, as organizações de excelência não são as que utilizam de tecnologia avançada e sofisticada, mas sim as que sabem extrair o máximo proveito de suas tecnologias atuais. Com isso, a adoção dos preceitos da Indústria 4.0, a qual é marcada pelo uso de novas tecnologias e novas formas de perceber o mundo Schwab[47], se tornam de grande relevância frente aos processos de logística.

Neste sentido referente ao contexto extrair o máximo proveito das tecnologias já se fala da Indústria 5.0 que vem a ser a evolução natural da Indústria 4.0, que ainda domina o mundo das pequenas e médias empresas na atualidade. A diferença entre estas duas modalidades de Indústria “4.0 e 5.0”, vem a ser que a nova era industrial origina-se do desenvolvimento de tecnologias 4.0, em particular nas áreas de *ICT* (Tecnologias da Informação e Comunicação), *IA* (Inteligência Artificial) e robótica.

Assim, a medida em que a eficiência nesses processos se torna indispensáveis para a continuidade dos negócios, a adoção das novas tecnologias se torna ainda mais essencial para a sobrevivência e o crescimento das organizações, visto que a Indústria 4.0 exige um desenvolvimento paralelo no setor de logística e isso está dando origem ao conceito de Logística 4.0 e 5.0.

2.2 ASPECTOS ASSOCIADOS AO PROCESSO LOGÍSTICO

Logística é uma ferramenta importante para os gestores, pois visa à redução de custos e disponibilidade dos produtos na condição exigida e no tempo certo. Trabalha com a integração de setores e usa principalmente a informação como tomada de decisão [19]. Em relação a compreensão do termo logística, a primeira palavra que geralmente é associada seria transporte. Entretanto logística é bem mais ampla e compreende como funções de apoio, além do transporte, armazenamento, manuseio de materiais, embalagem, aquisição de produtos, programação de produtos e informação [44].

A logística corresponde a todas as informações existentes desde o pedido do cliente, até a entrega do produto. Com isso, tem-se que o transporte e o armazenamento são as duas funções principais da logística [44]. A gestão de transporte concentra-se no planejamento, otimização e execução do uso de veículos para movimentar mercadorias entre armazéns, locais de varejo e clientes, enquanto o armazenamento, ou gerenciamento de depósito, inclui funções como gerenciamento de estoque e atendimento de pedidos [44].

A logística refere-se a uma estrutura de planejamento adotada pela administração de uma organização para facilitar os aspectos associados a distribuição de pessoal, material, serviço, informação e fluxos de capital. Assim, um processo logístico eficiente utiliza ferramentas para analisar e visualizar as complexidades envolvidas em sua produção. Deve-se observar que essas ferramentas devem integrar informações, armazém, produção, armazenamento, pessoal, materiais, embalagem e distribuição segura dos produtos finais [49].

A cadeia de suprimentos é um conjunto de processos executados desde a matéria-prima ao consumidor final. Processo este que sempre foi visualizado de forma complexa, por lidar com pessoas, clientes exigentes, transportes que dependem de fatores ambientais e de manutenção de frota, bem como gestão de estoque acoplada a logística reversa [4].

Frente a isso, a Gestão da Cadeia de Suprimentos (GCS) configura-se como um processo que visa o gerenciamento estratégico de diferentes fluxos, tais como bens, serviços, finanças e informações e, também, as relações entre empresas, objetivando atingir e firmar as metas organizacionais. Ressalva-se ainda que o gerenciamento da cadeia de suprimentos pode ser compreendido como um conjunto de métodos empregados para viabilizar uma melhor integração e gestão de todos os

parâmetros de uma rede, como transportes, estoques, custos, entre outros [25].

A logística pode ser definida como uma estratégia industrial, neste estudo cujo objetivo é satisfazer às necessidades dos consumidores finais, gerando valor para as organizações neste caso aqui direcionada para as indústrias [19]. Como um processo, a logística continua a se tornar mais complicada devido ao aumento da demanda por sistemas complexos de controle de informação e comunicação do ambiente de negócios global da atualidade [8]. Frente a isso, o emprego das novas tecnologias passou a ser crucial para o bom andamento dos processos logísticos, dando lugar a adoção da Logística 4.0.

2.3 EMPREGO DA TECNOLOGIA COMO FORMA DE INOVAR O PROCESSO LOGÍSTICO

No contexto da quarta revolução industrial e da transformação digital das empresas, analisando as cadeias logísticas, sua evolução e digitalização, a chamada Logística 4.0, tornou-se de interesse primordial para as organizações [8]. O termo Logística 4.0 refere-se aos vários aspectos da logística de ponta a ponta e gerenciamento da cadeia de suprimentos no contexto da Indústria 4.0 [2]. Neste sentido, a Logística 4.0 é definida como o uso e análises dos dados coletados pela fabricação inteligente para melhorar a eficiência e o desempenho da operação, o que significa que oferece muitas oportunidades para os gerentes de logística.

A complexidade das cadeias logísticas que tratam da distribuição de mercadorias, desde a matéria-prima até os produtos acabados, é determinada pela alta fragmentação em centenas de etapas. Tal processo envolve atores diferentes e heterogêneos distribuídos geograficamente pelo mundo. Essa estrutura fragmentada torna claramente difícil rastrear eventos, investigar acidentes e tomar ações direcionadas em resposta [8]. Além disso, o nível de digitalização não homogêneo dos diferentes *stakeholders* e da documentação associada aos processos logísticos muitas vezes representa um gargalo e geram custos. Outro ponto relevante de complexidade é representado pela segurança, padronização e interoperabilidade das fontes de dados logísticos [8]; [2].

Dessa forma, a inserção das novas tecnologias visa tornar tais processos mais inteligentes, ou seja, tornar a informação e seu fluxo eficiente e verificável ao longo do caminho, garantindo transparência, segurança e prestação de contas, para que os usuários tenham informações acessíveis, precisas e confiáveis [2]. Sendo assim, a Logística 4.0 tem como objetivo criar um ecossistema transparente, no qual todos os sistemas envolvidos possam expor dados relevantes. Pessoas, máquinas, sensores e dispositivos poderão compartilhar os dados necessários para

que a cadeia de suprimentos opere com eficiência, o que permitirá visibilidade e controle de ponta a ponta. Isso também apoiará as decisões da alta administração, fornecendo *insights* e previsões antecipadas sobre atrasos, avarias e interrupções para as partes interessadas envolvidas na cadeia de suprimentos [48].

Assim, a Logística 4.0 é a rede e integração de processos logísticos, são basicamente os efeitos da Indústria 4.0, ou seja, a rede e o intertravamento de clientes, objetos, processos e parceiros da cadeia de suprimentos por meio de tecnologias de informação e comunicação para aumentar a eficiência e eficácia de uma empresa [2].

Neste sentido, a Logística 4.0 é capaz de colaborar e se integrar com os procedimentos e sistemas da Indústria 4.0. Essa integração criaria um ambiente para a construção de um relacionamento comum e sinérgico entre os três: carregadores, fabricantes e usuários finais. Os processos autogerenciados são chamados de inteligentes porque se comunicam, tomam decisões, aprendem uns com os outros e controlam os processos logísticos [8]; [25]. Isso se torna possível graças ao uso de soluções como *Big Data*, *IA - Inteligência Artificial*, *Cloud Computing*, *Internet das Coisas (IOT)*, dentre outras [8]. Por esse motivo, a Logística 4.0 resulta principalmente em maior transparência, processos mais enxutos e menor taxa de erros.

A Logística 4.0 se mostra como uma proposta lucrativa de valor agregado para todas as organizações que desejam se afastar das complexidades de uma cadeia de suprimentos global, [2]; [48].

Logo, no atual cenário da sociedade, a Logística 4.0 está mudando completamente a forma como as organizações atuam no mercado, se apresentando como uma forma inovadora para seus processos logísticos em diferentes áreas.

III. METODOLOGIA

Com o intuito de verificar a importância do “Uso da Tecnologia na Inovação do Processo Logístico nas Indústrias”, buscou-se uma fundamentação teórica que estabelecesse conexões entre planejamento, estratégia para o processo do uso da tecnologia na inovação no processo logístico para resolver problemas, e realizar a tomada de decisão. Na sequência, foi realizado um levantamento da leitura de artigos que foram basilares para a compreensão destas relações.

O presente estudo aborda a literatura nacional e internacional, consentindo a identificação e mapeamento de estudos relevantes na atualidade referente ao tema. Consequentemente, a partir da dimensão “Uso da Tecnologia”, realizou-se a leitura e a análise de literatura e

artigos publicados, buscando respostas para as seguintes questões conforme Cooper e Schindler[13] seguindo as etapas: (I) descobrir os problemas; (II) escolher um problema para concentrar; (III) elaborar o planejamento; (IV) métodos de coleta de dados; (V) analisar, interpretar e produzir relatórios; e (VI) tomar a decisão para resolver o problema.

Com uma abordagem metodológica qualitativa onde se explana o uso da tecnologia na inovação do processo logístico nas indústrias, descrevendo assim algumas determinantes e desafios da digitalização da indústria em países desenvolvidos e em desenvolvimento. Sabe-se que a abordagem qualitativa é feita por meio da interpretação dos fatos, além de descrição e compreensão de dados.

Para tanto esta produção acadêmica além de ser qualitativa possui a metodologia de um estudo exploratório, baseado em pesquisa documental e eletrônica. Buscando aprovisionar uma visão geral do problema, do tipo aproximativa pela compreensão do investigador em relação ao fenômeno ou caso que resulta no aprimoramento de ideias [24].

A forma de coletar os dados possui natureza instrumental e viabilizou as informações objetivando a análise e a explicação dos aspectos em estudo. Coletar dados é uma observação da vida real que, quanto a sua natureza, e neste caso efetuou-se uso de dados secundários: extraídos por meio de análise documental, como livros, jornais, revistas, ou seja, pesquisas atuais que discorrem do assunto usando a tecnologia na inovação do processo logístico nas indústrias.

Nesse contexto com intuito enfatizar o quão os investimentos em tecnologias para as indústrias são considerados essenciais para a sobrevivência das mesmas no mercado frente a acirrada competitividade. Resultando assim no atendimento à crescente demanda por inovação, criatividade, qualidade, melhoria de processos, dentre tantas outras necessidades neste mundo globalizado.

IV. RESULTADO DA PESQUISA

As indústrias têm em seu perfil a busca constante no aprimoramento da produção, tecnologia e modelos inovadores são locais de transformação de qualquer matéria-prima em objetos prontos para o consumo, avulta-se a transformação em busca constante pelo aprimoramento da tecnologia, e atualmente ampliando para a logística. Indo esta inferência ao encontro do mencionado em estudos como de Arrivabene et al.,[3] e Lenart-Gansiniec[30].

A logística se mostra como uma proposta lucrativa de valor agregado para todas as organizações que desejam

se afastar das complexidades de uma cadeia de suprimentos global. Desta forma, pode-se afirmar que a inovação está em seu “DNA”, incorporado em todas as atividades na construção de matéria-prima em objetos prontos, cadeia de produção, e envio do produto “logística”, tendo como aliado a tecnologia mais adequada para reforçar a construção de inovar, e a busca constante em continuar no mercado global.

Por esse motivo, a Logística resulta principalmente em maior transparência, processos mais enxutos e menor probabilidade de erros nos processos industriais. A pesquisa alcançou seu objetivo pois demonstrou informações que sinalizam responder à pergunta referente ao problema. Ou seja, na atualidade em que se presencia com mudanças contínuas, as indústrias devem acompanhar a tecnologia e se adaptar às inovações, visto que a tecnologia é um dos instrumentos que mais altera o meio organizacional/indústria.

O estudo evidenciou o uso da tecnologia o qual tem sido amplamente utilizado, principalmente nos processos logísticos adotados pelas indústrias. A inserção da tecnologia mostra-se como uma importante aliada no processo de inovação dos processos logísticos, configurando a chamada Logística 4.0 a qual tem sido muito mencionada na atualidade. A Indústria está em constante desenvolvimento envolvendo a tecnologia como aliada nas perspectivas de (mão-de-obra) “trabalho”, (matéria-prima) “produto” e (transporte) “logística”, nas organizações/Indústrias. A Logística chamada 4.0, se baseia na ideia da aplicação dos novos recursos tecnológicos para otimizar todos os processos logísticos.

Esse novo setor logístico traz mais velocidade, eficiência e redução de custos, tendo a indústria foco em aprimoramento, por tratar de processos de transformação, neste momento percebe-se uma simetria, de produção e otimização de processo logístico caminhando junto com a tecnologia, e em busca de evolução industrial, e para o desenvolvimento econômica global.

Os aspectos relevantes para a indústria de transformação, que busca o aprimoramento, no produto, e a logística, como a temática abordada no estudo, “O Uso da Tecnologia na Inovação do Processo Logístico nas Indústrias”, sendo algo recente em relação ao cenário atual seja nacional e internacional, observa-se a busca da tecnologia como aliada e mundial. Contudo essa área do conhecimento adquire gradativamente *status* e credibilidade na competitividade de uso da tecnologia e suas modalidades, vêm ganhando força, principalmente por ser a inovação uma nova forma de aplicação dos novos recursos tecnológicos para otimizar todos os processos logísticos.

Nesse contexto para a pesquisa efetivar-se teve-se como intuito enfatizar o quão os investimentos em

tecnologias para as indústrias são considerados essenciais para a sobrevivência das mesmas no mercado frente a acirrada competitividade. Resultando assim no atendimento à crescente demanda por inovação, criatividade, qualidade, melhoria de processos, dentre tantas outras necessidades no mundo globalizado, como possibilidade de desenvolvimento socioeconômico. Os teóricos textos publicados têm como objetivo principal a discussão sobre a contribuição do uso da tecnologia na inovação do processo logístico nas indústrias, a leitura dos textos, levou a análises qualitativas para melhor interpretação e uso dos artigos relacionados na pesquisa.

Por fim, realizou-se análise dos artigos científicos que apresentam “o uso da tecnologia” uma ferramenta de investimento para o aprimoramento nos processos logísticos nas indústrias, em um mundo digital em constante desenvolvimento, e, portanto, se deve ter cautela, para trabalhar com severa confiabilidade e segurança. A pesquisa evidência o aprimoramento do uso da tecnologia digital como uma ferramenta de investimento para melhorar os processos logístico, com segurança, confiabilidade, redução de custo, e velocidade.

V. CONCLUSÃO

No âmbito das indústrias e tecnologias tem-se que a inovação é considerada um aspecto relevante de sucesso e sobrevivência a longo prazo para as organizações/indústrias. O presente estudo teve como objetivo elucidar referente a adoção da tecnologia como forma de inovar os processos logísticos nas indústrias.

As organizações/indústrias reconhecem que a inovação contribui para a criação de vantagens competitivas. Assim, a inovação é uma importante fonte de crescimento e um determinante-chave da vantagem competitiva para muitas organizações/indústrias.

A pesquisa teve seu objetivo alcançado, evidenciando a publicação de artigos que tem relevância da problemática do estudo, sendo o estudo relevante para o investimento, tecnologia, redução de custo, aumento de renda e o uso da tecnologia na indústria no processo logístico.

Neste contexto, a inovação de processos logísticos nas indústrias e tecnologia estão intimamente entrelaçadas. Duas maneiras muito notáveis pelas quais a tecnologia impulsiona a inovação é que ela estimula o ajuste e a experimentação, e isso por si só acelera os processos de inovação industrial.

Dessa forma, assim como a fábrica moderna está adicionando novas tecnologias inteligentes para criar fluxos de trabalho conectados e interoperáveis, a cadeia de

suprimentos moderna está rapidamente se tornando mais inteligente, mais conectada em rede e mais avançada tecnologicamente.

Embora a chamada quarta revolução industrial, que resultou na Indústria 4.0, receba a maior parte da atenção, há outra revolução ocorrendo simultaneamente no mundo da logística, a chamada Logística 4.0, a qual está mudando a maneira como os produtos passam das instalações de produção para os clientes. Com isso, as inovações logísticas respaldadas no uso das novas tecnologias representam mudanças e melhorias nos serviços de logística, sendo de grande relevância para inovar os processos logísticos nas indústrias.

Sugere-se dar novos direcionamentos a estudos com este intuito por ser o atual cenário mundial organizações e indústrias são afetadas de muitas formas por meio do uso das tecnologias, ocorrendo transformações sociais, econômicas e culturais na qual a sociedade necessita se adaptar.

VI. AGRADECIMENTOS

Agradecimentos à Órgão de Fomento. “O presente trabalho foi realizado com apoio da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Código de Financiamento 001”.

REFERÊNCIAS

- [1] Agostini, L., Filippini, R. (2019). Organizational and managerial challenges in the path toward industry 4.0. **European journal of innovation management**, v.22, p.406–421.
- [2] Almeida, F. A. S., Rosa, a. C. M., dos Santos, D. S., Neto, S. T. S. (2019). Indústria 4.0 e Logística 4.0: inovação, integração, soluções e benefícios reais decorrentes do mundo virtual. X Fateclog-Logística 4.0 & A Sociedade Do Conhecimento FATEC Guarulhos.
- [3] Arrivabene, A., Sassi, R. J., Andrelo, P. F. A.; Moura, M. L. A. de O. (2021). Analysis of the Impact of Adequacy on Operational Information Technology Processes to the Requirements of the Sarbanes - Oxley Act in a Financial Company. **Research, Society and Development**, v.10(1), e 7710111374, 2021(CC BY 4.0) | <http://dx.doi.org/10.33448/rsd-v10i1.11374>.
- [4] Ballou, R. H. (1993). **Logística empresarial: transportes, administração de materiais e distribuição física**. Atlas.
- [5] Belinski, R.; Miguel Peixe, A. M.; Frederico, G. F.; Garza-Reyes, J. A. (2020). Organizational learning and Industry 4.0: findings from a systematic literature review and research agenda. **Benchmarking: An International Journal**, v. 27, n. 8, p. 2435-2457.

- [6] Ben-Dayaa M., Hassinib, E.; Bahrouna Z. (2017). Internet of Things and Supply Chain Management: A Literature Review. **International Journal of Production Research**. DOI: 10.1080/00207543.2017.1402140. ISSN: 0020-7543 (Print) 1366-588X (Online) Journal homepage: <https://www.tandfonline.com/loi/tprs20>.
- [7] Biasi, N. B., Wiese, A. L. H. C., Caron, A., Seleme, R. (2018). Inovação como vantagem competitiva na indústria alimentícia. **Revista da FAE**, v. 21, n. 2, p. 7-20.
- [8] Carmona, A. L. M. (2017). Análise dos impactos da indústria 4.0 na logística empresarial. **Trabalho de Conclusão de Curso - Universidade Federal de Santa Catarina**, Joinville.
- [9] Carvalho, G. G., Tiosso, F., Reis, H. M. (2020). INDÚSTRIA 4.0: adoção de tecnologias como fator de competitividade. **Revista Interface Tecnológica**, v. 17, n. 2, p. 256-268.
- [10] Chen, Y., Yang, C., Zhang, Yan & LI, Y. (2020). Deep conditional adaptation networks and label correlation transfer for unsupervised domain adaptation. **Pattern Recognition**, v. 98, p. 107072, <https://doi.org/10.1016/j.patcog.2019.107072>.
- [11] Chiavenato, I. (2010). **Gestão de Pessoas: O Novo Papel dos Recursos Humanos nas Organizações**. 3. ed. Rio de Janeiro: Elsevier.
- [12] Conto, S. M. D., Antunes, J. A. V., Vaccaro, G. L. (2016). A inovação como fator de vantagem competitiva: estudo de uma cooperativa produtora de suco e vinho orgânicos. **Gestão & Produção**, v. 23, p. 397-407.
- [13] Cooper, D. R.; Schindler, P. S. **Métodos de pesquisa em Administração**. 12 ed. Porto Alegre: Bookman, 2016.
- [14] Ding, H. B., Pan, Z. B., Cen, Q. B., LI, Y. C. & Chen, S. a. (2020). Multi-scale fully convolutional network for gland segmentation using three-class classification. **Neurocomputing**, v. 380, p. 150–161. <https://doi.org/10.1016/j.neucom.2019.10.097>
- [15] Drucker, P. (1997). **Sociedade pós-capitalista**. 6 ed. São Paulo: Pioneira.
- [16] Drucker, P. (1998). **Introdução à administração**. 3a. ed. São Paulo: Editora Pioneira.
- [17] Etzioni, A. (1989). **Organizações modernas**. 8 ed. São Paulo: Pioneira.
- [18] Fang, Y. 1,2., Huang, X. 3., Qin, L. 4., Zhang, Y. 4., Zhang, W. 1., Cheng, R. 5. & Lin, X. 1,2. (2020). A survey of community search over big graphs. **The VLDB Journal**, v.29, p.353–392. <https://doi.org/10.1007/s00778-019-00556-x>
- [19] Fernandes, D., Pedro, J. G., dos Santos Coutinho, D. (2013). O papel da logística nas organizações: um estudo de caso em uma distribuidora de alimentos. In: **Colloquium Humanarum**, [SL]. p. 190-195.
- [20] Freeman, C. (1987). Technological infrastructure and international competitiveness, **The First Globelics Conference 'Innovation Systems and Development Strategies for the Third Millennium'**, Rio de Janeiro.
- [21] Fu, J. A. B., Liu, J. A., Li, Y. C., Bao, Y. C., Yan, W. C., Fang, Z. A. B., & Lu, H.A. (2020). Contextual deconvolution network for semantic segmentation. **Pattern Recognition**, v. 101, p. 107152. <https://doi.org/10.1016/j.patcog.2019.107152>
- [22] Gao, P., et al. (2020). Siamese Attentional Keypoint Network for High Performance. **Visual Tracking**, arXiv:1904.10128v2.
- [23] Ghobakhloo, M. (2018). The future of manufacturing industry: A strategic roadmap toward Industry 4.0. **J. Manuf. Technol. Mana.** v.29, p.910–936, [CrossRef].
- [24] Gil, A. C. (2017). **Como elaborar projetos de pesquisa**. 6. ed. São Paulo: Atlas.
- [25] Gomes, C. F. S., Ribeiro, P. C. C. (2020). **Gestão da cadeia de suprimentos integrada à tecnologia da informação**. Editora Senac/Rio.
- [26] Grützmann, A., Zambalde, A. L., Bermejo, P. H. D. S. (2019). Inovação, Desenvolvimento de Novos Produtos e as Tecnologias Internet: estudo em empresas brasileiras. **Gestão & Produção**, v. 26.
- [27] Han, X. 1,2,3., Zhang, Y. 1,2., Zhang, W. 1,2. & Huang, T. 4. (2020). An Attention-Based Model Using Character Composition of Entities in Chinese Relation Extraction. **Information**, v.11, p. 79; doi:10.3390/info11020079.
- [28] Hasan, N. M., da Silva Reis, J. D. **Organizações Inovadoras que Utilizam a Revolução 4.0. Interfaces Científicas-Exatas e Tecnológicas**, v. 2, n. 3, p. 9-20, 2018.
- [29] Lei, K. a, b., Zhang, B. a., Li, Y a., Yang, M. c. & Shen, Y. a. (2020). Time-driven feature-aware jointly deep reinforcement learning for financial signal representation and algorithmic trading. **Expert Systems with Applications**, v. 140 p. 112872. <https://doi.org/10.1016/j.eswa.2019.112872> 0957-4174/© 2019 Elsevier Ltd. All rights reserved.
- [30] Lenart-Gansiniec R. (2019). Organizational Learning in Industry 4.0. **Problemy Zarządzania-Management**, v.17(2), p.96-108.
- [31] Li, H., Liu, Y.; Mamoulis, N. & Fellow, D. S. R. (2020). Translation-Based Sequential Recommendation for Complex Users on Sparse Data. **Ieee Transactions on Knowledge and Data Engineering**, v. 32, n. 8, August 2020. Digital Object Identifier no. 10.1109/TKDE2906180. <https://www.ieee.org/publications/rights/index.html> for more information.
- [32] Li, J. a., Zhou, G. a, b., Qiu, Y. a., Wang, Y. a, b., Zhang, Y. d. & Xie, S. a, c. (2020). Deep graph regularized non-negative matrix factorization for multi-view clustering. **Neurocomputing**, V. 390, p. 108–116 <https://doi.org/10.1016/j.neucom.2019.12.054>.
- [33] Li, Y., Zeng, Y., Liu, T., Jia, X. & Bin, H. G. (2020). Simultaneously learning affinity matrix and data representations for machine fault diagnosis. **Neural Networks**, v. 122, p. 395–406, 2020. <https://doi.org/10.1016/j.neunet.11.007>.
- [34] Liao, W. a., Wang, Y. a., Yin, Y. b., Zhang, X. a., & Ma, P. a. (2020). Improved sequence generation model for multi-label classification via CNN and initialized fully connection. **Neurocomputing**, V. 382, p. 188–195. <https://doi.org/10.1016/j.neucom.2019.11.074> 0925-2312/© 2019 Elsevier B.V. All rights reserved.
- [35] Liao, Y., Deschamps, F., Loures, E.; Ramos, L. F. P. (2017). Past, present and future of Industry 4.0 a systematic literature review and research agenda proposal. **International Journal**

- of **Production Research**, v.55. - Issue 12. Published online: 28 Mar 2017. <http://bit.ly/2wNSNdq>.
- [36] Liu, Y. 1., Zhang, J. 1,2,3., Han, D. 1., Wu, P. 1., Sun, Y. 1. & Moon, Y. S. 4. (2020). A multidimensional chaotic image encryption algorithm based on the region of interest. **Multimedia Tools and Applications**. v.79, p. 17669–17705. <https://doi.org/10.1007/s11042-020-08645-8>.
- [37] Liu, Y., Han, J., Zhang, Q. & Shan, C. (2020). Deep Salient Object Detection with Contextual Information Guidance. **IEEE Transactions on Image Processing**, v. 29. Digital Object Identifier 10.1109/TIP.2019.2930906. See http://www.ieee.org/publications_standards/publications/rights/index.html for more information.
- [38] Liu, Y., Tobey H. K., Zhonglei G. & Jiming Liu, F. (2020). Identifying Key Opinion Leaders in social media via Modality-Consistent Harmonized Discriminant Embedding. **IEEE Transactions on Cybernetics**, v. 50, n. 2, FEBRUARY. See http://www.ieee.org/publications_standards/publications/rights/index.html for more information.
- [39] Machado, D. D. P. N. (2007). Organizações inovadoras: estudo dos fatores que formam um ambiente inovador. **INMR-Innovation & Management Review**, v. 4, n. 2, p. 05-28.
- [40] Miguel Peixe, A. M.; Balsan, J.; Pinto, J. S. de P. (2021). Corporate Governance and Information Technology Governance as a competitive advantage in organizations. **Research, Society and Development**, v. 10, n. 5, e7910514636. (CC BY 4.0) | ISSN 2525-3409 | DOI: <http://dx.doi.org/10.33448/rsd-v10i5.14636>.
- [41] Miguel Peixe, A. M.; Pinto, J. S. de P. (2022). Acoplamento Bibliográfico e o Avanço Tecnológico por Meio do Uso *Software Vosviewer*. **Research, Society and Development**, v. 11, n. 9, e39711931650, 2022 (CC BY 4.0) | ISSN 2525-3409 | DOI: <http://dx.doi.org/10.33448/rsd-v11i9.31650>
- [42] Nie, X. 1., Zhang, W. 1,2., Zhang, Y. 1. & Yu, D. 1,2. (2020). Method to Predict Bursty Hot Events on Twitter Based on User Relationship Network. **IEEE Access**. Digital Object Identifier 10.1109/ACCESS.2020.2977424. VOLUME 8. This work is licensed under a Creative Commons Attribution 4.0 License. For more information, see <http://creativecommons.org/licenses/by/4.0/v.8>.
- [43] Peixoto, N. E. S., Pereira-Filho M. M.; Farias, J. S. (2021). Panorama da Produção Empírica Internacional de Inovação em Serviços Turísticos entre 2008 e 2020: Uma Revisão Sistemática da Literatura. **Internext** | São Paulo, v.16, n. 1, p. 56-74, jan./abr.
- [44] Rodrigues, K. C.; Rabelo, M. H. da S. (2017). A importância do transporte na logística empresarial. **Revista Acadêmica Conecta FASF**, v.2(1):193- 207.
- [45] Rogers, E. M., Shoemaker, F. F. (1971). **Communication of innovations**. New York: Free Press.
- [46] Schumpeter, J. A. (1982). **A Teoria do Desenvolvimento Econômico**. Ed. Abril Cultural, SP (Os Economistas).
- [47] Schwab, K. (2018). **Aplicando a Quarta Revolução Industrial**. São Paulo: Edipro.
- [48] Silva, E. F., DOS SANTOS KAWAKAME, M. (2019). Logística 4.0: Desafios e inovações. In: **IX Congresso Brasileiro de Engenharia de Produção**.
- [49] Silva, F. C., Freitag, A. E. B. (2020). A logística como diferencial competitivo nas organizações varejistas. In: **VI Congresso Internacional de Logística e Operações do IFSP-Suzano**.
- [50] Sun, F. a., Zang, W. a., Gravina, R. b., Fortino, G. b. & Li, Y. E. a. (2020). Gait-based identification for elderly users in wearable healthcare systems. **Information Fusion**, v.53, p. 134–144. <https://doi.org/10.1016/j.inffus.2019.06.023>.
- [51] Teixeira, A. L. dá S.; Oliveira, V. C. P. de.; Mendes, P. S.; Lopes, D. P. T.; Rapini, M. S. (2021). Technological and Organizational Innovation for Knowledge-Intensive Business Services in Brazil. **Rev. Bras. Inov.**, Campinas (SP), 20, e021002, p. 1-29.
- [52] Tenório, F. G. (2007). **Tecnologia da Informação Transformando as Organizações e o Trabalho**. FGV Editora.
- [53] Tropic, C. E. Z., Silva, P. P., Dias, A. V. C. (2017). Indústria 4.0: Uma caracterização do sistema de produção. In: **XVII Congresso Latino-Iberoamericano de Gestão Tecnológica**. ALTEC.
- [54] Vilhena, S. F.; Miguel Peixe, A. M. (2021). Ambiente de inovação: uma análise conceitual dos elementos que caracterizam o ambiente inovador. **P2P E INOVAÇÃO**, [S. l.], v. 7, n. 2, p. 207–220. DOI: 10.21721/p2p.2021v7n2.p207-220. Disponível em: <https://revista.ibict.br/p2p/article/view/5492>. Acesso em: 18 jul. (2022).
- [55] Wang, R. a., MA, X. a., Jiang, C. a., YE, Y. a. & Zhang, Y. b. (2020). Heterogeneous information network-based music recommendation system in mobile networks. **Computer Communications**. V. 150, p. 429–437. <https://doi.org/10.1016/j.comcom.2019.12.002>.
- [56] Wu, C. 1,2,3., Zhang, Y. 1,3., Zhang, Y. 1,3., Zhang, W. 1,3., Wang, H. 1,3., Zhang, Y. 1,2,3 & Sun, X. 1,3. (2020). Motion Guided Siamese Trackers for Visual Tracking. Digital Object Identifier 10.1109/ACCESS.2017.DOI.10.1109/ACCESS.2020.2964269, **IEEE Access**. Date of current version December 24.
- [57] Wu, G. a., Miao, Y. a., Zhang, Y. a. & Barnawi, A. b. (2020) Energy efficient for UAV-enabled mobile edge computing networks: Intelligent task prediction and offloading. **Computer Communications**. v.150, p 556–562. <https://doi.org/10.1016/j.comcom.2019.11.037>.
- [58] Wu, Z. 1,4., He, L. 3., Wang, Y. 4., Goh, M. 2. & Ming, X. 5. c (2020). Knowledge recommendation for product development using integrated rough set-information entropy correction. **Journal of Intelligent Manufacturing**. v.31, p. 1559–1578. <https://doi.org/10.1007/s10845-020-01534-9>.
- [59] Yan, X., Liu, Y., & Jia, M. (2020). Multiscale cascading deep belief network for fault identification of rotating machinery under various working conditions. **Knowledge-Based Systems**. v. 193, p. 105484. <https://doi.org/10.1016/j.knsys.2020.105484>
- [60] Yao, Q., Wang, R., Fan, X., Liu, J. & Li, Y. (2020). Multi-class Arrhythmia detection from 12-lead varied-length ECG

- using Attention-based Time-Incremental Convolutional Neural Network. **Information Fusion**, V.53, p. 174–182. <https://doi.org/10.1016/j.inffus.2019.06.024>.
- [61] Yu, L. 1,2,3., Xu, G. 1,2., Wang, Y. 1,2., Zhang, Y. 1,2,3. & Li, F. 1,2. (2020). ADPE: Adaptive Dynamic Projected Embedding on Heterogeneous Information Networks. ADPE on HINs. v. 8, p. 38970-38984. This work is licensed under a Creative Commons Attribution 4.0 License. **For more information**, see <http://creativecommons.org/licenses/by/4.0/>.
- [62] Zhang, Y. et al. (2020). Keywords Extraction with Deep Neural Network Model. **Neurocomputing**, 383, 113-121.
- [63] Zhang, Y. et al. (2020). PGNet: A Part-based Generative Network for 3D Object Reconstruction. **Knowledge-Based Systems**, 194, p. 105574.
- [64] Zhang, Y. et al. (2020). Large-scale multi-label classification using unknown streaming images. *Pattern Recognition*, 99, 107-100.
- [65] Zhang, Z., et al. (2020). Joint Label Prediction Based Semi-Supervised Adaptive Concept Factorization for Robust Data Representation. **IEEE**, v.32(5).
- [66] Zhang, Z., ZHANG, Y., & REN, Y. (2020). Employing neighborhood reduction for alleviating sparsity and cold start problems in user-based collaborative filtering. **Information Retrieval Journal**, v.23, 449-472.
- [67] Zhao, X. L., Hao Xu, W., Xiang Jiang, T., Wang, Y., & NG, MICHAEL K. (2020). Deep Plug-and-Play Prior for Low-Rank Tensor Completion. ArXiv:1905.04449v3 [cs.CV] 4 May.

Quadratic Bounded Knapsack Problem Solving with Particle Swarm Optimization and Golden Eagle Optimization

Yona Eka Pratiwi¹, Firdaus Ubaidillah², Muhammad Fatekurohman³

¹Department of Mathematics, Jember University, Indonesia
Email: yonaep04@gmail.com

²Department of Mathematics, Jember University, Indonesia
Email : firdaus_u@yahoo.com

Received: 22 Jun 2022,

Received in revised form: 15 Jul 2022,

Accepted: 22 July 2022,

Available online: 31 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Knapsack, Optimization, Quadratic Bounded Knapsack, Particle Swarm Optimization, Golden Eagle Optimization

Abstract— Optimization problems are the most interesting problems to discuss in mathematics. Optimization is used to modeling problems in various field to achieve the effectiveness and efficiency of the desired target. One of the optimization problems that are often encountered in everyday life is the selection and packaging of items with limited media or knapsack to get maximum profit. This problem is well-known as knapsack problem. There are various types of knapsack problems, one of them is quadratic bounded knapsack problem. In this paper, the authors proposed a old and new algorithm, which is Particle Swarm Optimization (PSO) and Golden Eagle Optimization (GEO). Furthermore, the implementation of the proposed algorithm, PSO is compared to the GEO. Based on the results of this study, PSO algorithm performs better and produces the best solution than the GEO algorithm on all data used. The advantage obtained by the PSO algorithm is better and in accordance with the knapsack capacity. In addition, although the convergent iteration of the PSO takes longer time than GEO with the same number of iterations, GEO is able to find better solutions faster and able to escape from the local optimum. However, the computation time required by the PSO algorithm is faster than the GEO algorithm.

I. INTRODUCTION

Mathematics is one part of science that has an important role in the world of technology and companies. The rapidity of development, along with technological advances, increases the competition between industries, so companies are required to maximize performance in various fields. One of those fields is optimization problems that are often encountered in everyday life. Companies often experience some difficulties related to packaging of goods with limited media, or known as knapsack, to

transport all goods even though the number of storage media is more than one.

The knapsack problem is about how to choose goods from many choices where each item has its own weight and advantages, taking into account the capacity of the storage media, so that from the selection of these goods the maximum profit is obtained. The knapsack problem consists of several problems, including binary knapsack, bounded knapsack, and unbounded knapsack. The division is based on the pattern of storage of goods with various values and weights. The Binary knapsack problem, or

knapsack 0-1, is a knapsack problem where the items that are inserted into the storage media must be included all (1) or not at all (0). The bounded knapsack problem is a knapsack problem where each item is available as n units and the number of items inserted into the storage media is limited. It can be included in part or in full. The unbounded knapsack problem is a knapsack problem where each item is available in more than one unit and the number of items inserted into the storage media is unlimited [5].

Metaheuristic algorithms that have been used in research on optimization problems are as follows. The Particle Swarm Optimization (PSO) algorithm was first introduced, and their research based on the behavior of a flock of birds or fish in nature. PSO algorithms have been widely applied to almost every area of optimization, computational intelligence and scheduling design applications [3]. Another research is a metaheuristic algorithm approach to solving non-linear equation systems containing complex roots. From the results of the research, the PSO algorithm is considered to have the best accuracy results compared to the Firefly Algorithm and the Cuckoo Search algorithm because the value of its function is getting closer to zero [4].

Another metaheuristic algorithm that has been used is the Golden Eagle Optimization (GEO). The GEO algorithm was first introduced in his nature-inspired research to solve global optimization problems. In this study, the GEO algorithm was tested for its performance and efficiency using 33 problems from different classes. Furthermore, the performance results are compared with six other well-known metaheuristic algorithms through different statistical measures. It is proven that GEO can find global optimal and avoid local optima effectively, this is through intense movement by utilizing the best solution found during iteration [6].

Based on the basic problems that exist in the knapsack, there are several variations of the knapsack problem, which are multi-objective knapsack, multiple constraint knapsack, multiple knapsack, and quadratic knapsack. The multi-objective knapsack problem is a knapsack problem that has more than one objective function to maximize profits. The multiple constraint knapsack problem is a knapsack problem that has more than one constraint to maximize its profits. The multiple knapsack problem has more than one storage medium in which all items must be packed to maximize profits. The last, the quadratic knapsack problem, is a knapsack problem that aims to maximize the objective function in quadratic form for binary and linear capacity constraints [2].

Optimization problems, including knapsack problems, can be solved using several methods or algorithms. One of the algorithms that is often used is the metaheuristic algorithm. Many studies use this algorithm because it is an efficient way to produce a solution. Metaheuristic algorithms are algorithms created to solve optimization problems through approaches that are inspired by nature, such as biology, physics, or animal behavior [1].

Based on the description above, the writer is interested in researching a new problem, the quadratic bounded knapsack with multiple constraints. This problem arises when the objective function is obtained in the form of a quadratic with more than one constraint function and the minimum and maximum limits are known. These problems are adapted to everyday life; for example, the price of goods can change at any time. Research will be carried out using data in the form of simulation data. The data created will be adjusted based on the circumstances real and in accordance with the research problem, namely quadratic bounded knapsack with multiple constraints. In this study, the use of simulation data is intended to be able to represent data types that are more varied and universal.

Furthermore, the interesting thing that will be discussed in this research is how the application of PSO and GEO algorithms in solving quadratic problems bounded knapsack. Researchers would compare the results of the solutions given by the two algorithms to the problem. The purpose of this research is to analyze the application and review the comparison of the PSO and GEO algorithms for solving quadratic bounded knapsack problems.

II. PROBLEM AND ALGORITHM

3.1 Quadratic Bounded Knapsack

The Quadratic bounded knapsack problem with multiple constraints is a variation problem based on the parameters where there is a quantity of goods available of each type and there is more than one constraint. The purpose of the quadratic problem bounded knapsack with multiple constraints is to select a subset of units that have a weight that overall does not exceed the given knapsack capacity (C) so that it can be determined the amount of each type of good by obtaining the total profit maximum and meeting all constraints. The obstacles to this problem are: storage media capacity coverage in the form of weight and space, as well as cost or capital provided. An example of this problem is that it is assumed that each type of good has a minimum or maximum quantity availability limit that must be bought. The limitation has the aim of ensuring the minimum number of items to get maximum profit and do not exceed load capacity or cost.

Some explanations regarding the quadratic bounded knapsack with multiple constraints Among other things, each type of good has a number of goods available (m_j). Advantages of goods are calculated or obtained by multiplying the number of selected types of goods (y_j) by the unit profit (p_{jj}). There is an additional profit for each pair of item types i and j $i < j$ If the number of selected goods types and types of goods are both greater than zero (0), and there are three constraints that must be met, namely weight, volume, and capital.

Based on the description above, the quadratic bounded problem knapsack with multiple constraints can be defined as follows:

Purpose function:

$$\text{Maximize } Z = \sum_{j=1}^n y_j p_{jj} + \sum_{i=1}^{n-1} \sum_{j=i+1}^n t_i t_j p_{ij} \quad (1)$$

Constraint:

$$\sum_{j=1}^n y_j w_j \leq C \quad (2)$$

$$\sum_{j=1}^n y_j v_j \leq S \quad (3)$$

$$\sum_{j=1}^n y_j b_j \leq M \quad (4)$$

$$y_j \in \{0, 1, \dots, m_j\}, j = 1, 2, \dots, n \quad (5)$$

$$t_i \ \& \ t_j = \begin{cases} 0, & \text{if } y_j = 0 \\ 1, & \text{if other} \end{cases} \quad (6)$$

The optimum value of the objective function or total profit (Z), the number of types of goods (n), profit or profit of goods type i and j (p_{ij}). The decision variable is the number of goods type j which is inserted into storage media means if 1 if selected or 0 if not selected (y_i, y_j) the decision variable is the number of items of type i, j that is entered into storage media means if 1 if selected and gets additional profit (t_i, t_j), weight or the weight of the type of goods j (w_j), volume of goods type j with negligible dimensions of goods (v_j), purchase price of goods type j (b_j), the amount of availability of goods type j (m_j), weight capacity of storage media kg unit (C), storage media space capacity unit cm^3 (S), and modal (M).

3.2 Particle Swarm Optimization (PSO)

PSO algorithm there are stochastically generated particles in the search space. Each particle is a candidate solution for the problem which is represented by position, velocity and has a memory to help it remember the previous best position. The PSO algorithm consists of N particles. Each particle swarm has a type of topology that is used to identify several other particles to affect each individual so that it can describe the relationship between particles. Topologies that are often used include global best ($gbest$) and local best ($lbest$). Global best is the best position of the entire population used for fast search,

while local best is the best position of each particle used for slow search [3].

In summary, the steps of the PSO algorithm are presented in the Flowchart in Figure 1 below.

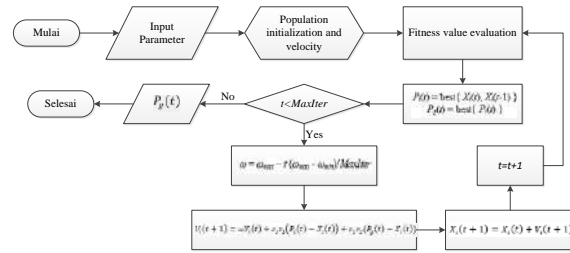


Fig. 1: Scheme of PSO algorithm

3.3 Golden Eagle Optimization (GEO)

The golden eagle is a bird of prey belonging to the Accipitridae family. Golden eagles are professional hunters who can catch prey of all sizes from insects to medium-sized mammals. This bird can fly at a speed of 190 km/h, with excellent eyesight and very strong claws [6].

In summary, the procedure of the Golden Eagle Optimization algorithm is presented in Algorithm 1:

Algorithm 1: Procedure GEO

```

Initialization population
Fitness value evaluation
Initialization of  $p_a$  and  $p_c$ 
for every iteration
    update  $p_a$  and  $p_c$ 
    for every golden eagle
        randomly select prey from population memory
        calculate exploitation vector  $\vec{A}$ 
        if exploitation vector length is not equal to zero
            calculate exploration vector  $\vec{C}$ 
            calculate exploration vector  $\Delta x$ 
            update position
            evaluate the fitness value of the new position
            if fitness is better than the  $i$ -th eagle memory
                update the memory of the  $i$ -eagle with its newest position
        end
    end
end
    
```

III. METHODOLOGY

The researcher used an experimental type of research. This study used simulation data consisting of data on a number of goods, vehicle data, and capital. For the type of product, the goods data used are the product name, minimum and maximum limits, weight, volume, purchase price, selling price, and profit.

The simulation data generation used was then generated using software. A random data generation program was used to generate simulation data, including the minimum limit for the number of goods (lb_j), the maximum limit for the number of goods (ub_j), weight, volume, purchase price, and selling price of goods. The size of the data used was 100 types of goods. This types of goods consisting of several data, which were the number of goods, weight capacity, volume capacity, and capital. The data generation program was written in a script with several rules to adjust the value of each type of data and identify the data according to the quadratic bounded knapsack problem.

The problem in this research will be solved using several steps. The steps used to solve the problem can be seen in Figure 2 below.

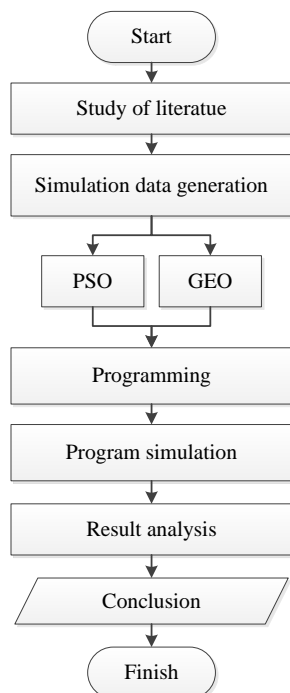


Fig. 2: Scheme of research method

The problem that became the object of this research would be processed using a metaheuristic algorithm that included the Pasrticle Swarm Optimization (PSO) and Golden Eagle Optimization (GEO). The form

of the solution for each metaheuristic algorithm that must be carried out was as follows.

1. Entering research data included the amount of availability of goods (m_j), weight of goods (w_j), volume of goods (v_j), purchase price of goods (b_j) and profit matrix (p), as well as determining the limit of constraints, which include knapsack weight capacity (C), capacity knapsack space (S) and modal (M).
2. Determining the parameter values, which included: population size (N_{pop}), number of iterations (I_{max}), control coefficient to set the local and globak best position influence (c_1, c_2), inertial weights govern the effect of particle velocity iterations before ($\omega_{max}, \omega_{min}$).
3. As a candidate solution, a randomly generated initial value vector ($x_i; 1 \leq i \leq N_{pop}$) was generated at the interval $[0, 1]$. $x_i = [x_{i1}, x_{i2}, \dots, x_{iD}]$ where D is the number of items
4. Changed the value (x) to the vector form of the decision variable (y) as the number of selected items. For the bounded knapsack problem, the conversion of vector to vector can be done using the following equation (7).

$$y_{i,j} = \text{round}(x_{i,j} * m_j), \quad j = 1, 2, \dots, D \quad (7)$$

5. Check the constraints of each candidate solution. The solutions of each knapsack must satisfy the following constraints:

$$\sum_{j=1}^n w_j y_j \leq C, \quad (8)$$

$$\sum_{j=1}^n v_j y_j \leq S, \quad (9)$$

$$\sum_{j=1}^n b_j y_j \leq M, \quad (10)$$

$$y_j \in \{0, 1, \dots, m_j\}, \quad j = 1, 2, \dots, n \quad (11)$$

If from these checks it is found that there are candidate solutions that do not meet the constraints, then the candidate solutions must be penalized using the following equation (12)

$$x_{ik} = \left| x_{ik} - \frac{1}{m_k} \right| \quad (12)$$

Where i was the index of candidate solutions that did not meet the constraints, and k was the index of the type of good that must be reduced (chosen randomly). The penalty step must be repeated until the candidate solution satisfies the constraint.

6. Calculated total profit (objective function). The profit value of each solution was calculated based on the total profit.

$$Z = \sum_{j=1}^n y_j p_{jj} + \sum_{i=1}^{n-1} \sum_{j=i+1}^n t_i t_j p_{ij} \quad (13)$$

where t_i, t_j was zero (0) if no item i, j was selected, and one (1) if any item i, j was selected.

7. Apply PSO and GEO algorithm. Solution representation and evaluation steps are carried out as the PSO and GEO algorithms described above.

After the application of the algorithm was completed, it was continued with the creation and simulation of the program. The experiment was run ten times because the metaheuristic algorithm contains random or stochastic values that allow the algorithm solution to vary. The parameter test of the PSO and GEO algorithms consists of six parameters, namely population size (N_{pop}), control coefficient to set the local and global best position influence (c_1, c_2), inertial weights govern the effect of particle velocity iterations before ($\omega_{max}, \omega_{min}$), and maximum iteration (I_{max}). Next, the program was tested to complete the entire research data. The next step was to analyze the results and draw conclusions.

IV. RESULT AND DISCUSSION

In this section, we will describe the results, the application of the quadratic bounded knapsack problem using simulation data, and the discussion. In the discussion section, it will be explained the influence of parameters, the comparison of PSO and GEO algorithms, and the best results from these algorithms. The solution was carried out using the help of MATLAB software, which was run on a laptop with an Intel (R) Core (TM) i7-4510U @ 2.00GHz CPU, 4GB RAM, and a 64-bit OS. The results of the research on the PSO and GEO algorithms that has been carried out are as follows.

3.1 Tested Parameters

The program for implementing the PSO and GEO algorithms that have been developed was tested on the data that has been collected. In this study, experiments were carried out according to the data taking as many as 100 kinds of goods with the provisions of the weight capacity is 8100 kg, volume capacity is 12100000 cm^3 , and capital of Rp 88.700.000,00. Each parameter value was tested with a population of 100 and a maximum iteration of 1000.

In the parameter test (c_1 and c_2), the value (ω_{max} and ω_{min}) used was 0.9 and 0.1. the simulation program was run ten times for each parameter value used. The best result obtained from the parameter test (c_1 and c_2) was both 1. In the parameter test (ω_{max} and ω_{min}), the value (c_1 and c_2) used was 1 and 1. the simulation program was run ten times for each parameter value used. The best result obtained from the parameter test (ω_{max} and ω_{min}) was 0.9 and 0.5.

3.2 Final Simulation

After the parameter test was completed, a final simulation was carried out to test the PSO and GEO

algorithms in solving 100 types of items quadratic bounded knapsack problem. The value of the parameters used in this final simulation was based on the results of the parameter test, namely the value that was able to produce or improve a better solution. The parameter values include: $N = 100; I_{max} = 1000; c_1 = 1; c_2 = 1; \omega_{max} = 0.9$ and $\omega_{min} = 0.5$. The final simulation results obtained from the best parameter test for each algorithm are presented in Table 1.

Table.1: The best final profit simulations for PSO and GEO

No	PSO		GEO	
	Best profit	Average	Best Profit	Average
1	18997000		17640000	
2	19051000		17881000	
3	18009000		17763000	
4	18916000		17859000	
5	18964000	18801200	17630000	1777800
6	18646000		17780000	
7	18644000		17806000	
8	18898000		17894000	
9	18921000		17810000	
10	18966000		17717000	

Furthermore, from the final simulation results, the average iteration of non-improved solutions was obtained, and the average computation time (execution time) of the program was run ten times. The results of the convergent iteration averages and computational times for the PSO algorithm and the GEO algorithm are presented in Table 2.

Table.1: The simulation of the final convergent iteration and the computing time of the PSO and GEO

No	PSO		GEO	
	Convergent Iteration	Computing Time	Convergent Iteration	Computing Time
1	971	56,1118	987	194,3299
2	815	49,4042	977	154,8863
3	986	24,0281	989	112,1724
4	995	25,7097	975	121,0958
5	867	27,6347	990	118,9619
6	538	24,9073	982	112,7621
7	1000	34,2521	923	120,5419
8	999	25,3172	986	115,1079
9	983	26,4481	987	122,2256
10	973	25,3768	929	117,1695

Based on the results of the final simulation (Table 1) that has been carried out, the best profit was calculated from 100 types of goods that has been determined using the best parameters that have been tested. It can be seen that the existing PSO algorithm has provided a better solution than the new algorithm, whis is GEO. The difference in profits between the PSO and GEO algorithms, it can be seen that the difference in the average in the average profit is RP 1.110.400,00. The comparison of the advantages obtained by the PSO and GEO algorithms can be seen in Figure 2.

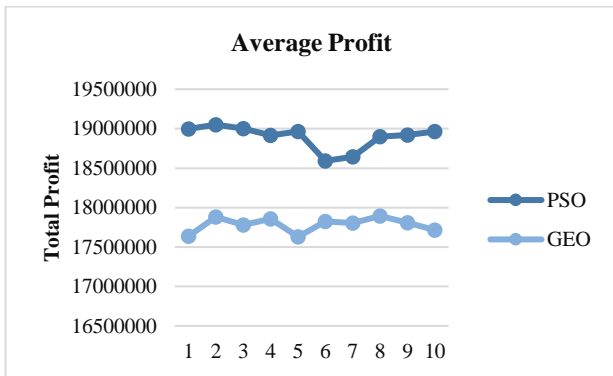


Fig. 3: Graph of the best profits of PSO and GEO

Furthermore, based on the final simulation with the combination of values used (see Table 1), it can be seen that the GEO algorithm is superior in its speed of finding a better solution, meaning that it quickly meets the convergence limit compared to the PSO algorithm. A convergent iteration is an iteration that indicates the algorithm is not able to find a better solution until the iteration reaches the maximum limit specified. The graph of the convergent iteration average can be seen in Figure 3.

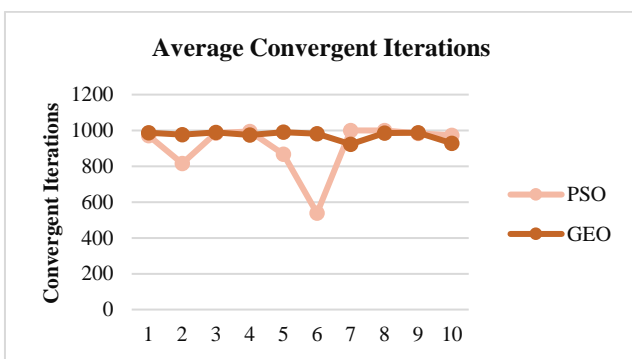


Fig. 4: Convergent iterations of PSO and GEO

Based on the convergent iteration and computational time of the algorithm presented in Table 2, it can be seen that the GEO algorithm is faster to find the convergence limit than the PSO algorithm. The computation time of the GEO algorithm is relatively larger than that of the PSO algorithm along with the larger data size. The graph of the

average computational time of the PSO and GEO algorithms can be seen in Figure 4.

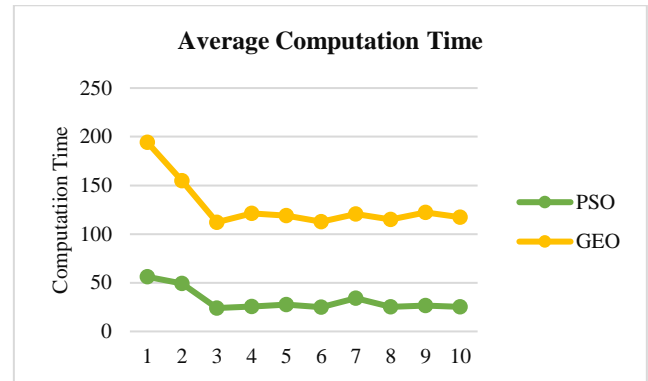


Fig. 5: PSO and GEO computation times

Based on the results of the research that has been conducted, it can be said that the old algorithm is PSO algorithm can compete with the newly discovered algorithm, which is GEO algorithm. Mathematically, the PSO and GEO algorithms can be said to be effective and efficient even though there are shortcomings for each algorithm.

V. CONCLUSION

Based on the results and discussion, it can be concluded that PSO algorithm gives the best profit of Rp 19.051.000,00 and GEO algorithm gives the best profit Rp 17.894.000,00 for every 100 types of items taken. From these two advantage, it can be concluded that the PSO algorithm is superior to the GEO algorithm for the quadratic bounded knapsack problem.

REFERENCES

- [1] Boussaid, I., J. Lepagont dan P. Siarry. 2013. A survey on Optimization Metaheuristics. *Information Sciences* 237: 82-117.
- [2] Clerk Maxwell (1892), *A Treatise on Electricity and Magnetism*, 3rd ed., vol. 2. Oxford: Clarendon, pp.68-73.
- [3] Kellerer, H., D. Pisinger dan U. Pferschy. 2004. *Knapsack Problem*. Berlin: Springer.
- [4] Kennedy, J. dan R. Eberhart. 1995. Particle Swarm Optimization. *Proceedings of ICNN'95: International Conference on Neural Networks*.
- [5] Sari, M. P., A. Kamsyakawuni, A. Riski dan K. A. Santoso. 2020. Metaheuristic algorithm approach to solve non-linear equations system with complex roots. *Soedirman's International Conference on Mathematics and Applied Sciences (SICoMAS)*.
- [6] Supriadi, D. 2016. Perbandingan penyelesaian knapsack problem secara matematika, kriteria greedy dan algoritma greedy. *Indonesian Journal on Computer and Information*

Technologi, 1(2) : 91,
<https://doi.org/10.31294/ijcit.v1i2.1835>

- [6] Yazdi, M. T., A. M. Balani, M. D. Nayeri dan A. Azar. 2021. Golden Eagle Optimizer: A nature-inspired metaheuristic algorithm. *Computers and Industrial Engineering* 152: 107050.

Challenges, Reflections and Possibilities Experienced During the COVID-19 Pandemic Period by an Interdisciplinary Professional Doctorate Course in the State of Pernambuco, Brazil: Experience Report

Telma Lúcia de Araújo Silva¹, Moacyr Cunha Filho², Jorge Luiz Schirmer De Mattos³

¹Doctoral student, Postgraduate Program in Agroecology and Territorial Development, Rural Federal University of Pernambuco (UFRPE) Campus Recife - PE, Brazil

Email: telmalua@hotmail.com

²Teacher, Postgraduate Program in Agroecology and Territorial Development, Rural Federal University of Pernambuco (UFRPE) Campus Recife - PE, Brazil

Email: moacyr.cunhafo@ufrpe.br

³Teacher and Coordinator of the Postgraduate Program in Agroecology and Territorial Development, Rural Federal University of Pernambuco (UFRPE) Campus Recife - PE, Brazil

Email: jorge.mattos@ufrpe.br

Received: 29 Jun 2022,

Received in revised form: 21 Jul 2022,

Accepted: 25 Jul 2022,

Available online: 31 Jul 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license

[\(https://creativecommons.org/licenses/by/4.0/\)](https://creativecommons.org/licenses/by/4.0/).

Keywords— *post-graduation, Covid-19, Remote Learning, Qualitative Research*

Abstract— *The Covid-19 pandemic, which directly impacted the entire education network in a global context, also caused a process of reinvention and emergence of skills that were required in the relationships between students and teachers, from the moment that educational institutions were forced to cancel face-to-face teaching. In this sense, this article socializes and reflects on the experience lived by a team of collaborators and students of the Postgraduate Program course in Agroecology and Territorial Development (PPGADT) of the Federal Rural University of Pernambuco (UFRPE), located in the city of Recife, Pernambuco, Brazil, facing the challenges imposed by the Covid-19 pandemic, elaborated from participant observation conducted between March 2020 and January 2021. This is an interdisciplinary research with a qualitative approach, whose data were collected from bibliographic and documentary research, field diary, and evaluation meetings of the school semester. A systematic survey of the main difficulties faced was carried out, as well as the strategies adopted to perform the practical part of the course, required by the course regulations. The results indicate that the field immersion model proposed by PPGADT, faced with the emergency situation of remote teaching, even with many setbacks presented, is feasible and reproducible. Moreover, it generated significant reflections and learning that act in the transformation of the doctoral students.*

I. INTRODUCTION

In this article, we will report on the strategies and tools adopted to transform practical field classes of a professional doctorate, into an interactive and dynamic remote learning experience, with as little impact as possible for the student team.

The Covid-19 pandemic has created an unprecedented global health crisis. As a measure to contain the infected and the dead, social isolation and quarantine measures were adopted in many countries. As a result of these actions, routine classroom teaching at all levels was initially suspended. Given this scenario, global leaders and teaching professionals were forced to find an alternative to minimize the impacts suffered by the 2020 school year, adopting Emergency Remote Learning, a term used by distance learning scholars to highlight a clear difference between the classic distance learning we have known for several years (HODGES et al., 2020).

Covid-19 is a class of Severe Acute Respiratory Syndrome (SARS) triggered by the SARS-CoV-2 virus (new coronavirus) and is mainly airborne transmitted through respiratory droplets or close contact with infected patients, and even asymptomatic patients. The symptoms are generally dry cough, fatigue, fever, sore throat, headache, fatigue, runny nose, and diarrhea. The disease in its severe state can rapidly progress to acute respiratory distress syndrome (ZHENG et al., 2020).

The World Health Organization issued an alert in January 2020 to the emergence of a new lethal virus that was spreading rapidly across the planet: the Sars-cov-2 virus, causing Covid-19 disease. This virus had its epicenter in the city of Wuhan, China. and was causative of severe respiratory symptoms, which evolved, often to death (WORLD HEALTH ORGANIZATION, 2020). The Covid-19 pandemic was declared on March 11, 2020 by the director-general of the World Health Organization. At that time, there were already more 118,000 cases in 114 countries and 4,200 people killed by the virus worldwide, and thousands more fighting for their lives in the hospital network (PAN-AMERICAN HEALTH ORGANIZATION/World Health Organization AMERICAS, 2020).

As a way to moderate the rate of transmission of the disease, social distancing, social isolation, and paralysis of numerous routine activities, educational activities, religious activities, urban transport services, and leisure were adopted. Only those services considered essential were not stopped. These drastic measures generated serious consequences, especially from the economic and mental health point of view, however, they were necessary precautions to contain the proliferation of

the virus, because the pace of contemporary urban mobility was a determining factor in the rapid spread of the disease, generating strong pressure on the world health system (SPOSITO; GUIMARÃES, 2020).

With the arrival of the Covid-19 pandemic in Brazil, in-person classes were replaced by classes in digital media, through Ordinance No. 343 of March 17, 2020, which authorized this situation, on an exceptional basis, for up to thirty days, extendable until the pandemic situation lasts (BRASIL, 2020a). As time passed, the pandemic situation only worsened, so a new official document was published revoking Ordinance No. 343, and establishing new guidelines for remote teaching. Ordinance No. 544 of June 16, 2020 determines that the educational institutions will be responsible for defining the curricular components that will be replaced; and all academic activities not performed must be replaced in their entirety in order to comply with the course workload (BRASIL, 2020b).

In the midst of the chaotic situation and extreme uncertainty that Brazil and the world were going through, the public authorities faced a duality regarding the return of in-person classes. It was understood that there was not enough security for the return of classes, however, the damage to students and their respective school semesters was already huge. Given this panorama, the President of the Republic sanctioned Law No. 14.040 of August 18, 2020, which establishes exceptional rules to be adopted during the state of public calamity of Covid-19 in the levels of infant, primary, secondary, technical and higher education (BRASIL, 2020c). Months later, through Ordinance No. 1.030 of December 1, 2020, it determines the return of face-to-face classes in higher education institutions that are part of the federal education system as of January 4, 2021 (BRASIL, 2020d), however, in the face of pressure from the growing rates of infected and dead, on December 7, 2020, the Ministry of Education published Ordinance No. 1.038, which determines that the face-to-face return should only occur as of March 1, 2021, provided that all biosafety protocols for facing the Covid-19 pandemic are followed (BRASIL, 2020e).

With a scenario of uncertainties and adaptations, remote classes followed without national guiding guidelines officially established by the Ministry of Education, which only occurred on December 10, 2020, through Resolution CNE/CP No. 2, prepared by the Ministry of Education and the National Education Council, which establishes exceptional educational standards to be adopted by teaching systems, institutions, and school networks, public, private, community, and confessional. This official document was determinant for the remote teaching process to be regulated, monitored, and above all

guided according to technical norms so that all levels and educational institutions could standardize the pedagogical and health protocols applied (BRASIL, 2020f).

The rapid advancement of Covid-19 caused a discomfort in students, families, and teachers, who had little time to adapt to the context of remote learning and the digital platforms. Everyone would need more time to adjust to the aspects proposed by classes in a remote environment (RIBEIRO JUNIOR et al., 2020). However, it is necessary to highlight that "remote teaching has become the primordial foundation to follow up studies and provide favorable circumstances for teaching-learning without shaking the norms of mandatory social distance, preventing the dissemination of the coronavirus [...]" (ANDRADE; MATOS; FERNANDES, 2022, p. 12).

The technological support in teaching has positive results because it allows students to develop analytical and cognitive skills with greater ease. However, online teaching also acts as an obstacle when it comes to hands-on learning as it limits the construction of fundamental skill sets triggered by direct communication and interactions (BROWN, 2017; TARRANT; THIELE, 2014)

Remote teaching is characterized by being non face-to-face, transmitted via a virtual network, radio or TV. This teaching modality can be presented in two ways, with asynchronous and/or synchronous classes, transmitted to students through digital platforms such as Google Classroom, Google Meet, or even through cell phone applications and social networks, enabling the realization of asynchronous activities (CUNHA; SILVA; SILVA, 2020).

The new remote teaching, according to Garcia et al. (2020) can be considered one that establishes the following aspects: 1. communication with the student in real time, synchronous moment, or at different times, asynchronous moment; 2. more intensive use of technological resources, digital or analog, as tools to support teaching and learning; 3. planning with time management in content presentation and time for reading and deepening.

Remote teaching and distance learning are not synonymous, although both are related to the use of digital technology, remote teaching is more comprehensive from the point of view of the use of auxiliary tools that are not necessarily educational. Remote teaching enables the sharing of teaching materials on teaching platforms, however, remote teaching covers several challenges, which involve people, technologies, expertise, and infrastructure (GARCIA et al., 2020).

Asynchronous learning, whose content is made available online, but without live classes, has as its greatest

advantage the flexibility (HRASTINSKI, 2008), on the other hand, some students take a while to adapt to this modality because they feel they need face-to-face guidance from an educational instructor (HUGHES, 2014). Synchronous learning, whose classes are online and in real time, has the benefit of instantaneous interaction between students and collaborators (HRASTINSKI, 2008), however, it is necessary to establish schedules in a very organized way and compatible with the students' routine (HUGHES, 2014).

Even in the face of very well-structured planning, it is possible for eventualities to occur, as in the case of the field immersion of the academic semesters 2020.1 and 2020.2 of the UFRPE doctoral students, who were totally caught by surprise with the arrival of the Covid-19 pandemic. Also according to Cruz (1997, p. 94-95) "not everything, however, can be predicted by the planning of a field research: unforeseen events often occur.

Worldwide, about 1.6 billion students spread over 190 countries were impacted by the consequences caused by Covid-19 (HUSSEIN et al., 2020). The use of online education suddenly generated a great need for the publication of investigative studies, case studies, and experience reports that could share the experiences lived in various parts of the world.

The pandemic was a moment of resilience for many professionals, institutions, and educators, who at the moment of reinventing ways to adapt their routine discovered new skills and innovations. A clear demonstration of this process could be observed in a work conducted by Guedes (2021), who used as a strategy to minimize the lack of field classes, free images made available by Google Earth. Thus, the students of the Hydrography course participated in a virtual field practice, being possible in the identification of natural and artificial features found in the geographic space.

Teixeira and Ribeiro (2020) analyzed the impacts on management and on the school daily life by the context of the Covid-19 pandemic, verifying the limits and the challenges imposed to educators in the teaching and learning process with the use of information and communication technologies (ICTs). The results point out that the emotional health of the teaching staff was greatly impacted for 3 main reasons: the employees' work routine increased considerably; there were occurrences of concern about the need to learn how to use new technologies; and the low capacity to mediate with students in remote teaching.

Another research that reports impacts of the Covid-19 pandemic on education, was the one developed by Andrade; Matos and Fernandes (2022) with basic

education teachers from two schools, being a public school in the state of Pernambuco and a private school in the state of Minas Gerais. This work analyzed the perception of teachers of the area of Nature Sciences regarding the challenges of practical classes with digital tools, and how these contributed positively to the teaching-learning process of students during the pandemic. They concluded that it is necessary to invest in the initial and continued training of these professionals in order to improve their role in the face of the technologies used nowadays, as well as the latent need to apply public policies aimed at this type of training and to encourage the technological support of teachers and students.

In the academic context focused on graduate studies, Silveira and Bastos (2021), portrayed the negative effects generated by the Covid-19 pandemic in the field work of research conducted in 18 graduate programs in Geography in the five regions of Brazil, in the period between March 2020 and February 2021. The results showed that 59.4% of the students interviewed had to completely interrupt their field activities in the first 12 months of the pandemic, and there were extensions of deadlines in cases where adjustments and adaptations were not possible.

In a study conducted at a public university in Dubai, the prospects of distance learning in an undergraduate science course were explored. According to the reports of teachers and students, the major advantages of distance learning were related to flexibility, time efficiency, and adherence of a larger number of students per class. Challenges, on the other hand, were associated with psychosocial well-being, changes in institutional policies, changes in the interface of the learning environment, and challenges with handling new teaching-learning technologies (KHAN; KAMBRIS; ALFALAH, 2022).

Sousa, Moreira and Santos (2021) in an article dealing with the pandemic context, discussed the challenges and impacts of rural education in the municipality of Bom Jesus da Lapa, in the state of Bahia, with the arrival of the Covid-19 pandemic. The results of this research detected precariousness of the teaching work, due to excessive workloads, weakened emotional health, and lack of investments to provide minimum conditions to provide the remote classes.

From a positive perspective of remote teaching during the pandemic, Butler (2022) shares the lived experience of an extension program in Oregon that successfully adapted field-based environmental education programming during the Covid-19 pandemic. The program is based on an interdisciplinary experience that underwent

several successful adaptations during the pandemic. The strategies adopted were based on strict security measures and quarantine, which allowed the meetings to continue to take place in person. It is worth mentioning that this strategy was only possible because the campus is located in a very isolated territory, and all supplies and food were produced there, with no outside contact.

The virtual platforms and the social networks have been instruments of communicative support among the most diverse subjects committed to the teaching-learning process. In view of this, Soares Neto et al. (2021) state that for the quality of remote teaching is intrinsically associated with the skills of handling technologies, and for this to occur effectively, training is needed for the entire team involved: teachers, students and school managers.

The interdisciplinary study that collaborates with the scientific community to clarify the connections between the global pandemic, environmental challenges, and justice and equity is extremely relevant and necessary (RODRIGUES; LOWAN-TRUDEAU, 2021).

Godoi et al. (2020) presents as a result of their research, several challenges encountered by teachers during the period of remote teaching, they are: motivation and commitment of students in the virtual environment; personal difficulties faced by students in their social and family cycle that impact on the pedagogical relationship; institutional charges; flexibility and adaptation regarding the use and learning of technological tools for teaching; emergence of feelings of doubt, insecurity and work overload.

Remote learning throughout 2020 was used as being exceptional and challenging for students and faculty at all levels. In graduate school it was no different. Universities have devised tactics and used technological resources to manage to maintain teaching activities for their postgraduates, and to minimize the impacts. From this perspective, this article intends to describe how the pedagogical practices focused on the practical workload of a professional doctoral course in Brazil were reinvented. In view of the above, the following questions arose: What changes occurred, during the emergency remote teaching period, in order to ensure the practical classes of the PPGADT UFRPE? How was the planning, specifically, of the field immersions readjusted? What reflections were generated from these experiences in remote format? Throughout this article these concerns will be discussed.

In order to answer the research problem, the general objective of this research was to report the experience lived by students of the interdisciplinary doctoral course PPGADT UFRPE, from the conception of

one of the authors of this article about the field immersions during the Covid-19 pandemic.

1.1 Postgraduate Course in Agroecology and Territorial Development – PPGADT

The Professional Doctorate is a Postgraduate modality that aims to promote the integrated articulation of professional training with demanding entities of diverse natures, aiming to improve the effectiveness and efficiency of public and private organizations through problem solving and generation and application of appropriate innovation processes. This modality was created by the Ministry of Education (MEC) and instituted through Ordinance No. 389, of March 23, 2017 (BRASIL, 2017). The Professional Doctorate was regulated by Ordinance No. 60 of 2019, from the Coordination for the Improvement of Higher Level Personnel (CAPES), which says that one of the objectives of these programs is to train doctorate with a profile characterized by autonomy, the ability to generate and transfer technologies and innovative knowledge for unprecedented solutions to problems of high complexity in their field of expertise (BRASIL, 2019).

Brazil currently has 77 graduate programs in the Academic Doctorate modality and only 3 graduate programs in the Professional Doctorate modality, of these, the Graduate Program in Agroecology and Territorial Development (PPGADT) offers the first professional and interdisciplinary doctorate course in Brazil (CAPES, 2022).

The PPGADT was recognized by Ordinance No. 479 of May 13, 2020 and started its activities on August 1, 2019 (BRASIL, 2020g). It has 3 partner and associated educational institutions: the State University of Bahia (UNEB); the Federal Rural University of Pernambuco (UFRPE); and the Federal University of São Francisco Valley (UNIVASF).

The regulations in force establish rules for the organization and operation of the Professional Doctorate in Agroecology and Land Development, in the form of Broad Association of Higher Education Institutions (IES) - UNIVASF, UNEB and UFRPE. According to this regulation, the PPGADT aims at the interdisciplinary formation of professionals from different areas of training that will be capacitated to act in the promotion of Agroecology and Territorial Development, with regards to socio-environmental diversity and the challenges to the agroecological transition and promotion of sustainable agro-food systems and that present insertion in the program's sole area of concentration: Society, Nature, Sociotechnical Innovations and Public Policy. This area of concentration encompasses five research lines: 1. identity,

culture and territorialities; 2. society, economy and construction of knowledge; 3. socioecological transitions and biodiverse productive systems; 4. living with the semi-arid region, socio-technical innovations and development; 5. environment, health and agri-food systems (UNIVASF, 2021). O propósito deste curso é preparar profissionais com visão interdisciplinar e profissionalizante, para atuar no Nordeste e, mais especificamente no semiárido, considerando as suas especificidades e a dívida histórica que o estado e a nação têm com a região. É regimental que todas as disciplinas do PPGADT deverão ser ofertadas no formato teórico e prático; já que a teoria e a prática se complementam e a teoria serve para criticar a prática e vice-versa (UNIVASF, 2021).

The subjects must be taught by at least two professors from different but related areas, taking care to make them theoretical and practical, using technical visits, laboratory classes, videos, field experiences, preparation and execution of projects, stimulating know-how, in attention to the methodological proposal of the course, which is to form an intellectual for work, training for the critical exercise of citizenship, autonomy, emancipation and for political practice, reorganizing the knowledge produced, with gains in all dimensions, by the attitudes, skills and behaviors developed (UNIVASF, 2021).

According to Almeida (1994), the joint action between teachers from different disciplines is interdisciplinary when these professionals appropriate a common object of study, define the indicators to be researched, develop the methodologies and, finally, discuss the results, all together.

The field experience, according to Cruz (1997), is capable of portraying a unique opportunity for direct contact between the researcher and the object of study, which provides the connection with aspects that would improbably be captured only by theoretical research. The field experience promotes the intellectual development of the researcher, which culminates in the enrichment of research and academic tasks. Fieldwork, however, requires prior planning that must include the delimitation of objectives, the elaboration of a script, and a schedule of activities.

The practical workload of the courses is concentrated in a moment called "field immersion". Always at the end of each semester or module, concentrated practical activities are carried out addressing themes related to the courses offered. These "field immersions" are experiences that stimulate the understanding of the person-environment relationship, based on a critical and multi-sensorial training model. That is why there was great concern about how these

immersions would be carried out during the pandemic. The students and teachers could no longer go to the territories to have the experiences, however, the digital tools were able to bring the territories into the homes of all of them.

The field immersions aim to establish a dialogue between disciplines based on the reference of the practical context visited; to favor interdisciplinary connections between students and teachers of the course; and to exercise practical elements in the light of theoretical concepts and reality.

The field immersion is an experience planned to provide multisensory, scientific, and interdisciplinary learning, whose formative pedagogical mediation is reflective. This experience aims, for one or more weeks, to put researchers in contact with the object of study, far from external influence (AZEVEDO; HIGUCHI; BARCELOS, 2009; BOLZAN, 2002; TARDIF, 2011).

The propulsive field classes in the teaching-learning process, while promoting greater flexibility to the teaching staff, enables students a unique learning experience outside the classroom and the classic teaching methods. They also enable the formation of ethical citizens with the territory where they live, while they are important teaching strategies that through problematization and interdisciplinarity promote reflection (CAMPOS, 2012; KRASILCHIK, 2008).

II. METHODOLOGY

This is a qualitative, descriptive, bibliographic and documental research whose approach has an interdisciplinary character and was developed between March 2020 and July 2022. To achieve the objectives, three phases of study were outlined. The first phase constituted the theoretical, bibliographical, and documental survey, searching for classical and contemporary theoretical references with the objective of substantiating this investigation. The bibliographical survey was carried out in scientific databases, such as Scielo and Web of Science, using the following keywords: "field class" AND "remote teaching" AND "Covid-19". The documentary and institutional research was done by analyzing official documents published between January 2020 and January 2021 by Brazilian government agencies, UFRPE and PPGADT-UFRPE, about the Covid-19 pandemic. In the analysis of the documents, the lesson plans of the courses, which were shared with the students, also served as support for our study. It is worth mentioning that the documents corresponding to the years 2020 - 2021 were verified, as this corresponds to the period when the field immersions 2020.1 and 2020.2 took place, both in virtual format. Subsequently, all the activities developed

during the remote field immersions were described in detail, based on the reports collected from the field diary and the reports from the semester's evaluation meetings. Finally, the last stage corresponded to the interpretation of the facts brought forward, as well as to expose reflections generated by the experiences.

This experience report was developed by a team involving a student, a professor and the coordinator, all belonging to the PPGADT UFRPE, after previous authorization from the course coordination. The project of this research was not submitted to the Research Ethics Committee because it is a report based on the experience of one of the authors, with the consent of the coordination of the doctoral program and guarantees of confidentiality of the data and all those involved.

This research will be guided by the concept of Daltro and Faria (2019), which defines Experience Report as being a category of study belonging to qualitative research, which, although it contemplates the descriptive universe, is considered much more comprehensive. It is an instrument used to describe the experiences under analysis, sustaining their uniqueness, built from historical, critical, theoretical, and contextual elements, from the perspective of those who report the facts. It is advisable that at least one of the authors is a participant in the context under study, and should present as final considerations, the lessons learned.

This research works the data in a qualitative way, establishing subjective relationships and experimentation. Qualitative research, according to Dezin and Lincoln (2006), works with an interpretive approach to the world, and its researchers study objects in their natural environments, seeking to understand the various phenomena through the vision of the actors involved.

Research is classified, according to Gil (2002), according to its general objectives and based on the technical procedures used. This research is descriptive, as to the general objectives, and bibliographic and documental, as to the methodological procedures applied. Descriptive research is characterized by the detailed description of "a certain population or phenomenon, or the establishment of relations between variables. [...] and one of its most significant characteristics is the use of standardized techniques for data collection, such as the questionnaire and systematic observation" (GIL, 2002, p. 42). "The bibliographical research is developed based on already elaborated material, consisting mainly of books and scientific articles" (GIL, 2002, p. 44). Finally, documentary research are those "elaborated based on documents, the documentary research is based on materials that have not yet received an analytical treatment" (GIL,

2002, p. 45). This category includes documents published by public agencies, ministerial orders, memoranda, bulletins, among others.

Andrade (2002) points out that descriptive research focuses on observing, recording, analyzing, classifying and interpreting the facts, without being influenced by the researcher.

The documentary research, according to Sá-Silva, Almeida e Guindani (2009, p. 5), "is a procedure that uses methods and techniques for the apprehension, understanding and analysis of documents of the most varied types".

The use of field diaries as a research tool enables the detailed description of the study procedures, the steps taken during the activities, as well as possible adaptations made during the research development. This instrument also serves as a personal narrative of the researcher's impressions about the object of study. The textual narrative present in the field diary brings the actions, desires, advances, obstacles encountered, knowledge acquired along the trajectory and proposals for intervention (PEZZATO; L'ABBATE, 2011).

Oliveira (2014) highlights the field diary as a record capable of capturing the subtleties involved in data collection, perception of expressions of emotion, among other intimate details, which even in recordings are not possible to capture.

According to Weber (2009) the field diary is an important instrument for self-analysis of the researcher, not being a complete text, being a fragmented material for research analysis, and may contain excerpts that will not be relevant in scientific publications, but that within a holistic view of data analysis, should be considered.

Kroef, Gavillon and Ramm (2020, p. 464) establish that the use of the field diary "participates in the production of the researcher's attention in its insertion in the field-theme, so that the memories, habits and the insertion of the researcher in everyday contexts also compose the research, taken as a political act that intervenes in reality".

In the field research process, "it is of utmost importance the use of the field diary as an instrument in which are inserted the descriptions, sensations, notes of what happened, what was seen and heard" (SANTOS; RODRIGUES; CASTELAR, 2022, p. 77).

III. RESULTS AND DISCUSSION

From the records collected from the field diary and the interpretations generated by the semester evaluation

meetings, data analysis related to the daily experience observed by one of the authors were prepared. The records sought to bring together the theoretical knowledge of the disciplines and the practical part, thus, the results and discussions presented in this article show the reflections on the challenges posed by the Covid-19 pandemic in the development of the practical activities of a doctoral course in Brazil, guided by the theoretical concepts already mentioned.

3.1 Timeline of events

The timeline presented below, details the series of events, including the stoppage of face-to-face meetings, which triggered the beginnings of remote classes and field immersions in remote format, which started 6 months after all face-to-face classes were suspended for students all over Brazil. Field immersion 2020.1, was supposed to take place in the month of May 2020, while field immersion 2020.2, in the month of September 2020, however, they took place in September/October 2020 and January 2021, respectively.

The Timeline of events leading up to the start of the remote field immersions are as follows:

- Official Note published on the UFRPE website suspending the Academic Calendar until March 31, with possible extension according to future evaluations. Published on March 16, 2020 by UFRPE's Management and the Teaching, Research and Extension Council (CEPE);
- Publication of Ordinance No. 343, which provides for the replacement of face-to-face classes with classes in digital media for the duration of the pandemic situation of the New Coronavirus - Covid-19. Published on March 17, 2020 by the Ministry of Education;
- Publication of Ordinance No. 345, which amends MEC Ordinance No. 343, of March 17, 2020. Published on March 19, 2020 by the Ministry of Education;
- Publication of the Official Note published on the UFRPE website suspending the Academic Calendar indefinitely. Published on March 27, 2020 by the UFRPE's Management and the Teaching, Research and Extension Council (CEPE);
- Publication of Ordinance No. 473, which extends the deadline provided in § 1 of art. 1 of Ordinance No. 343, March 17, 2020. Published on May 12, 2020 by the Ministry of Education;
- Publication of Ordinance No. 544, which provides for the replacement of face-to-face

classes by classes in digital media, for the duration of the pandemic situation of the new coronavirus - Covid-19, and revokes MEC Ordinances No. 343, of March 17, 2020, No. 345, of March 19, 2020, and No. 473, of May 12, 2020. Published on June 16, 2020 by the Ministry of Education;

- Publication of Law No. 14,040, establishing exceptional educational standards to be adopted during the state of public calamity recognized by Legislative Decree No. 6, of March 20, 2020; and amending Law No. 11,947, of June 16, 2009. Published on August 18, 2020 by the Acts of the Legislative Branch;
- September 24, 2020: First elective day of the 2020.1 remote field immersion;
- Publication of Ordinance No. 1,030, which provides for the return to face-to-face classes and the exceptional nature of the use of digital educational resources for the completion of the workload of teaching activities for the duration of the pandemic situation of the new coronavirus - Covid-19. Published on December 1st, 2020 by the Ministry of Education;
- Publication of Ordinance No. 1.038, amending MEC Ordinance No. 544 of June 16, 2020, which provides for the substitution of face-to-face classes by classes in digital media, for the duration of the pandemic situation of the new coronavirus - Covid-19, and MEC Ordinance No. 1.030 of December 1, 2020. Published on December 7, 2020 by the Ministry of Education;
- Publication of Resolution CNE/CP No. 2, establishing National Guiding Guidelines for the implementation of the provisions of Law No. 14.040, of August 18, 2020, which establishes exceptional educational standards to be adopted by education systems, institutions and school networks, public, private, community and confessional, during the state of calamity recognized by Legislative Decree No. 6, of March 20, 2020. Published on December 10, 2020 by the Ministry of Education and the National Education Council;
- January 21, 2021: First elective day of the 2020.2 remote field immersion.

The documentary analysis presented here is the result of a data survey that took place between March 2020 and January 2021, in the UFRPE Portal, Diário Oficial da

União, official PPGADT website and official documents sent to the email box of the students.

3.2 Remote field classes: transition from face-to-face teaching to distance learning

Due to the urgency of the transition to distance learning, the course coordinators dialogued together to promote the practical workload, characterized by field immersion, in a fully virtual version. To this end, all in-person evaluation processes that could not be adapted to distance learning were removed.

The field immersions started to be planned to take place remotely. Contact was established with leaders active in their territories so that they could participate in the field immersions, sharing their experiences and life trajectories.

It is undeniable that Information and Communication Technologies (ICTs) have contributed a lot to the advance and success of remote learning. Google meet is a video communication service developed by Google, and was one of the tools used for the meetings of the activities developed by PPGADT. Another tool used was Youtube, a video sharing platform, which was widely used by teachers to enrich their asynchronous classes. WhatsApp, an instant messaging and voice call application for cell phones, optimized a lot the communication and sharing of important notices. The creation of groups on WhatsApp, related to each subject, facilitated quick access to the teaching staff.

Some strategies were adopted to increase the involvement between students and professors and guests. The microphones and webcams were facilitators of the learning process, without a doubt, the chats, however, exercised a primordial role during the sessions, since, at any moment a question, reflection, or compliment could be made to the speaker who was presenting, without any interruption and prejudice of the presentation. The chat was also available in a private format, when the content of the conversation was not shared with the whole group, but only accessible to the student and the session facilitator, so that questions and comments could be made anonymously.

Synchronous classes had the advantage of contact with the faculty in real time. The preference for synchronous sessions was quite evident, however, the need to provide recordings of these live sessions was imperative. The recordings were important because some students constantly had problems with internet connection on rainy days and instability due to the use of many people at home, so the recordings served as support in missed passages and to review the content explained before the evaluations.

The concentration aspect during remote teaching was greatly affected as everyone had to deal with the many distractions around them, such as the high noise levels generated by children, lack of privacy, daily household responsibilities, and poor quality internet and insufficient bandwidth. With everyone at home, working and studying remotely, the internet service has become overloaded, causing connection drops and instability. As a result, at many moments the class was asked to turn off the cameras, in order to make the connection lighter and the class not be interrupted. This impacted the interaction of the class and caused a low rapport, no doubt.

Regarding announcements, materials posted by teachers and activities, they were always posted through Google Classroom, which according to Schiehl and Gasparini (2016) is a virtual classroom environment where there is interaction between teachers and students. In this virtual space, the teacher organizes and manages his class, makes his materials available, and monitors the students through activities posted there. All the information recorded by the teacher concerning a certain subject is sent to the students, minimizing the big bottleneck that is communication failure. In Google Classroom, all the recordings of the lectures that took place via Google Meet were made available, so that any student who had experienced internet instability could follow the entire recording, with no harm to their learning. It was also the environment where the teachers shared the slides whose guests had used in their presentations, and all the materials of the asynchronous moments.

Most of the assessment activities were distributed to the students through Google Forms, and were thoroughly described there in Google Classroom, with their given deadlines and place to upload the file.

With so many abrupt changes in the school calendar, there was a substitution of materials to be used for the implementation of the new curricular proposal, and the evaluation systems adopted by the teachers also changed.

All the activities of the semester, teaching activities, including the field immersions, were evaluated by the teaching staff and the students. On an individual basis, the coordination team sent feedback, criticism, and evaluation forms to all the students, and always at the end of the semester there was a collective moment between teachers, students, and coordination so that everyone could explain, reflect, and suggest improvements in the teaching-learning process. The students' participation in the field immersion activities was monitored by means of an online attendance list on Google Forms, whose link to be filled in was only available at the end of the teaching activities.

Each student should fill in his or her own attendance list with personal and academic data.

During the evaluation meetings of the semester, many difficulties encountered by teachers and students during the emergency regime of non presence classes were reported, among which we can highlight insufficient mastery of technological tools; few or no skills with digital technologies; insufficient quantities of devices for the use of all the people in the home environment; setbacks provided by digital resources, such as battery discharge, defective battery charger, and problems with the internet connection; absence of a satisfactory environment to make the video calls and record the classes; change in the work and study schedule, becoming more exhausting and stressful; difficulties of concentration during virtual meetings; lack of control over the work demands via WhatsApp making it more difficult or not having the separation between work routine and personal routine.

There was an excess of demands regarding the volume of evaluative activities directed to the students, which generated an atmosphere of discontent and anxiety, which was increased by the situation of confinement to which everyone was exposed. However, this moment of adversity experienced in the teaching/learning process of the remote format was understood by the collective, since it was a moment of adaptation that everyone was going through, especially the teaching staff in their evaluative planning.

The field immersions under analysis in this article are those referring to the academic year 2020, which occurred in 3 editions, two in the academic semester 2020.1 and one in the academic semester 2020.2. Each edition was organized in 3 days, addressing different themes and the dynamics of each day was divided into 4 moments, two synchronous and two asynchronous, as can be seen in Table 2. All contact between students, faculty and guests was exclusively virtual, through meetings provided by the video communication platform, Google Meet.

Table 1. Distribution of daily activities during the field immersions

Time	Dynamic of the day
8:00 am to 10:00 am	Readings and videos - asynchronous moment
10:00 am to 12:00 pm	Lectures and conversations with the guests - Synchronous moment
2:00 pm to 4:00 pm	Moment of individual reflection on the theme from the script of guiding questions - Asynchronous moment
4:00 pm to	Collective debate about the experiences

6:00 pm	and immersion of the day - Synchronous moment
---------	---

Source: Prepared by the authors

At the end of each field immersion, the students should send to the teaching staff, as an evaluation requirement, a report of reflections about the experiences lived during the days of practical classes. To this end, the teachers previously sent a script of guiding questions to guide the construction of the report.

3.3 Field Immersion 2020.1 - during the pandemic

The practical experiences related to the disciplines of module I of semester 2020.1 was entitled "Field immersion in the Sertão do Pajeú", since the culminating activities between the disciplines and the practice were developed with elements, leaders and experiences inserted in the territory of Sertão do Pajeú, a semi-arid region located in the State of Pernambuco.

In the first module of the 2020.1 semester, 3 courses were offered: Self-Management and social and Entrepreneurship; Epistemology and Methodology of Interdisciplinary Research; and Social History of the Semi-Arid Peasantry, under the guidance of 7 professors.

The 2020.1 field immersion of module I took place on September 24th, 25th, and 26th, 2020, and had the objective of deepening the knowledge experienced in the three disciplines of the first module, establishing relations of the construction process of inter and transdisciplinary knowledge in the experiences and knowledge shared by the guests. The themes worked in this field immersion were: Women, Agroecology and Networks; Organizational Processes, Agroecology and Territorial Development; and Traditional Communities, Agroecology and the Semi-arid.

On September 24, 2020, in the morning, we received 3 female leaders linked to the theme "Women, Agroecology and Networks". The first invited to share her experiences was a representative of the Pajeú Network of Women Producers.

The Network of Women Producers of Pajeú operates in 11 municipalities of the state of Pernambuco and mobilizes rural women to build their autonomy through entrepreneurship. The network is formed by productive groups that produce individually, but for a collective benefit. It is not a project that deals only with the economic aspect, it is a space that aims to build women's participative democracy so that they can mobilize other women from oppressive contexts to fight for their rights, have a voice, and contribute to the end of gender inequalities.

The exchange of experiences generated from this network provides the formation of critical and interdisciplinary thinking because it involves the productive, political, and especially environmental dimensions, when respect for natural resources is shared, the implementation of the living pharmacy and the planting of seedlings in their productive capitals. This knowledge is multiplied through workshops and training held with the women who lead the groups, while empowering and strengthening these women who still come from a sertanejo culture that is mostly machista patriarchal, which cooperates with the condition of oppression, submission, inequality, and domestic violence.

The second guest of the morning of September 24, 2020, was a leader of a feminist non-governmental organization, which for more than 30 years has strengthened gender equality in the Northeast region.

The organization's main ideological pillars are: feminist educational practices, increased political participation of women, feminist technical assistance, self-organization, economic autonomy of women, problematization of the division of domestic labor, and highlights the importance of women in the reproduction of life.

Its entire work philosophy is linked to sustainability, and brings to the debates the problems inserted in the territories where Pajeú operates, such as the pollution of the Pajeú river, silting up, deforestation of the riparian forests and the use of pesticides.

This NGO emphasizes in its philosophy the agroecology based on racial equality, feminism and solidarity economy. It managed, through its strong performance, to contribute to the creation of the Network of Women Producers of Pajeú.

And finally, the last guest of the 24th was a UFRPE professor, active in projects related to the feminist economy, and sexual and reproductive rights of rural women. This guest contributes to the Interdisciplinary Network of Academic Women of the Semi-Arid.

All the experiences lived from the reports of the three guests of the first day, reflect the importance of female emancipation in the deconstruction and perpetuation of toxic masculinity, patriarchy (which, by the way, feeds fascism), and machismo. And above all, how the valorization of reproductive work is still hidden. But little by little, agroecology comes as a science to break with these depreciative hierarchizations, teaching reciprocity as a modifying element of a system that is still eminently patriarchal.

On September 25, in the morning we received all the contributions from the reports of a representative of an Association for Sustainable Rural Development, active in two municipalities in the state of Pernambuco. The association, with years of history, gave origin to a cooperative that focuses on organic and agroecological production. This association counts, for the success of its work, on the mobilization and training of farmers for the agroecological transition, reinforcing its importance for the maintenance of the systems. It also highlights the insertion of rural youth in the transmission of this interdisciplinary knowledge and their performance in the process of environmental and cultural education, in the agroecological perspective.

To conclude September 25, we received one of the leaders of a network of social enterprises distributed throughout Brazil for the marketing of organic products from agrarian reform farmers. This network is a space for gender equality, political expression and representation of an agriculture that generates products that carry with them a baggage of struggle, resistance and traditional knowledge.

The debate and the experiences brought on September 25 reinforced the thesis that the peasantry and the peasant rationality have not been extinguished, they have only been remodeled to be inserted in a world today prepared for reflections, questionings, and problematizations.

On the last day of the field immersion, September 26th, experiences and agroecological knowledge were shared with representatives of traditional communities of the Brazilian semiarid region. First, the experiences of a quilombola community leader; then, we listened to two indigenous members of different peoples, bringing their experiences.

It was possible to verify how the cultural richness that traditional peoples carry, and how peasant rationality still strongly persists in quilombola and indigenous communities. The respect for natural resources is alive and nourished by the worldview, which provides the belonging that these people have to their territories.

The dialogue, no doubt, generates empowerment and rescue of the identity of these peoples. That is why agroecology comes as a science that works in a subjective and respectful way, involving education, ancestrality, beliefs, spirituality, and traditional knowledge. Quite different from what Cartesian science proposes in terms of its rationality.

The 2020.1 field immersion of module II was held on October 22, 23, and 24, 2020, and aimed to connect the experiences brought from the territories with the knowledge experienced in the 3 disciplines of the second

module: Ecologically Based Agriculture and Markets; Plants in the Treatment of Health and the Environment, and; Information and Communication Technology Applied to Territorial Development. The subjects in this module were supervised by 7 professors from interdisciplinary areas. The themes worked in this field immersion were: Information and Communication Technologies in Organic Food Certification; Traditional Knowledge in Health; and Agroecological Fairs and Agro-Shops.

On the morning of October 22, 2020, we listened to the experience reports of two representatives that work in the area of computerized systems for the management of organic certification data. The first one invited to share his experiences was a professor from a public Federal University in the Northeast of Brazil.

The experience reported by the professor reinforces the importance of connecting information and communication technologies (ICTs) with the development of traditional communities. The development of easy-to-understand applications built from the needs reported by the family farmers themselves, generates a tool for managing and registering the data that permeates that rural property and facilitates the bureaucratic processes of distribution of agro-ecological production, such as organic certification.

These applications and platforms developed support the registration of inputs, outputs, pest and disease records throughout the year, and all the data generated facilitates the management of management and inputs within the production units.

ICTs also favor the systematization of agroecological production in terms of the farmer's financial management, since the applications are able to register what is produced and what is sold, presenting possible surpluses or productive demands.

Another advantage linked to ICTs is that they are able to generate reports that can be shared among all the members of an association, cooperative, advisory NGOs, agroecological organic fairs, or sales stores, in order to guarantee public transparency in the territory, give visibility to the experiences of the state, and, foster the social credibility of the work performed in the collective.

Data science and statistics have revolutionized predictability in the peasantry, and can indeed act to benefit agroecology and territorial development. Technology cannot be characterized as beneficial or harmful, the question to be analyzed is to whom it belongs and how it will be applied.

The second guest of the morning of October 22, 2020, was a leader of a network that organizes producing

families into associations, cooperatives or informal groups, focused on participatory certification of organic products.

In this participative certification process, the network uses a Software developed in a participative way, from its design to the information fields. It was implemented to manage all aspects of organic production, and this information management tool has greatly optimized the management of data needed for the certification process, especially in terms of the size of the network in terms of number of collaborators.

Among the obstacles encountered during the process of using the tool is the farmers' difficulty with basic computer skills, which hampers the use of the tool in aspects such as scanning documents that usually remain illegible, difficulties for farmers in filling out forms and documents, and the lack of internet access. Another bottleneck is the lack of dialogue with the leaders of the networks in order to think in a participatory way improvements in the software so that it becomes more and more objective for users.

On the evening of October 22, 2020, we received two more guests to compose the immersion debate, at this time the experiences were connected with the theme of plants in health treatment. The first guest of the evening was a professor specialized in the area, who presented the current scenario of bioactive plants in Brazil and in the world, as well as the main researches that are being developed in this line. The second guest of the evening was a Doctor in Biotechnology, who brought knowledge about fermented beverages using bioactive plant species.

The factors that influence the concentration of active ingredients in a plant species were discussed, such as: plant age, variation of active ingredients in different parts of the plant, soil type, rainfall, sun exposure, and type of management used in cultivation.

The evening's debate brought the reflection that phytotherapy is a very important front to boost agroecology, because it rescues the use of bioactive plants in healing, respects and perpetuates the diversity of medicinal species, and proposes the promotion of health with agroecological bases.

On October 23, 2020, in the morning we received all the contributions from the reports of an Indigenous representative and a Quilombola representative.

The first guest of the morning talked about the insertion of traditional knowledge in the health of her community, through the cultivation of native medicinal plants and the transmission of traditional knowledge within the families.

Then, on the same morning of October 23rd, there was a continuation of the discussion about how popular knowledge is being preserved in traditional communities. The intervention of allopathic medicine in the territories of traditional peoples was also debated, as was the polemic of the prohibition of the use of "garrafadas", which, according to traditional medicine, are not concentrated herbal medicines, but toxic ones.

The afternoon of October 23, 2020 generated debates around the theme of the advances and setbacks brought by ICTs in the territories of indigenous peoples. For this moment, we had the contributions of the reports of 3 indigenous representatives who work with documentary production in the social bias, empowering the experiences and memories of indigenous peoples. It brings up the debate about the perspective of the audiovisual content produced by the Indians themselves, and not by third parties, which many times mischaracterize their cultural reality.

The production of this content by the members of the indigenous communities themselves guarantees the demythification of the folkloric image that the indigenous people carry in the history told by Brazilian textbooks, which places them in a caricatured position.

On the last day of the field immersion, October 24, 2020, in the morning we received three guests who shared their experiences with the use of plants to treat the environment, the well-known natural defensive agents.

We first received a professor who exercises in his teaching practices the culmination between chemistry and agroecology.

The guests brought the problem of the decline of cashew trees due to anthropic and climatic issues in the municipality where they live and the agroecological intervention used by researchers from a nitrogen-based extract from the leaf of Algarrobo as a way to combat the white fly on cashew trees. As the greatest products of this project, there was the social and economic rescue of the cashew culture, and the strengthening of the premise that empirical and technical knowledge should go together.

As the last guest of the morning of October 24, 2020, we had the contributions of a representative of organic cotton production, who reinforced the importance of agroecological cotton production in his region, as a form of economic growth of his territory, social empowerment, and sustainable production. He was also a professional who trained in an educational institution and returned to his territory to apply all the knowledge acquired.

The reflection comes from the importance of integration between different sciences for a common good,

exercising interdisciplinarity, as could be seen in this experience report, where there was the union of a technical and bench science, chemistry, with the needs coming from a field science, agronomy.

To close the field immersion, in the afternoon of the same day, we received three guests to talk about the context of markets and commercialization of ecologically based agriculture, and the experience of TICS in the promotion of agroecology.

At first we received the experience of a network that commercializes all the agroecological production from agrarian reform settlements, then we had the reports about the production of podcasts and content on youtube of ecological bias, and finally, we received a specialist, who reported the challenges faced in mobilizing the network of agroecological fairs and agro-stores in Pernambuco and how ICTs contributed in this pandemic period.

3.4 Field Immersion 2020.2 - during the pandemic

The practical experiences related to the disciplines of modules I and II of semester 2020.2 were entitled "Field immersion in the Sertões do São Francisco", since the culminating activities between disciplines and practice were developed with elements, leaders and experiences inserted in this territory.

The field immersion was related to the mandatory discipline of modules I and II of the academic semester 2020.2: Agroecological transition and agrifood systems, under the guidance of 5 professors of the PPGADT.

The 2020.2 field immersion was held quite late in its academic calendar and occurred between January 21 and 23, 2021. This practical stage of the semester was very important for us to establish the connections between the theoretical knowledge discussed in module II and the knowledge shared by the leaders of the territories and prominent social actors in this theme. The territory chosen for the immersion was one of the hinterlands inserted in the territory of the São Francisco river basin, a stretch of the semi-arid region of the state of Pernambuco.

On January 21, 2021, in the morning, we received as a guest, a professor from a federal university in the Northeast of Brazil, who presented a lecture entitled "Impacts of the transposition of the São Francisco River in the water destination communities: the case of the State of Paraíba", which lasted 30 minutes and generated many reflections and concerns for the debate that took place afterwards.

Through this lecture, it was possible to learn how the transposition process occurred in the state of Paraíba involving social movements, from a critical theoretical

debate about the socio-environmental impacts of public policies in the Northeastern semi-arid region.

It was verified that the low prices of labor here in the Northeastern territory were determinant for the emergence of the label of the Northeast as "labor for the Brazilian industrialization process", bringing submission of the international capital that entered Brazil.

It was possible to reflect on the public policies created for the northeast and how they were formed under the premise that "we need water". The crisis was intensified by the process of emigration from the backlands of the Northeast in the 1980s, by the cotton crisis.

It is inferred that drought becomes drought because there are no organized structures in the Northeast to coexist with drought, causing social chaos.

In 2003 the debate about the water deficit in the Northeast grew stronger and the first rumors about the transposition of the São Francisco River emerged.

The debate brought to the surface the discussion about the environmental impacts existing along the channels. The transposition interconnects basins that make these waters come from the agribusiness regions of Bahia of soy, cotton, and mineral extraction, so they are waters contaminated with agrochemicals, synthetic fertilizers and heavy metals.

The reflection about this presentation is that it is necessary to transform these transposition channels into agro-ecological development models for the Semi-Arid, composing recovery of degraded areas, socially just, inclusive, and with active social technologies for family agriculture. There must be a struggle for agrarian reform and guarantee that the lands of the sertão are at the service of the people of the sertão.

The transposition emerged as a project of inclusion and articulation of the Semi-Arid, but contradictorily a phenomenon of land concentration tendency, incentive to soy production, fish farming, among other problems emerged. Economic exploitation around the lands that border the canals.

On January 21, 2021, in the afternoon shift, we received a guest who presented the lecture entitled "Impact of the transposition of the São Francisco River in the communities of origin of the waters: the case of the Sub-Médio São Francisco", which lasted 35 minutes and brought important points for further debate.

The theme of the transposition occupied between 2005 and 2015 a stronger debate, and with this debate emerged a front of mobilization and popular resistance with a religious and ecological background against the transposition.

It is of utmost importance to problematize the transposition of the São Francisco River, which is a work of public over-investment and unsustainable from an ecological and economic point of view, because it contaminates the soil and the water with agrochemicals, and generates poor quality jobs, degrading and conflictive social situations.

With the work, there was an increase in the incidences of erosion, silting, deforestation of the riparian forest, and pollution by rural, urban and industrial waste in the São Francisco River, according to data brought by environmental impact reports.

The transposition brings the discussion that the problem in the Northeast is not the lack of water, but the access to water, which is badly distributed and badly used, that is, there is a bad management of water. This can be seen in the people who live on the banks of the river and yet live in shortage of water and water treatment.

It is necessary to have strategies for coexistence with the semi-arid region and its caatinga biome, always knowing how to get the best out of this climate and biome so rich in biodiversity.

The semi-arid does not need a transposition project, but an efficient and fair management of the existing water resources. Only the organized civil society as social movements and traditional communities can stop the project and demand the reorientation of practices towards true sustainability.

It is worth noting that the pandemic came as a block to the forces of resistance to the movement against the current and future impacts of the transposition, since there is no way to make public mobilizations in a physical way.

On January 22, 2021, in the morning, a lecture was given by a leader who has been working for more than 30 years with family agriculture in agroecological transition projects. The lecture entitled "Food Sovereignty, Agrifood Systems, and Irrigated Perimeters" was presented, and lasted 20 minutes.

In his presentation were highlighted the main social and environmental impacts generated by the irrigated perimeters of the San Francisco River: High production of fruit for export; exploitative wage labor with the degradation of health; contamination of soil and water; soil erosion; coal mining, with 20% of the mineral activity of the country in this perimeter; displacement of communities to build dams; and installation of wind farms and solar energy that impact communities of deep pasture in Bahia.

Food sovereignty is not established in this perimeter since the entire production of fruit farming is exported. As

a consequence, there is exclusion and poverty in family farming in this region.

Also on January 22, 2021, in the morning, we received a rural extensionist to contribute to the day's theme. This guest started her work out of discomfort with the issue of social inequality and degradation in the territories where she worked. So she started to coordinate agroecological projects.

She reports that it was very difficult and there was resistance from her team, but with periodic training of the team she managed to overcome the resistance. As a first action he implemented agroecological fairs in the region of the São Francisco valley and changed his perception as an agronomist trained in conventional agriculture.

On January 23, 2021, in the morning, we received 3 leaders of associations of the São Francisco region to contribute to the lecture entitled "Conservation and Agrobiodiversity in the Sertão do São Francisco", which lasted 40 minutes

The first to bring her experience was a leader of an association of women family farmers from a farm located near Petrolina-Pe.

This association works with agro-extractivism of umbu, and has an agro-industry that is under construction and currently produces umbu pulp, jam, liqueur, jelly, and compote.

The association does not have a sanitary surveillance seal, so they do not export. They point out that the absence of a seal makes it difficult to sell, and many times they produce and cannot sell. All transportation costs are on their own.

The second person invited to contribute was a member of an association located in the state of Alagoas.

This association has been in existence for 9 years and was created with the objective of training women farmers in the processing and extraction of pink pepper, cambuí, araçá and mangaba. They produce sweets, jams and jellies and are formed by more than 50 women. In this case, the agro-industry is already built and fully operational.

The experiences shared on the 23rd made me reflect on how patriarchy promotes invisibility and inequality to women's work, so there is no agroecological transition without a fair division of labor. These women are above all guardians of agrobiodiversity, who, with their capacity for self-management, have reinforced the importance of female participation in strengthening the permanence in the rural territory and income generation.

IV. CONCLUDING REMARKS

The experiences brought from the point of view of one of the authors of this article, present their trajectory over two semesters whose curricular practical activities took place remotely. Furthermore, this experience report provides an understanding of how the field immersions in an interdisciplinary doctoral course in a public educational institution in Brazil, has intensely complex demands.

The present work is inserted in the perspective of contributing to the debates around the theme under analysis, complementing the theoretical framework. This research arises as a basic assumption in order to contribute to possible eventualities occurring during the course of the academic calendar, guiding in the process of adapting the teaching-learning activities for graduate courses of an interdisciplinary and practical nature.

The current state of technology has made the PPGADT doctoral course field classes possible, and the teaching-learning has become particularly well adapted to the emergency remote format. And with the right tools and approaches, effective distance knowledge construction can be achieved.

Despite the difficult situation that everyone was going through around them, it is rewarding to continue the teaching process, even if remotely.

The daily meeting with classmates was very satisfying in contributing to mental health and preserving the perception of community, aspects that were directly affected by the Covid-19 pandemic.

The remote teaching during the pandemic also brought a positive outlook on the ability to do homework, including flexible scheduling. Considering that most of the students live in other states, there was a reduction in logistics, airfare, and lodging costs.

The experiences of the field immersions in remote format showed that it is feasible to do this kind of activity, which, in theory, requires experiences in an external environment. Although the class has adapted very well to teaching using digital platforms, and the whole team has shown itself to be resilient in the midst of such atypical semesters, an interdisciplinary professional doctorate in agroecology and territorial development has the differential of contact with popular knowledge, the territories, the leaders and their people as a form of participant experience of the dynamics under study, therefore, when everything returns to normal, it is preferable that the field immersions return to the face-to-face format.

The relevance of this study is the illustration of the obstacles encountered by the students of a professional

doctoral class who were removed from field practices to live a complex experience in a fully virtual environment. We hope that this self-study will encourage other graduate programs of the same methodological nature to view ICTs as allies, should we experience circumstances similar to this Covid-19 pandemic. And that the skills and challenges faced in this process contribute to the continuous improvement of their own praxis.

Programs that take the student beyond the classroom are capable of causing substantial changes in the teaching and learning process, since it is through contact with the concrete and real world that powerful connections with the studied object are established (SOUSA; ALBUQUERQUE, 2019).

It is necessary to look at all situations through a positive prism, because it is through them that we are constantly challenged to put out skills that were not known until then. Andrade, Matos, and Fernandes (2022, p. 2) corroborate this line of reasoning when they state that during the pandemic educators "improved in relation to the various technological tools and started to take pleasure in them. They discovered that they could diversify their classes, make them more attractive, fun, and enriching."

The experiences reported here raise some points that should be highlighted because it sets precedents for improvement. It is necessary and fundamental to invest in public policies aimed at the initial and continued training of graduate teachers, especially in professional and interdisciplinary courses, which are practical in nature and carry with them pedagogical particularities. A better formation of this category implies in a better preparation of the doctoral students in their teaching-learning process. It is necessary that the educational institutions are equipped with a broad multidisciplinary team from the psychosocial field that can provide support to the teachers and students in the event of another event that again imposes social distancing, as happened with the pandemic caused by Covid-19.

The discussions presented here indicate that the field immersion model proposed by PPGADT, faced with the emergency situation of remote teaching, even with many setbacks presented, generated significant reflections and learning that act in the transformation of doctoral students.

This experience also gave the students and teachers the opportunity to develop skills for self-formation of the individual, and the ability to critically evaluate their own reality, while contributing to the maturation and professional qualification, in an immeasurable way. Which corroborates with Azevedo and Higuchi (2017, p. 4), who argues that " the immersion

experience "positively affects" everyone involved, and that our contribution has a limit, but also has an individual reach that is difficult to measure."

The analysis and discussion that this research brought, was able to present the scenario of challenges and vulnerabilities experienced by faculty, students and those indirectly involved in the process of knowledge construction within a doctoral program in Brazil. It is clear that all those involved went through a complex learning process, which caused, according to the reports analyzed, uneasiness, excessive work demands, fears, emotional instability, and hesitation.

The pedagogical mediation used in this doctorate aims strongly at the reflective exercise; at this point, group dynamics, such as conversation wheels, facilitate the understanding of the contents. As the field immersions could not be face-to-face, there was an immense loss in the relationships of coexistence and affective exchanges among the members of the class, which sometimes occurred during meals and during the cooperation among groups for the execution of tasks.

The records kept in the field diary were fundamental for the development of this experience report, once the use of this methodological tool was consolidated as an intervention instrument by generating reflections about the field immersion practice in virtual format and the measures taken regarding planning, elaboration, and scientific publication.

REFERENCES

- [1] ALMEIDA, J. R. de. **Ecologia aplicada ao planejamento ambiental**. Rio de Janeiro: UFRJ, 1994.
- [2] ANDRADE, M. M. de. **Como preparar trabalhos para cursos de pós-graduação: noções práticas**. 5. ed. São Paulo: Atlas, 2002.
- [3] ANDRADE, M. de F.; MATOS, I. de J. P.; FERNANDES, M. de M. O ensino de ciências da natureza durante a pandemia da Covid-19: desafios e possibilidades nas redes pública e privada. **Research, Society and Development**, v. 11, n. 2, p. 1–16, 2022. Disponível em: <https://doi.org/10.33448/rsd-v11i2.25390>
- [4] AZEVEDO, G. C. de; HIGUCHI, M. I. G. IMERSÃO TOTAL NO AMBIENTE DE FLORESTA MEDIANDO VIVÊNCIAS QUE TRANSFORMAM O PENSAR E FAZER DOCENTE. In: 2017, Curitiba. **XVI ENCONTRO PARANAENSE DE EDUCAÇÃO AMBIENTAL**. Curitiba: Universidade Federal do Paraná, 2017. p. 1–4.
- [5] AZEVEDO, G. C. de; HIGUCHI, M. I. G.; BARCELOS, V. Contribuição do INPA na formação continuada de professores em educação ambiental: desafios, práticas e reflexões! . **Ambiente & Educação**, v. 14, n. 1, p. 89–109, 2009. Disponível em: <https://periodicos.furg.br/ambeduc/article/view/1138>. Acesso em: 6 jul. 2022.
- [6] BOLZAN, D. **Formação de professores: compartilhando e reconstruindo conhecimentos**. 1. ed. Porto Alegre: Editora Mediação, 2002.
- [7] BRASIL. **Portaria nº 389, de 23 de março de 2017**. Dispõe sobre o mestrado e doutorado profissional no âmbito da pós-graduação stricto sensu. Brasília: Ministério da Educação/Gabinete do Ministro, 2017. Disponível em: <https://abmes.org.br/arquivos/legislacoes/Port-MEC-389-2017-03-23.pdf>. Acesso em: 19 jul. 2022.
- [8] BRASIL. **Portaria nº 60, de 20 de março de 2019**. Dispõe sobre o mestrado e doutorado profissionais, no âmbito da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - CAPES. Brasília: Ministério da Educação/Fundação Coordenação de Aperfeiçoamento de Pessoal de Nível Superior/Gabinete, 2019.
- [9] BRASIL. **Portaria nº 343, de 17 de março de 2020**. Dispõe sobre a substituição das aulas presenciais por aulas em meios digitais enquanto durar a situação de pandemia do Novo Coronavírus - COVID-19. Brasília: Ministério da Educação/Gabinete do Ministro, 2020 a. Disponível em: <https://www.in.gov.br/en/web/dou/-/portaria-n-343-de-17-de-marco-de-2020-248564376>. Acesso em: 30 jun. 2022.
- [10] BRASIL. **Portaria nº 544, de 16 de junho de 2020**. Dispõe sobre a substituição das aulas presenciais por aulas em meios digitais, enquanto durar a situação de pandemia do novo coronavírus - Covid-19, e revoga as Portarias MEC nº 343, de 17 de março de 2020, nº 345, de 19 de março de 2020, e nº 473, de 12 de maio de 2020. Brasília: Ministério da Educação/Gabinete do Ministro, 2020 b. Disponível em: <https://www.in.gov.br/en/web/dou/-/portaria-n-544-de-16-de-junho-de-2020-261924872>. Acesso em: 30 jun. 2022.
- [11] BRASIL. **Lei nº 14.040, de 18 de agosto de 2020**. Estabelece normas educacionais excepcionais a serem adotadas durante o estado de calamidade pública reconhecido pelo Decreto Legislativo nº 6, de 20 de março de 2020; e altera a Lei nº 11.947, de 16 de junho de 2009. Brasília: Atos do Poder Legislativo, 2020c. Disponível em: http://www.planalto.gov.br/ccivil_03/_ato2019-2022/2020/lei/14040.htm. Acesso em: 2 jul. 2022.
- [12] BRASIL. **Portaria nº 1.030, de 1º de dezembro de 2020**. Dispõe sobre o retorno às aulas presenciais e sobre caráter excepcional de utilização de recursos educacionais digitais para integralização da carga horária das atividades pedagógicas enquanto durar a situação de pandemia do novo coronavírus - Covid-19. Brasília: Ministério da Educação/Gabinete do Ministro, 2020 d. Disponível em: www.abmes.org.br. Acesso em: 2 jul. 2022.
- [13] BRASIL. **Portaria nº 1.038, de 7 de dezembro de 2020**. Altera a Portaria MEC no 544, de 16 de junho de 2020, que dispõe sobre a substituição das aulas presenciais por aulas em meio digitais, enquanto durar a situação de pandemia do novo coronavírus - Covid- 19, e a Portaria MEC no 1.030, de 1º de dezembro de 2020, que dispõe sobre o retorno às aulas presenciais e sobre caráter excepcional de utilização de recursos educacionais digitais para integralização da carga horária das atividades pedagógicas, enquanto durar a

- situação de pandemia do novo coronavírus - Covid-19. Brasília: Ministério da Educação/Gabinete do Ministro, 2020e. Disponível em: <https://www.in.gov.br/web/dou/-/portaria-mec-n-1.038-de-7-de-dezembro-de-2020-292694534>. Acesso em: 2 jul. 2022.
- [14] BRASIL. **Resolução CNE/CP nº 2, de 10 de dezembro de 2020**. Institui Diretrizes Nacionais orientadoras para a implementação dos dispositivos da Lei nº 14.040, de 18 de agosto de 2020, que estabelece normas educacionais excepcionais a serem adotadas pelos sistemas de ensino, instituições e redes escolares, públicas, privadas, comunitárias e confessionais, durante o estado de calamidade reconhecido pelo Decreto Legislativo nº 6, de 20 de março de 2020. Brasília: Ministério da Educação/Conselho Nacional de Educação, 2020f. Disponível em: <https://www.in.gov.br/en/web/dou/-/resolucao-cne/cp-n-2-de-10-de-dezembro-de-2020-293526006>. Acesso em: 2 jul. 2022.
- [15] BRASIL. **Portaria nº 479, de 13 de maio de 2020**. Reconhece os cursos de pós-graduação stricto sensu (mestrado e doutorado), acadêmicos e profissionais, recomendados pelo Conselho Técnico-Científico - CTC-ES, da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Capes, na 181ª Reunião, realizada no período de 28 a 30 de novembro de 2018. Brasília: Ministério da Educação/Gabinete do Ministro, 2020g.
- [16] BROWN, J. P. Teachers' perspectives of changes in their practice during a technology in mathematics education research project. **Teaching and Teacher Education**, v. 64, p. 52–65, 2017. Disponível em: <https://doi.org/10.1016/j.tate.2017.01.022>. Acesso em: 5 jul. 2022.
- [17] BUTLER, M. Interdisciplinary experiential learning during COVID-19: lessons learned and reflections for the future. **Journal of Environmental Studies and Sciences**, 2022. Disponível em: <https://doi.org/10.1007/s13412-021-00734-w>
- [18] CAMPOS, C. R. P. A saída a campo como estratégia de ensino de ciências: reflexões iniciais. **Revista sala de aula em foco**, v. 1, n. 2, p. 25–30, 2012. Disponível em: <https://ojs.ifes.edu.br/index.php/saladeaula/issue/view/76/28>. Acesso em: 6 jul. 2022.
- [19] CAPES. **Cursos Avaliados e Reconhecidos**. [s. l.], 2022. Disponível em: <https://sucupira.capes.gov.br/sucupira/public/consultas/coleta/programa/quantitativos/quantitativoAreaAvaliacao.xhtml>. Acesso em: 19 jul. 2022.
- [20] CRUZ, R. de C. A. da. Os caminhos da pesquisa de campo em geografia. **GEOUSP: Espaço e Tempo (Online)**, v. 1, n. 1, p. 93–97, 1997. Disponível em: <https://doi.org/10.11606/issn.2179-0892.geousp.1997.123230>. Acesso em: 2 jul. 2022.
- [21] CUNHA, L. F. F. da; SILVA, A. de S.; SILVA, A. P. da. O ensino remoto no Brasil em tempos de pandemia: diálogos acerca da qualidade e do direito e acesso à educação. **Revista Com Censo: Estudos Educacionais do Distrito Federal**, v. 7, n. 3, p. 27–37, 2020. Disponível em: <http://www.periodicos.se.df.gov.br/index.php/comcenso/article/view/924>. Acesso em: 5 jul. 2022.
- [22] DALTRO, M. R.; FARIA, A. A. de. Relato de experiência: Uma narrativa científica na pós-modernidade. **Estudos e Pesquisas em Psicologia**, v. 19, n. 1, p. 223–237, 2019.
- [23] DEZIN, N. K.; LINCOLN, Y. S. **O planejamento da pesquisa qualitativa: teorias e abordagens**. 2. ed. Porto Alegre: Artmed, 2006.
- [24] GARCIA, T.; MORAIS, I.; ZAROS, L.; RÉGO, M. carmem. **Ensino Remoto Emergencial: Proposta de design para organização de aulas**. Natal, Brasil: SEDIS/UFRN, 2020. *E-book*. Disponível em: <https://repositorio.ufrn.br/handle/123456789/29767>
- [25] GIL, A. C. **Como Elaborar Projetos de pesquisa**. 4. ed. São Paulo: Editora atlas, 2002.
- [26] GODOI, M.; KAWASHIMA, L. B.; GOMES, L. de A.; CANEVA, C. O ensino remoto durante a pandemia de covid-19: desafios, aprendizagens e expectativas dos professores universitários de Educação Física. **Research, Society and Development**, v. 9, n. 10, 2020. Disponível em: <https://doi.org/10.33448/rsd-v9i10.8734>. Acesso em: 6 jul. 2022.
- [27] GUEDES, J. D. A. Hidrografia e Google Earth: aula de campo virtual em tempos de pandemia. **Ensino em Perspectivas**, v. 2, n. 2, p. 1–12, 2021.
- [28] HODGES, C.; MOORE, S.; LOCKEE, B.; TRUST, T.; BOND, A. **The Difference Between Emergency Remote Teaching and Online Learning**. [s. l.], 2020. Disponível em: <https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and->. Acesso em: 30 jun. 2022.
- [29] HRASTINSKI, S. Asynchronous and synchronous e-learning. **Educause Quarterly**, n. 4, p. 51–55, 2008. Disponível em: <https://er.educause.edu/-/media/files/article-downloads/eqm0848.pdf>. Acesso em: 5 jul. 2022.
- [30] HUGHES, A. **Comparing Asynchronous and Synchronous Learning**. [s. l.], 2014. Disponível em: <https://learningsolutionsmag.com/articles/1577/comparing-asynchronous-and-synchronous-learning>. Acesso em: 5 jul. 2022.
- [31] HUSSEIN, E.; DAOUD, S.; ALRABAIH, H.; BADAWI, R. Exploring undergraduate students' attitudes towards emergency online learning during COVID-19: A case from the UAE. **Children and Youth Services Review**, v. 119, 2020. Disponível em: <https://doi.org/10.1016/j.childyouth.2020.105699>. Acesso em: 5 jul. 2022.
- [32] KHAN, S.; KAMBRIS, M. E. K.; ALFALAH, H. Perspectives of University Students and Faculty on remote education experiences during COVID-19- a qualitative study. **Education and Information Technologies**, v. 27, p. 4141–4169, 2022. Disponível em: <https://doi.org/10.1007/s10639-021-10784-w>
- [33] KRASILCHIK, M. **Prática de ensino de biologia**. São Paulo: Editora da Universidade de São Paulo, 2008.
- [34] KROEF, R. F. da S.; GAVILLON, P. Q.; RAMM, L. V. Diário de Campo e a Relação do(a) Pesquisador(a) com o Campo-Tema na Pesquisa-Intervenção. **Estudos e**

- Pesquisas em Psicologia**, v. 20, n. 2, p. 464–480, 2020. Disponível em: <https://doi.org/10.12957/epp.2020.52579>
- [35] OLIVEIRA, R. de C. M. de. (ENTRE)LINHAS DE UMA PESQUISA: o Diário de Campo como dispositivo de (in)formação na/da abordagem (Auto)biográfica. **Revista Brasileira de Educação de Jovens e Adultos**, v. 2, n. 4, p. 69–87, 2014. Disponível em: <https://www.revistas.uneb.br/index.php/educajovenseadultos/article/view/1059>. Acesso em: 6 jul. 2022.
- [36] ORGANIZAÇÃO PAN-AMERICANA DA SAÚDE/ORGANIZAÇÃO MUNDIAL DA SAÚDE AMÉRICAS. **OMS afirma que COVID-19 é agora caracterizada como pandemia**. Washington, D.C., United States of America, 2020. Disponível em: <https://www.paho.org/pt/news/11-3-2020-who-characterizes-covid-19-pandemic>. Acesso em: 2 jul. 2022.
- [37] PEZZATO, L. M.; L'ABBATE, S. O uso de diários como ferramenta de intervenção da Análise Institucional: potencializando reflexões no cotidiano da Saúde Bucal Coletiva. **Physis: Revista de Saúde Coletiva**, v. 21, n. 4, p. 1297–1314, 2011. Disponível em: <https://doi.org/10.1590/S0103-73312011000400008>. Acesso em: 6 jul. 2022.
- [38] RIBEIRO JUNIOR, M. C.; FIGUEIREDO, L. S.; OLIVEIRA, D. C. A. de; PARENTE, M. P. M.; HOLANDA, J. D. S.; RESUMO. ENSINO REMOTO EM TEMPOS DE COVID-19: APLICAÇÕES E DIFICULDADES DE ACESSO NOS ESTADOS DO PIAUÍ E MARANHÃO. **Boletim de Conjuntura (BOCA)**, v. 3, n. 9, p. 107–126, 2020. Disponível em: <https://doi.org/10.5281/ZENODO.4018034>. Acesso em: 3 jul. 2022.
- [39] RODRIGUES, C.; LOWAN-TRUDEAU, G. Global politics of the COVID-19 pandemic, and other current issues of environmental justice. **The Journal of Environmental Education**, v. 52, n. 5, p. 293–302, 2021. Disponível em: <https://doi.org/10.1080/00958964.2021.1983504>. Acesso em: 5 jul. 2022.
- [40] SANTOS, A. O. S.; RODRIGUES, L.; CASTELAR, M. Relato de experiência de uma imersão no campo da Psicologia Jurídica. **Passagens: Revista Internacional de História Política e Cultura Jurídica**, v. 14, n. 1, p. 70–88, 2022. Disponível em: <https://doi.org/10.15175/1984-2503-202214104>
- [41] SÁ-SILVA, J. R.; ALMEIDA, C. D. de; GUINDANI, J. F. Pesquisa documental: pistas teóricas e metodológicas. **Revista Brasileira de História & Ciências Sociais**, v. 1, n. 1, p. 1–15, 2009. Disponível em: <https://periodicos.furg.br/rbhcs/article/view/10351>. Acesso em: 3 jul. 2022.
- [42] SCHIEHL, E. P.; GASPARINI, I. Contribuições do Google Sala de Aula para o Ensino Híbrido. **RENOTE**, v. 14, n. 2, p. 1–11, 2016. Disponível em: <https://doi.org/10.22456/1679-1916.70684>. Acesso em: 3 jul. 2022.
- [43] SILVEIRA, A. C. da; BASTOS, F. D. H. IMPACTOS DA PANDEMIA DE COVID-19 NOS TRABALHOS DE CAMPO DAS PESQUISAS GEOGRÁFICAS. **Estudos Geográficos: Revista Eletrônica de Geografia**, v. 18, n. 2, p. 152–165, 2021. Disponível em: <https://doi.org/10.5016/estgeo.v19i2.15727>
- [44] SOARES NETO, J.; PINHO, F. V. A. de; MATOS, H. L.; LOPES, A. R. de O.; CERQUEIRA, G. S.; SOUZA, E. P. de. Tecnologias de ensino utilizadas na Educação na pandemia COVID-19: uma revisão integrativa. **Research, Society and Development**, v. 10, n. 1, p. 1–14, 2021. Disponível em: <https://doi.org/10.33448/rsd-v10i1.11974>. Acesso em: 3 jul. 2022.
- [45] SOUSA, M. e S.; ALBUQUERQUE, E. L. S. Aula de campo no entendimento do espaço geográfico: vivências do CETI Governador Freitas Neto, Teresina, Piauí. **Geografia: Publicações Avulsas**, v. 1, n. 1, p. 29–47, 2019. Disponível em: <https://revistas.ufpi.br/index.php/geografia/article/view/8887/7654>. Acesso em: 30 jun. 2022.
- [46] SOUSA, R. de O.; MOREIRA, A. D.; SANTOS, A. R. dos. Educação do Campo em tempos de pandemia em Bom Jesus da Lapa-BA: impactos, desafios e percepções. **Revista de Políticas Públicas e Gestão Educacional (POLIGES)**, v. 2, n. 2, p. 82–111, 2021. Disponível em: <https://doi.org/10.22481/poliges.v2i2.8980>. Acesso em: 2 jun. 2022.
- [47] SPOSITO, M. E. B.; GUIMARÃES, R. B. **Por que a circulação de pessoas tem peso na difusão da pandemia: Difusão da Covid-19 no país segue modelo relacionado a interações espaciais na rede urbana**. São Paulo, Brasil, 2020. Disponível em: <https://www2.unesp.br/portaal#!noticia/35626/por-que-a-circulacao-de-pessoas-tem-peso-na-difusao-da-pandemia>. Acesso em: 2 jul. 2022.
- [48] TARDIF, M. **Saberes docentes e formação profissional**. 12. ed. Petrópolis: Editora Vozes, 2011. *E-book*. Disponível em: <https://www.google.com/search?q=TARDIF%2C+Maurice.+Saberes+docentes+e+forma%C3%A7%C3%A3o+profissional.+12+ed.+Editora+Vozes%2C+Petr%C3%B3polis%2C+325p.+2011.&aq=chrome..69i57.625j0j9&sourceid=chrome&ie=UTF-8>. Acesso em: 6 jul. 2022.
- [49] TARRANT, S. P.; THIELE, L. P. The Web We Weave: Online Education and Democratic Prospects. **New Political Science**, v. 36, n. 4, p. 538–555, 2014. Disponível em: <https://doi.org/10.1080/07393148.2014.954790>. Acesso em: 5 jul. 2022.
- [50] TEIXEIRA, S. L.; RIBEIRO, M. A. G. Educação do Campo em tempo de pandemia: impactos, limites e desafios. **Revista Com Censo: Estudos Educacionais do Distrito Federal**, v. 7, n. 4, p. 36–48, 2020.
- [51] UNIVASF. **Resolução nº 003/2021**. Estabelece o Regimento Interno do Programa de Pós-graduação em Agroecologia e Desenvolvimento Territorial (PPGADT) da Universidade Federal do Vale do São Francisco (Univasf), doutorado profissional em associação ampla de instituições

de ensino superior (UNIVASF/UFRPE/UNEB). Petrolina: Conselho Universitário, 2021.

- [52] WEBER, F. A entrevista, a pesquisa e o íntimo, ou: por que censurar seu diário de campo? **Horizontes Antropológicos**, v. 15, n. 32, p. 157–170, 2009.
- [53] WORLD HEALTH ORGANIZATION. **Coronavirus disease 2019 (COVID-19): situation report, 51**. [s. l.], 2020. Disponível em: <https://apps.who.int/iris/handle/10665/331475?locale-attribute=en&>. Acesso em: 2 jul. 2022.
- [54] ZHENG, Q.; LU, Y.; LURE, F.; JAEGER, S.; LU, P. Clinical and radiological features of novel coronavirus pneumonia. **Journal of X-Ray Science and Technology**, v. 28, n. 3, p. 391–404, 2020. Disponível em: <https://doi.org/10.3233/XST-200687>. Acesso em: 2 jul. 2022.

Geometrical Model of bearing Capacity for a Safe Rectangular Vertically Loaded Shallow Pad Foundation on a Cohesionless (Sandy) Soil with Minimum Angle of Friction

A.G. Okeniyi¹, A.S. Akolade², S.A. Adefisoye², O. T. Akanbi³, O.D. Okeleye¹

¹Department of Civil Engineering, The Polytechnic Ibadan, Nigeria

²Department of Civil Engineering, Lead City University, Nigeria

³Department of Mechatronics Engineering, Bowen University, Nigeria

Corresponding author: okeniyiag@yahoo.com

Received: 25 Jun 2022,

Received in revised form: 17 Jul 2022,

Accepted: 23 July 2022,

Available online: 31 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords — *Structural Footing, Bearing Capacity, Depth Factor, Inclination Factor, Geometry*

Abstract— *Provision of adequate structural footing in building infrastructures is sensitive and highly challenging. Thus to alleviate the challenges of the subject task, a model was developed for simulating behavior of a pad rectangular footing on a cohesionless soil under the action of a vertical load. The approach is purely mathematical techniques of modeling, concept and application. A governing equation was theoretically formulated based on a specified condition, theories and applicable parameters. This was experimentally simulated to describe the relationship between variable parameters and to predict the geotechnical behaviour (bearing capacity) of the sandy soil underneath a shallow foundation. The geometry is specified by footing length, L , breadth, B and the placement depth, D_f of the element. The model clearly established the interrelationship between the dominant parameters of the soil and footing geometry for determining bearing capacity to help engineering decisions in the design of a safe footing on a sandy soil environment.*

I. INTRODUCTION

1.1 General Background: The earth crust consists of the rock and soil. Rock is simply the hard solid mineral that forms part of the earth, while soil can be described from engineering point of view as all materials of the earth crust, organic and inorganic, overlying the rock. Engineering structures, like buildings, bridges and retaining walls are designed to be supported by the earth.

If a building is to be constructed on an outcrop of sound rock, no foundation is required. In the contrast, the foundations are provided in the designed to serve as a remedy for the deficiencies of whatever nature (whimsical) has provided for the support of the structure at a particular

site. Thus, foundation is a crucial component, it is that part of the structure which is in direct contact with the soil and transmits loads to it. Therefore, Terzaghi, in one of his comments, describes foundation as a “necessary evil” (Murthy, 2008). However, the stability of such engineering structures depends upon the capability (at design) and stability (at service live) of the supporting soil. The significant of foundation in the design and construction of engineering projects remains a determinant for functionality and so a sensitive challenge to the engineers.

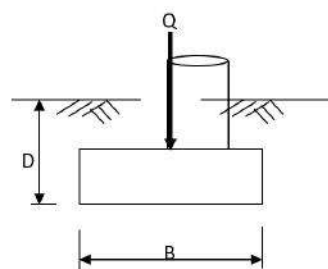
From civil engineering point of view, the adequacy of a structural footing is majorly a function of its geometry. However, the geometry of the footing is dictated by the strengths of the supporting types of soil underneath the

foundation. That is to say, different types of soil require different features of foundation geometry under natural condition and a set of specified structural materials grade.

Foundation is therefore, an integral part of a structure, which may be shallow or deep. A foundation is customarily regarded as shallow if the depth of the foundation is less than or equal to the width of the foundation (Terzaghi, 1943). Later, investigator suggested that foundations with depth, D equals to 3 to 4 times their width may be defined as shallow foundations.

Shallow foundations generally are designed to satisfy two criteria: **bearing capacity** and **settlement**. The bearing capacity criterion ensures that there is adequate safety against possible bearing capacity failure within the underlying soil. This is done through provision of an adequate factor of safety of about 3. In other words, shallow foundations are designed to carry a working load of one-third of the failure load. For raft foundations, a safety factor of 1.7 to 2.5 is recommended (Bowles 1996). The settlement criterion ensures that settlement is within acceptable limits. For example, pad and strip footings in cohesionless soils generally are designed to settle less than 25 mm.

Unless a shallow foundation can be founded on strong rock, some noticeable settlement will occur. Design of shallow foundations should ensure that there is an adequate factor of safety against bearing failure of the ground, and that the settlements, including total and differential settlement, are limited to allowable values. Distress experienced on structures founded on sand is not uncommon, especially for sub-soils containing large amounts of cobbles. Excessive settlement or sometimes even shear failure can take place when there is a sudden change of the water table elevation.



For shallow foundations founded on cohesionless soils, the allowable load is usually dictated by the allowable settlement, except where the ultimate bearing capacity is significantly affected by geological or geometric features. Examples of adverse geological and geometrical features are weak seams and sloping ground respectively.

Stability of a structure depends upon the stability of the supporting soil underneath the foundation for which the following two guiding principles are considered (Murthy, 2008);

- (a) The foundation must be stable against shear failure of the supporting soil.
- (b) The foundation must not settle beyond a tolerable limit to avoid damage to the structure.

Hence, an engineer must perform three major steps for effective design of the type of foundations

- (i) The site of the proposed structure must be located.
- (ii) Obtain information concerning the superstructure and the loads to be transmitted to the foundation.
- (iii) Obtain the subsurface soil condition.

1.2 Ultimate Bearing Capacity of the Soil: The case of a shallow foundation at simplest consideration is the one subjected to a central vertical load, Q when the footing is founded at a depth, D below the ground surface. The settlement, S of the footing is recorded and plotted against the applied load, Q to obtain the load settlement curves similar to that of stress-strain curve, Fig. 1.

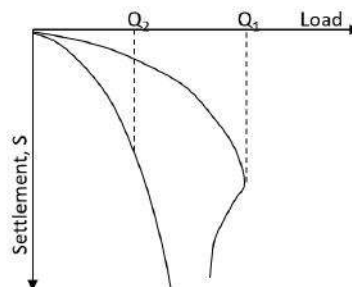


Fig. 1: Typical Shallow Footing and load-settlement curve (Murthy, 2008)

However, the test by Vesic (1967) revealed that the shape of the curve depends on the dimension (geometry) of the footing, the composition of the supporting soil, the character, rate and frequency of loading.

II. METHODOLOGY

2.1 Determination of Ultimate Bearing Capacity, UBC of Soil: Three methods are adoptable in determining UBC of soils;

- (i) General shear failure theory of Terzaghi

- (ii) Theoretical solution presented by Meyerhof, Brinc Hansen and Vesic.
- (iii) Solution based on in-situ tests soils as PLT, SPT and CPT.

However, Terzaghi’s method is more popular and the same is considered in this model. Terzaghi (1943) used theoretical equation proposed by Prandtl (1921) for determining the bearing capacity of soil and extended his theory to take account the weight of soil and the effect of soil above the base of the footing on the bearing capacity. He made some assumptions for developing equation for determining UBC, q_d for $c-\phi$ soil with a Strip Footing, that of which was modified for other types of foundation by introducing shape factors as follows;

i) Strip Footing: $q_d = Q_d/B = cN_c + \gamma D_f N_q + \frac{1}{2}\gamma BN_\gamma$ (i)

where, q_d = ultimate bearing load per unit length of footing

- c = unit cohesion
- γ = effective unit weight of soil
- D_f = depth of foundation

N_c , N_q and N_γ = bearing capacity factors that are functions of friction, ϕ .

The cohesion, c and angle of internal friction, ϕ determined using triaxial apparatus, Fig. 2.15.

ii) Square Footings: $q_d = 1.3cN_c + \gamma D_f N_q + 0.4\gamma BN_\gamma$ (ii)

iii) Circular Footing: $q_d = 1.3cN_c + \gamma D_f N_q + 0.3\gamma BN_\gamma$ (ii)

iv) Rectangular Footing: $q_d = (1+0.3B/L)cN_c + \gamma D_f N_q + (1-0.2B/L)\frac{1}{2}\gamma BN_\gamma$ (iii)

2.2 The Governing Equation: Considering the ultimate bearing capacity as presented by Das (2007) in equations (i), (ii), and (iii) which are for continuous, square, and circular foundations only; they do not address the case of rectangular foundations ($0 < B/L < 1$). Also, the equations

do not take into account the shearing resistance along the failure surface in soil above the bottom of the foundation. To account for all these shortcomings, Meyerhof (1963) suggested the understated general bearing capacity equation, also documented by Das (2007).

$$q_u = c'N_cF_{cs}F_{cd}F_{ci} + qN_qF_{qs}F_{qd}F_{qi} + \frac{1}{2}\gamma BN_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i} \tag{iv}$$

where,

- c' = cohesion
- q = effective stress at the level of the bottom of the foundation
- γ = unit weight of soil
- B = width/diameter of foundation

$N_cN_qN_\gamma$ = bearing capacity factors

$F_{cs}F_{qs}F_{\gamma s}$ = shape factors

$F_{cd}F_{qd}F_{\gamma d}$ = depth factors

$F_{ci}F_{qi}F_{\gamma i}$ = load inclination factors

The shape, depth and load inclination factors are empirical factors based on experimental.

With cohesionless soil, $c = 0$

$$q_u = qN_qF_{qs}F_{qd}F_{qi} + \frac{1}{2}\gamma BN_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i} \tag{v}$$

2.3 The Inclination Factors: Meyerhof (1963), Hanna and Meyerhof (1981) documented the following as inclination factors;

$$F_{ci} = F_{qi} = (1 - \beta^{\circ}/90^{\circ})^2 \tag{vi}$$

$$F_{\gamma i} = (1 - \beta / \phi')^2 \tag{vii}$$

Since the load is non-inclined i.e vertically loaded, inclination factors not applicable. Thus equation (v) reduced to;

$$q_u = qN_qF_{qs}F_{qd} + \frac{1}{2}\gamma BN_\gamma F_{\gamma s}F_{\gamma d} \tag{viii}$$

2.4 The Bearing Capacity Factors (BCF): These are factors that are non-dimensional and are functions only of the soil friction angle, ϕ' . The variations of the BCF are given in **Table 1**.

Table 1: Bearing capacity factors

ϕ'	N_c	N_q	N_γ	ϕ'	N_c	N_q	N_γ
0	5.70	1.00	0.00	26	27.09	14.21	9.84
1	6.00	1.10	0.01	27	29.24	15.90	11.60

2	6.30	1.22	0.04	28	31.61	17.81	13.70
3	6.62	1.35	0.06	29	34.24	19.98	16.18
4	6.97	1.49	0.10	30	37.16	22.46	19.13
5	7.34	1.64	0.14	31	40.41	25.28	22.65
6	7.73	1.81	0.20	32	44.04	28.52	26.87
7	8.15	2.00	0.27	33	48.09	32.23	31.94
8	8.60	2.21	0.35	34	52.64	36.50	38.04
9	9.09	2.44	0.44	35	57.75	41.44	45.41
10	9.61	2.69	0.56	36	63.53	47.16	54.36
11	10.16	2.98	0.69	37	70.01	53.80	65.27
12	10.76	3.29	0.85	38	77.50	61.55	78.61
13	11.41	3.63	1.04	39	85.97	70.61	95.03
14	12.11	4.02	1.26	40	95.66	81.27	115.31
15	12.86	4.45	1.52	41	106.81	93.85	140.51
16	13.68	4.92	1.82	42	119.67	108.75	171.99
17	14.60	5.45	2.18	43	134.58	126.50	211.56
18	15.12	6.04	2.59	44	151.95	147.74	261.60
19	16.56	6.70	3.07	45	172.28	173.28	325.34
20	17.69	7.44	3.64	46	196.22	204.19	407.11
21	18.92	8.26	4.31	47	224.55	241.80	512.84
22	20.27	9.19	5.09	48	258.28	287.85	650.67
23	21.75	10.23	6.00	49	298.71	344.63	831.99
24	23.36	11.40	7.08	50	347.50	415.14	1072.8
25	25.13	12.72	8.34				

Source: Kumbhojkar (1993) and Das (2007)

For cohesionless (sandy) soil, the angle of friction, ϕ' usually ranges from 26° to 45° (Das, 2007). At minimum value, $\phi' = 26^\circ$, from Table 1, $N_q = 14.21$ and $N_\gamma = 9.84$.

Substituting the value, equation (viii) becomes

$$q_u = 14.21qF_{qs}F_{qd} + 4.92 \gamma BF_{\gamma s}F_{\gamma d} \tag{ix}$$

2.5 The Shape Factors: Expressions for the shape factors F_{cs} , F_{qs} and $F_{\gamma s}$ were given by De Beer (1970) as;

$$F_{cs} = 1 + (B/L)(N_q/N_c) \tag{x}$$

$$F_{qs} = 1 + (B/L)\tan \phi' \tag{xi}$$

and

$$F_{\gamma s} = 1 - 0.4(B/L) \tag{xii}$$

Where L = length of the foundation (L > B)

Since $c = 0$, equation (x) not applicable and with $\phi' = 26^\circ$, equation (xi) becomes;

$$F_{qs} = 1 + 0.4877(B/L) \tag{xiii}$$

Put (xii) and (xiii) in (ix),

$$q_u = 14.21\{1 + 0.4877(B/L)\}qF_{qd} + 4.92\{1 - 0.4(B/L)\}\gamma BF_{\gamma d}$$

Thus, (ix) becomes;

$$q_u = \{14.21 + 6.9302(B/L)\}qF_{qd} + \{4.92 - 1.968(B/L)\}\gamma BF_{\gamma d} \tag{xiv}$$

2.6 The Depth Factors: As presented by Hansen (1970), the following equations are for the depth factors;

$$F_{cd} = 1 + 0.4 (D_f/B) \tag{xv}$$

$$F_{qd} = 1 + 2 \tan \phi' (1 - \sin \phi')^2 (D_f/B) \tag{xvi}$$

$$F_{\gamma d} = 1 \tag{xvii}$$

Where D_f is the depth of foundation of embedment of the footing.

Note, equations (viii) and (ix) are applicable for $D_f/B \leq 1$. For a depth $D_f/B > 1$, the following expressions are applicable;

$$F_{cd} = 1 + 0.4 \tan^{-1} (D_f/B) \tag{xviii}$$

$$F_{qd} = 1 + 2 \tan \phi' (1 - \sin \phi')^2 \tan^{-1}(D_f/B) \tag{xix}$$

$$F_{\gamma d} = 1 \tag{xx}$$

However, the factor $\tan^{-1}(D_f/B)$ in (xi) and (xii) above must be in radians (Das, 2007).

Recall $c = 0$ and $\phi' = 26^\circ$, then (xv) not applicable and (xvi) becomes

$$F_{qd} = 1 + 0.3076 (D_f/B) \tag{xxi}$$

Substituting (xvii) and (xxi) in (xiv),

$$q_u = 14.21q\{1 + 0.3076 (D_f/B)\} + 6.9302(B/L)q\{1 + 0.3076(D_f/B)\} + 4.92 \gamma B(1) - 1.968(B/L) \gamma B(1)$$

Hence, (xiv) becomes

$$q_u = 14.21q + 4.3710 q(D_f/B) + 6.9302(B/L)q + 2.1320 q (D_f/L) + 4.92 \gamma B - 1.968(1/L)\gamma \tag{xxii}$$

Also substituting effective stress, $q = \gamma D_f$ in equation (xxii).

$$q_u = 14.21 \gamma D_f + 4.3710\gamma D_f^2/B + 6.9302\gamma D_f(B/L) + 2.1320 \gamma D_f^2(1/L) + 4.92 \gamma B - 1.968(1/L)\gamma \tag{xxiii}$$

Equation (xxiii) is therefore the **model governing equation**

III. RESULTS

Equation (xxii) indicates that the bearing capacity of a shallow pad foundation on a cohesionless soil is a function of the effective stress at the level of the bottom of the foundation, the unit weight of the soil at the location and the footing geometry.

Thus, the model tested, considering the bearing capacity, q_u of a rectangular pad foundation required to support a particular total vertical load at depths, D_f of 0.40m, 0.60m, 0.80m and 1.00m with footing length, L of 1.00m at a varying breadth, B of 1.00m, 1.20m, 1.40m, 1.60m and 1.80m on a dense sandy material of 18kN/m³ unit weight with water table located at a depth, $d > B$.

Substituting $L = 1.00m$ and $\gamma = 18kN/m^3$ in the governing equation (xxiii)

$$q_u = 255.7800D_f + 78.6780D_f^2/B + 3.8651 D_fB + 19.188D_f^2 + 88.56B - 17.424 \dots \dots \dots \tag{xxiv}$$

Details of the bearing capacities, q_u at varying breadth, B and depth, D are as shown in **Table 2** below.

Table 2: Bearing capacity at varying breadth and depth

B (m)	D _f (m)	D _f ²	D _f ² /B	D _f B	Constant (k)	q _u (kN/m ²)	Diff. & Ave (kN/m ²)
1	2	3	4	5	6	7	8
1.00	0.40	0.16	0.16	0.40	17.424	190.650	-
1.20			0.13	0.48		206.309	15.66
1.40			0.11	0.56		222.754	16.45
1.60			0.10	0.64		239.986	17.23
1.80			0.08	0.72		256.443	16.46 (16)
1.00	0.60	0.36	0.36	0.60	17.424	262.156	-
1.20			0.30	0.72		275.609	13.45
1.40			0.26	0.84		290.636	15.03
1.60			0.23	0.96		306.449	15.81
1.80			0.20	1.08		322.273	15.82 (15)
1.00	0.80	0.64	0.64	0.80	17.424	341.481	-
1.20			0.53	0.96		351.155	9.67
1.40			0.46	1.12		363.976	12.82
1.60			0.40	1.28		377.584	13.61
1.80			0.36	1.44		392.776	15.19 (13)

1.00	1.00	1.00	1.00	1.00	17.424	428.647	-
1.20			0.83	1.20		433.754	5.11
1.40			0.71	1.40		442.796	9.04
1.60			0.63	1.60		454.985	12.19
1.80			0.56	1.80		467.970	12.99 (10)

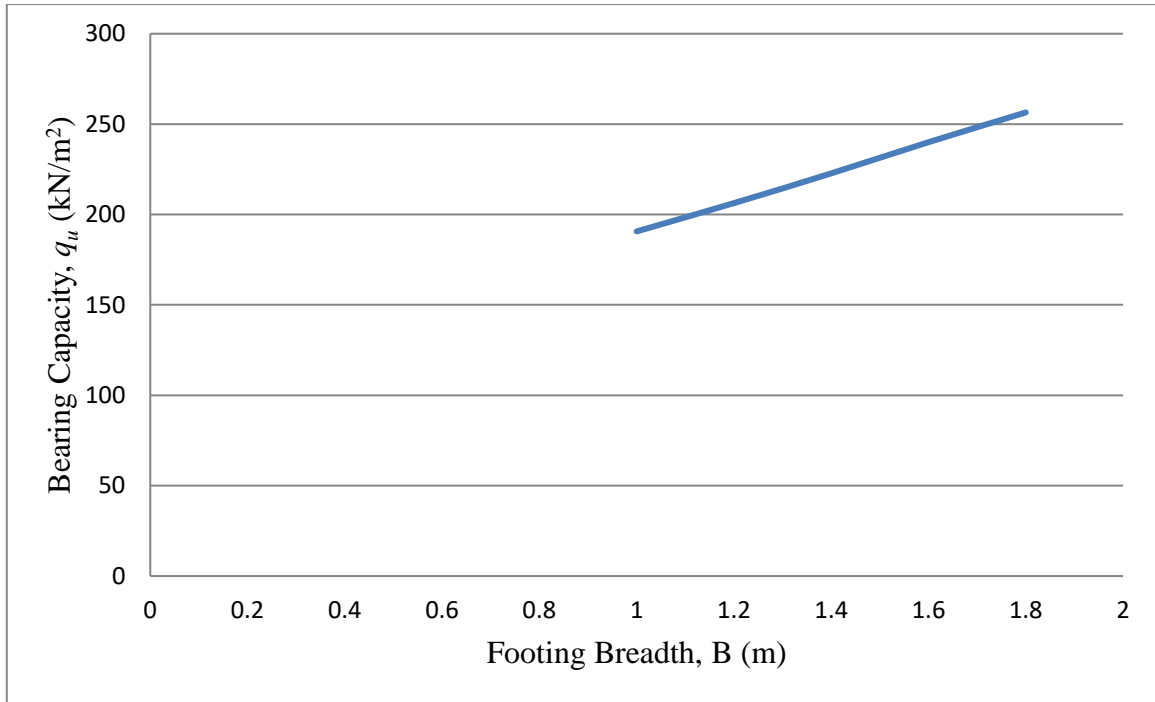


Fig. 2: Bearing capacity at 0.40m depth, 1.00m length and varying breadth

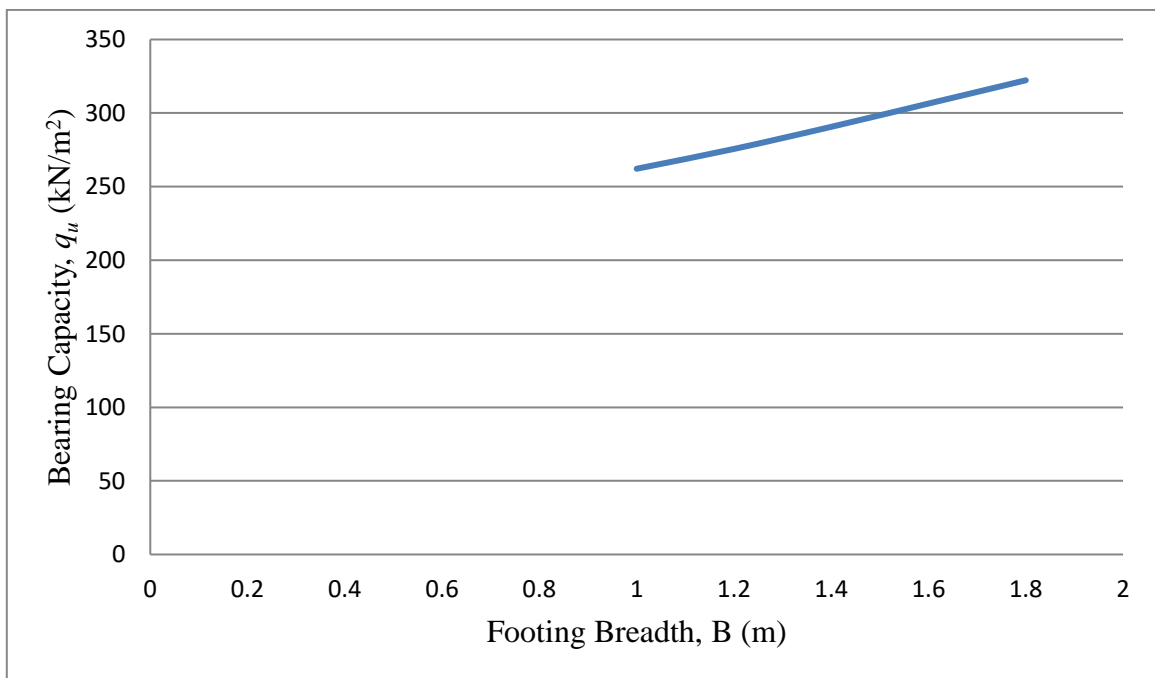


Fig. 3: Bearing capacity at 0.60m depth, 1.00m length and varying breadth

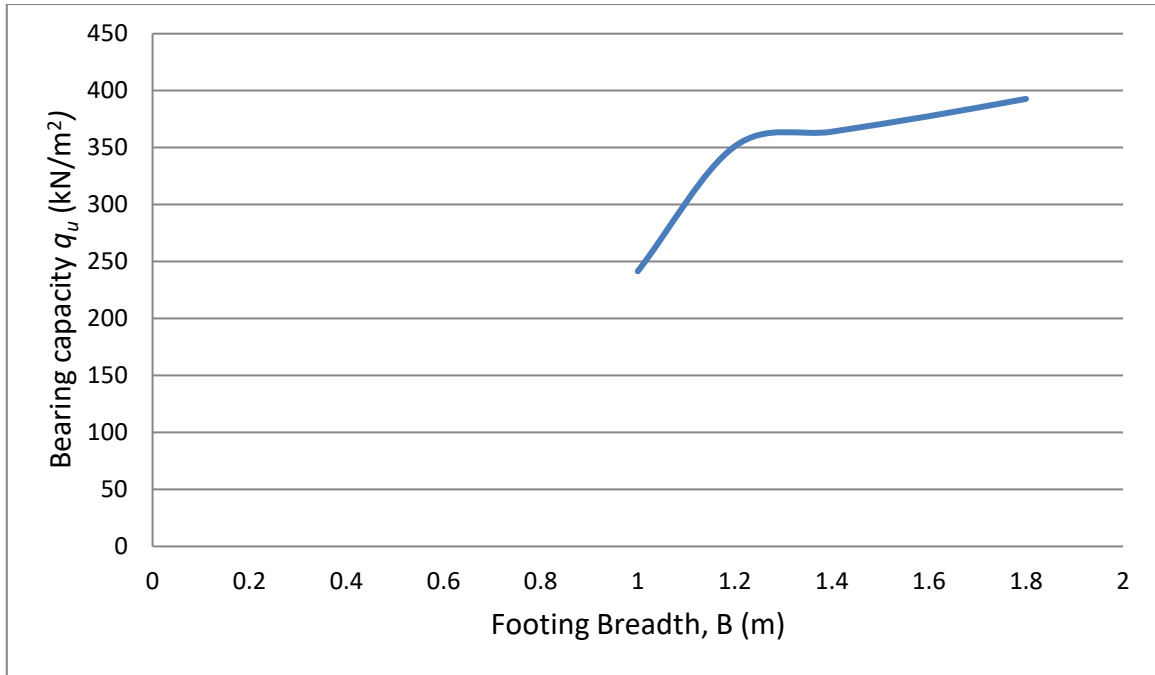


Fig. 4: Bearing capacity at 0.80m depth, 1.00m length and varying breadth

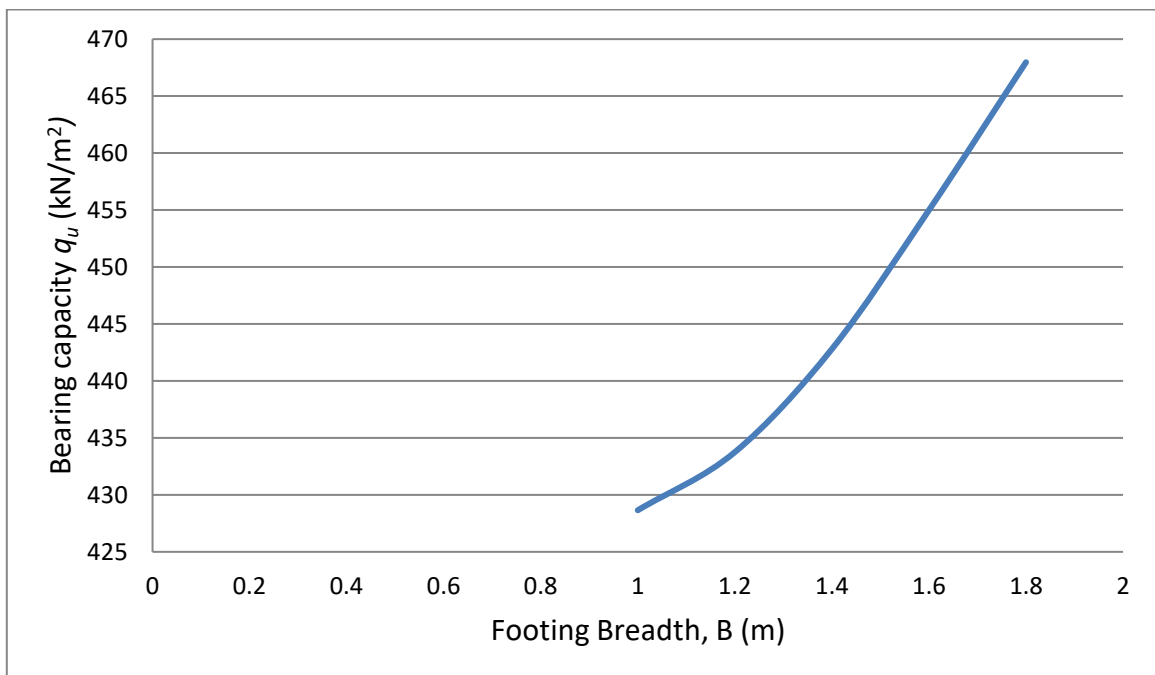


Fig. 5: Bearing capacity at 1.00m depth, 1.00m length and varying breadth

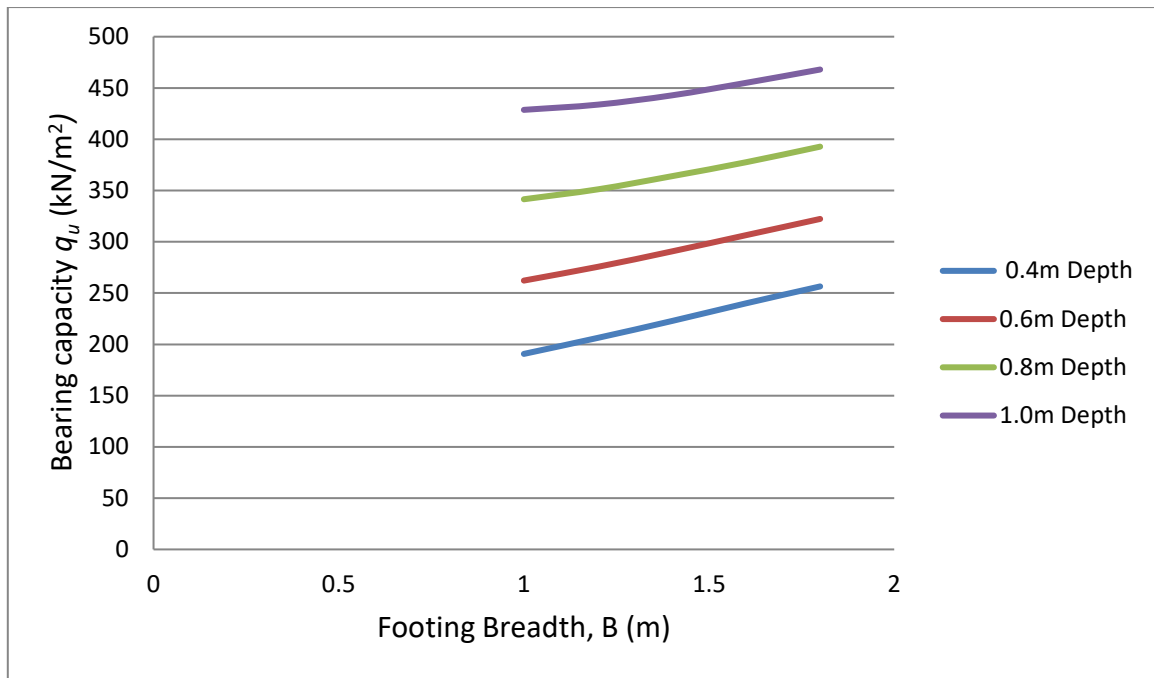


Fig. 6: Summary of the Bearing capacity (BC) at 1.00m length and varying breadth and depth of a shallow foundation footing

IV. DISCUSSION

Considering the bearing capacity (BC) details generated in Table 2 above as obtained from the model equation derived by incorporating existing registered data of the earth crust material of a cohesionless/sandy soil under dry condition and at minimum angle of friction, 26°. The three dimensional geometry parameters of the rectangular foundation footing were iterated at 1m length and varying breadth from 1m and varying depth from 0.4m respectively, to obtain the behavior at an increasing trend of 0.2m.

The bearing capacity data in Table 02, column 12 and 13 reveals that an increase 0.2m in the breadth of a rectangular foundation footing at a particular depth results in an increase in the load BC of a sandy soil at average value ranging from 16 to 10kN/m². It is also noted that the increase trend reduces as depth increases ranging from being directly proportional generating straight line curve to an indirectly proportional curve line nature, Figures 2 to 5.

However, it was also discovered that increase in the depth of the footing at a fixed length and breadth produced a progressive increase in the BC of a sandy soil. Considering 1.00m length by 1.00m breadth at the varying depth for instance, Table 3.

It should be recalled that the test by Vesic (1967) documented that the shape of the curve of footing settlement, S plotted against the applied load, Q is similar to that of stress-strain curve which depends on the dimension (geometry) of the footing, the composition of the supporting soil, the character, rate and frequency of loading.

The nature of the curves in Figures 2 to 6 predicts the geotechnical behavior of a rectangular foundation footing on a cohesionless (sandy) soil which stand as a useful information in foundation engineering practice.

Table 03: Bearing capacity at varying depth

Footing Length, L (m)	Footing Breadth, B (m)	Footing Depth, D _f (m)	q_u (kN/m ²)	Diff. (kN/m ²)
1.00	1.00	0.40	190.650	-
		0.60	262.156	71.506
		0.80	341.481	79.325
		1.00	428.647	87.166

V. CONCLUSION

Foundations are provided in the designed to serve as a remedy for the deficiencies of whatever nature has provided to support of the structure at a particular location and loading condition. The model thus predicts the geotechnical behavior of a rectangular foundation footing on cohesionless (sandy) soil and also clearly established the interrelationship between the dominant parameters of the soil and footing geometry for determining bearing capacity. The knowledge of this will therefore go a long way to help engineering decisions in the design of a safe footing on a sandy soil environment.

REFERENCES

- [1] Arora, K.R. (2009), Soil Mechanics and Foundation Engineering. Reprinted Edition, Standard Publishers , Delhi. 773-785
- [2] Craig, R.F. (1978), Soil Mechanics. Reprinted Edition, Van Nostrand Reinhold Co. Ltd, London
- [3] Das, B.M. (1984), Principle of foundation engineering. First Edition, Brook/Cole Engineering Division, Monterey.
- [4] Das, B.M. (2007), Principle of foundation engineering. Sixth Edition, Thomson Canada Limited, United State.
- [5] Kumbhojkar, A.S (1993), Numerical Evaluation of Terzaghi's N_f . Journal of Geotechnical Engineering, American Society of Civil Engineers, Vol. 119, No. 3, pp 598-607
- [6] Meyerhof, G.G. (1965), Penetration tests and bearing capacity of cohesionless soils. *Jnl. Soil Mech. Found. Division, ASCE*, SM1.
- [7] Murthy, V.N.S. (2008), Soil mechanics and foundation engineering. Reprinted Edition, Satish Kumar Jain Publishers and Distributors, New Delhi
- [8] Smith, G.N (1982), Elements of soil mechanics. 5th Edition, Granada, London
- [9] Smith, G.N (1978), Elements of soil mechanics for Civil Engineers. First Edition, Granada, London
- [10] Terzaghi, K. (1943), Theoretical soil mechanics. Waley.
- [11] Vesic, A.S. (1963), Bearing capacity of deep foundation in sand. Highway reseach board, National Academy of Science, Washington.

Decentralization and Humanization of Public Health Services

Marlene Simões e Silva¹, Pamela Nery do Lago¹, Carolina Costa Pinto¹, Renata Castro Mendes¹, Luciana de Moraes Lisboa¹, Ronaldo Gomes Rodrigues¹, Ana Paula Caetano Pereira¹, Luciana Moreira Batista¹, Andréia Elias da Cruz Nascimento¹, Pablo Raphael de Freitas¹, Merilaine Isabel dos Santos¹, Carla Renata dos Santos¹, Karine Letícia de Araújo Costa¹, Marília Antônia de Paula¹, Danielle Cristina de Oliveira Silva Saturnino¹, Liene de Fátima Carvalho¹, Nicolle Silva de Menezes¹, Flávia Lima Miranda¹, Aline Borges Penna¹, Maria Emília Lúcio Duarte¹, Raquel Resende Cabral de Castro e Silva¹, Mariângela Ferraz Rodrigues Araújo², Hirlla Karla de Amorim³, Kiwisunny Galvão Franzoi³, Fabiana Ribeiro da Silva Braga³, Ana Paula Ferreira Marques de Araújo³, Hilma Keylla de Amorim⁴, Luzimare de Matos Avelino Ventura⁴, Darlan dos Santos Damásio Silva⁴, Juliane Guerra Golfetto⁵, Leticia do Nascimento⁵, Marcelo Danglly Duarte Fernandes⁶, Rafaela Bezerra Gama Guimarães⁶, Maria Ivanilde de Andrade⁷, Leonardo Oliveira Silva⁸, Michelly Angelina Lazzari da Silva⁸, Diva Maria de Oliveira⁹, Samantha Lara da Silva Torres Anaisse¹⁰, Juliana Grazielle Lobato Alexandre¹¹, Eugênio Barros Bortoluzi¹², Fernando Henrique da Silva Costa¹², Luciana Latorre Galves Oliveira¹³, Walter Guimarães de Jesus¹³, Gisela Pereira Xavier Albuquerque¹⁴, Siomara Jesuina de Abreu Rodrigues¹⁵, Cijara Leonice de Freitas¹⁶, Raiane Almeida Silva¹⁷, Andressa Caline Inácio Natalino Campos¹⁸, Eliseu da Costa Campos¹⁹, Edmilson Escalante Barboza²⁰, Liane Medeiros Kanashiro²⁰, Tatiana Alves Costa²⁰

¹Clinical Hospital of the Federal University of Minas Gerais, Belo Horizonte, Brazil.

²University Center UNA Bom Despacho, Bom Despacho, Brazil.

³Clinical Hospital of the Federal University of Pernambuco, Recife, Brazil.

⁴Professor Alberto Antunes University Hospital of the Federal University of Alagoas, Maceió, Brazil.

⁵University Hospital of the Federal University of Santa Maria, Santa Maria, Brazil.

⁶University Hospital of the Federal University of Sergipe, Aracaju, Brazil.

⁷Municipal Prefecture of Lagoa Santa, Lagoa Santa, Brazil.

⁸University Hospital of the Federal University of Grande Dourados, Dourados, Brazil.

⁹Military Police Hospital, Belo Horizonte, Brazil.

¹⁰Walter Cantídio University Hospital of the Federal University of Ceará, Fortaleza, Brazil.

¹¹Hospital Sofia Feldman, Belo Horizonte, Brazil.

¹²Faculty of Applied Social Sciences, Campina Grande, Brazil.

¹³Faculty of Health and Human Ecology, Lagoa Santa, Brazil.

¹⁴University Hospital Complex of the Federal University of Pará, Belém, Brazil.

¹⁵Faculty of Health of Human Ecology and the Faculty of Education of Minas Gerais, Matozinhos, Brazil.

¹⁶Ana Bezerra University Hospital of the Federal University of Rio Grande do Norte, Santa Cruz, Brazil.

¹⁷Dr. Washington Antônio de Barros Teaching Hospital, Federal University of Vale do São Francisco, Petrolina, Brazil.

¹⁸Júlio Müller University Hospital, Federal University of Mato Grosso, Cuiabá, Brazil.

¹⁹Clinical Hospital of the Federal University of Triângulo Mineiro, Uberaba, Brazil.

²⁰Maria Aparecida Pedrossian University Hospital, Federal University of Mato Grosso do Sul, Campo Grande, Brazil.

Received: 29 Jun 2022,

Received in revised form: 16 Jul 2022,

Accepted: 24 July 2022,

Available online: 31 July 2022

©2022 The Author(s). Published by AI Publication. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *Collective Health, Fundamental Right, Health.*

Abstract— *The public disservice in health has become part of the daily lives of citizens, even with public policies of humanization and decentralization of services, representing an exceptional milestone for Brazilian public health. Thus, this research will investigate the proposal for decentralization and humanization of services to users, in line with article 6 of the Federal Constitution of Brazil (1988), and the Universal Declaration of Human Rights. It consists of a bibliographic survey, in which it was investigated through the Virtual Library in Saúyde, in the SciELO, LILACS databases and in the national legislation portal, in which the laws, decrees and ordinances referring to the subject of the study were researched, since which aims to present a proposal for the decentralization and humanization of health services to users in Brazil. 17 publications were analyzed in full, which were suitable for the purpose of this review. The decentralization of health services in Brazil is an important advance, bringing autonomy to health regions and a more directed management towards the adequate allocation of public resources to health in the country. Despite the legal support, what is perceived in practice is still far from what was expected and there is a long way to go to reach the desired quality standard when it comes to humanization of care. It is concluded, then, that even if the current legislation, there is still an important path to be followed for the health services provided in our country, present the desired level of excellence.*

I. INTRODUCTION

Health constitutes a fundamental right in concomitance with the point of view defended by the Portuguese scholar Andrade [1]; That said, there is a need to develop an intervention plan, whose main objective is to provide the user with better care that will guarantee him better human dignity.

According to Article 1, Universal Declaration of Human Rights (UDHR), “All human beings are born free and equal in dignity and rights”; that is, they are equal in rights and duties; In order to guarantee the human dignity of all, in this sense, item 1 of Article 25 of the UDHR, also considers health as one of the main human rights: “Everyone has the right to a standard of living sufficient to ensure and your family health and well-being” [2].

In this sense, Marques [3] argues that “the fundamental right to health, for example, does not depend on the occurrence of any fact to be claimed and does not find a necessary correlation in state duties”; that is, regardless of legal action, health constitutes a fundamental right, the one guaranteed by the Federal Constitution.

According to this line of reasoning, Law 8.080/1990 establishes the principles of health: integrality, universality and equity; as the basic principles of health. However, it is important to point out that these principles are not always guaranteed in basic health services, such as the Family Health Strategy (ESF), provided for in the National Policy and Primary Care [4, 5, 6].

Thus, this research has as main objective to prove the constitutionality of one of the main rights that the human being has in order to ensure human dignity, one of the principles of the UDHR; despite the explicit evidence of violation of the Federal Constitution and the UDHR [2, 7].

In this way, this work has as main objective, to present a proposal for decentralization and humanization of health services to users, in line with article 6 of the Federal Constitution of Brazil and the Universal Declaration of Human Rights; therefore, this work has the following specific objectives: to evaluate the positive and negative aspects of the decentralization of Health Services; to determine the effects of the regulation of the Constitutional Amendment 29 on the financing of Brazilian Public Health.

II. METHODOLOGY

This is a bibliographic research considering that this is a research alternative that proposes to search and analyze the published knowledge regarding a certain theme. A search was carried out in two databases, namely: SciELO (Scientific Electronic Library Online), LILACS (Latin American and Caribbean Literature on Health Sciences) and in the Virtual Health Library Network (BVS), with national and international publications. portal of national legislation, in which laws, decrees and ordinances referring to the subject of the study were researched, since it aims to present a proposal for decentralization and humanization of health services to users in Brazil.

As a criterion for inclusion in the sample, a search was carried out on the bases mentioned above with the Descriptors in Health Sciences (DeCS): public policy, humanization of care and women's health. The inclusion criteria defined for the selection of articles were: articles published in Portuguese, complete articles and articles published and indexed in the aforementioned databases. There was no temporal cut, since we sought to know the general panorama of public policies in the area of decentralization and humanization in health. A pre-analysis of all the articles found was performed, through the initial reading of the titles and abstracts and articles that were not related to the theme were excluded. Articles published in journals, Ministry of Health programs published in the VHL and published laws, decrees and ordinances related to the subject of the present study were considered as analysis documents.

The review in the databases resulted in 39 publications. Considering the inclusion and exclusion criteria, 22 were excluded from the study, as they did not specifically address the subject studied. Therefore, 17 publications were analyzed in full, which were suitable for the purpose of this review.

The presentation of the results and discussion of the data obtained was designed in a descriptive way, allowing the reader to assess the applicability of the review developed, in order to achieve the objective of this method, providing subsidies to nurses in their daily decision-making.

III. RESULTS AND DISCUSSION

Health as a Fundamental Right

Fundamental Rights are the basic individual, social, political and legal rights that are provided for in the Federal Constitution of a nation. As a rule, fundamental rights are based on the principles of human rights, guaranteeing freedom, life, equality, education and

security. They are essentially linked to the rights to freedom and dignity of the human person. Its emergence dates back to the French Revolution and the Declaration of the Rights of Man of 1789, consisting of the internalization by the Constitutional Charters of Sovereign States, of the precepts of the Declaration that preached freedom, equality and fraternity. They will deal with obligations to do (positive charge) applicable to state action. They will be configured as a result of the principle of material equality, in the case of social, cultural, economic and collective rights, born from the formatting of the Social State, which took place in the 20th century. It has immediate applicability, which rejects the thesis that considered second-generation fundamental rights as programmatic constitutional norms, which would depend on the regulation of the infraconstitutional norm for their effectiveness. These rights are the result of the social struggles that marked the 19th century; struggles motivated by the perception that the freedom and equality presented by the liberal capitalist state did not translate into material equality, having a merely formal character [8].

In this way, it ends up requiring a provision by the State for the realization of social justice, with the participation of all in social well-being. The dignity of the human person ends up becoming the value that will guide all development of human rights and fundamental rights. Its defense will be the principle and objective of the action of the State or the international community. Dignity becomes the principle that will centralize and lend unity to the entire national legal system, and thus all constitutional and infraconstitutional interpretation must be carried out with the fundamental precepts that make up this dignity as a guide. The right to health, as previously mentioned, is directly related to the principle of human dignity [9].

However, according to Article 6 of the Civil Code of Brazil; health also constitutes a Constitutional Law; "Education, health, work, housing, leisure, security, social security, maternity and childhood protection, assistance to the helpless are social rights" [7].

In this way, health is a fundamental social right, endowed with immediate applicability, although in certain cases with limited effectiveness. This immediate applicability brought in the text of the constitution serves to reinforce the normativity of these fundamental rights, in a clause that seeks to "ensure determinability to fundamental legal norms to the greatest extent possible, providing them with reinforced normativity [10].

Following this line, the Federal Constitution of 1988, in its article 196, also defends the following: "Health is a right of all and a duty of the State, guaranteed through

social and economic policies aimed at reducing the risk of disease and other health problems”. and universal and equal access to actions and services for their promotion, protection and recovery”; that is, health is a constitutional right that needs to be guaranteed by the State [7].

However, it is important to emphasize that this right has been violated, since the current health policies, despite having indispensable measures, the reality experienced by health users in Brazil is quite different, since the country has a population of 209 .3 million inhabitants; however, there are Brazilian areas that are geographically quite distant, which is one of the main reasons for the lack of assistance [11].

It is important to emphasize that the fundamental right in a subjective dimension is related to an idea of justiciability. Thus, the individual holder of a subjective right can appeal to the Judiciary to guarantee it, having a right of action to ensure that right. The question that arises is when a fundamental right assumes a subjective character [12].

Following this line, according to the approach of Machado, Lima and Baptista [13]; “The analysis of health policy in the last 26 years reveals numerous contradictions, which can be exemplified in three strategic challenges: the inclusion of health in the development model and in Social Security, financing and public-private relations”; that is, contemporary public policies are insufficient to meet the current demand in this century [13].

Thus, it is important to highlight that Article 2 of Law 8080/1990 argues that: “Health is a fundamental human right, and the State must provide the conditions necessary for its full exercise”; that is, the State must provide conditions for this fundamental right to be continuous for the population, however it is exposed in the media: television, connected and printed; the non-compliance with the duty of the executive branch related to the provisions of this article [14].

Thus, according to Machado, Lima and Baptista [13], they argue that “problems related to the disarticulation between spheres of government and sectors of social policy were frequently manifested and the efforts of integration remained restricted to certain strategies”; that is, the authors state that the lack of articulation of the governments can be constituted as one of the main causes of these violations mentioned.

Thus, Law 8142/1990 defends the right of health users to participate in the management of resources destined for this service from the Health Councils, in which some representatives of health users are chosen; in this sense, each municipality has the duty to create its respective

councils so that the right provided for in public policies is fully complied with [4].

Following this line, Item I of Article 3 of Law 8080/1990 [4]; has three pillars of public health:

Integrity – constitutes the set of everything used to form or complete a whole; completeness, that is, the total coverage of public health services for the population is foreseen [15].

Universality – quality or character of universality, generality, that is, health coverage needs to be full, for the entire population and not just part of it [15].

Equity – characteristic of something or someone that reveals a sense of justice, impartiality, exemption and neutrality, that is, the government should contribute to fairer access to health, including for people who live in places where access to health services is available. health are scarce [15].

Following this line, it is important to emphasize that it is up to the government to promote and effectively implement public policies that meet the pillars of health services. However, the government's ineffectiveness in complying with these principles is not new, since the contemporary population of this second decade of the 21st century lives in an epidemic of diseases that had already been eradicated from the lives of Brazilians such as measles and chickenpox. Thus, despite the public policies in force in the Brazilian territory providing for the integrity in guaranteeing this Constitutional Health Law, there is still much to be done for the effectiveness of national health guidelines, since before the implementation of the 1988 Constitution, the situation was much worse. [7].

Decentralization in Health

As highlighted by Fundação Oswaldo Cruz [16], the decentralization of both management and health policies in Brazil was based on the Federal Constitution of 1988 and regulated by Laws 8080/90 (Organic Health Law) and 8142/90.

Made in an integrated way between the Union, states and municipalities – it is one of the organizational principles of the Unified Health System (SUS). According to this principle, power and responsibility over the sector are distributed among the three levels of government, with the aim of providing services with more efficiency and quality, as well as inspection and control by society [16].

Since the legislative regulation, “each sphere of government is autonomous and sovereign in its decisions and activities, respecting the general principles and the participation of society” [16].

Decree 7,508 of 2011, which regulates Law 8,080/90, institutes a new arrangement for decentralization, in which the provision of SUS actions and services is based on the constitution of health regions. Each health region must guarantee integrality in the provision of services through the partnership between the member municipalities, and regulated by the Organizational Contract of Public Action (COAP) [16].

Analyzing these constitutional determinations, it is clear that a better management of public services through local autonomy is desired, which is extremely positive, since each place has its specificities and needs, thus being able to define in a personalized way the proper direction of public resources.

Principles of humanization in health

Aside from all the management of health services, it is also up to Organs competent bodies to legislate on the humanization of the care provided, as this goes beyond just considering the illness itself. Approaching humanization in health goes beyond treating the patient's physical body, but understanding their pain. In this sense, Hilab [17] notes that there are three principles proposed by the Ministry of Health:

Inseparability between care and management of health production processes: it is understood that practices are interdependent and complementary.

Transversality: these are concepts and practices that cross the different actions and instances, thus expanding the level of openness of intra- and inter-group communication, directly reflecting changes in health practices.

Autonomy and protagonism of the subjects: they are related to the co-responsibility between managers, users and the collective participation in the processes and management, that is, the service user has a voice and turn through the Health Councils and other instances.

Considering these principles, humanized health care "consists of treating the patient as an individual who needs excellence in care and reception during consultations, exams and other procedures. It is important to remember that humanization must be present in hospitals, clinics, offices, laboratories and other public and private health spaces" [17]. When there was the pain of the other, it is reasonable to offer the best possible care, even if the resources available are not the most advanced and complete.

IV. CONCLUSION

This work addressed the humanization and decentralization of health services to users, in line with article 6 of the Federal Constitution of Brazil (1988) and the Universal Declaration of Human Rights.

The decentralization of health services in Brazil is an important advance, bringing autonomy to health regions and a more careful management in the sense of adequate allocation of public resources to health in the country.

Despite the legal support, what is perceived in practice is still far from what was expected and there is a long way to go to reach the desired quality standard when it comes to humanization of care. The intertwining of senior management with those on the front line of service provision is necessary so that the real needs of users are understood and they can be assisted in a personalized way, conferring humanization on the service.

These are subjects of inexhaustible discussion. They can and should be addressed in new studies, as well as proposed improvements to the gaps that still exist in our public health services.

REFERENCES

- [1] Andrade, J. C. V. (2006). Os Direitos Fundamentais na Constituição Portuguesa de 1976. 3ª. ed. rev. atual. e aum. Brasília: Almedina.
- [2] Brasil. (1948). Declaração Universal de Direitos Humanos. Londres. Retrieved from http://www.mp.go.gov.br/portalweb/hp/7/docs/declaracao_universal_dos_direitos_do_homem.pdf.
- [3] Marques, S. B. (2004). Direito, Escassez e Escolha: em busca de critérios jurídicos, para lidar com a escassez de recursos e as decisões trágicas. Resenhas, [s. l.], 138-141. Retrieved from https://www.researchgate.net/publication/286372176_Resenha_Nacional/fulltext/5668264208ae8905db8e6346/Resenha-Nacional.pdf.
- [4] Brasil. (1990). Lei nº 8.142. Dispõe sobre a participação da comunidade na gestão do Sistema Único de Saúde (SUS) e sobre as transferências intergovernamentais de recursos financeiros na área da saúde e dá outras providências. Brasília. Retrieved from http://www.planalto.gov.br/ccivil_03/leis/L8142.htm.
- [5] Brasil. (2000). SUS - Princípios e Conquistas. Brasília: Ministério da Saúde. Retrieved from http://bvsms.saude.gov.br/bvs/publicacoes/sus_principios.pdf.
- [6] Brasil. Portaria nº 2.436, de 21 de setembro de 2017. (2017a). Aprova a Política Nacional de Atenção Básica, estabelecendo a revisão de diretrizes e normas para a organização da atenção básica, para a Estratégia Saúde da Família (ESF) e o Programa de Agentes Comunitários de Saúde (PACS). Política Nacional de Atenção Básica,

- Brasília. Retrieved from https://bvsm.s.saude.gov.br/bvs/saudelegis/gm/2017/prt2436_22_09_2017.html.
- [7] Brasil. [Constituição (1988)]. (2016). Constituição da República Federativa do Brasil. Brasília. Retrieved from https://www2.senado.leg.br/bdsf/bitstream/handle/id/518231/CF88_Livro_EC91_2016.pdf.
- [8] Bonavides, P. (1999). Curso de Direito Constitucional. 8ed. São Paulo: Malheiros.
- [9] Sarlet, I. W. (2012). A Eficácia dos Direitos Fundamentais: uma teoria geral dos Direitos Fundamentais na Perspectiva Constitucional. 11. ed. rev. atual e aum. [S. l.]: Livraria do Advogado.
- [10] Figueiredo, J. A. (2018). O controle das parcerias entre o estado, o terceiro setor e seus reflexos na concretização dos Direitos Sociais. Dissertação de Mestrado. Universidade Federal de Alagoas, Maceió. Retrieved from <http://www.repositorio.ufal.br/bitstream/riufal/3422/1/O%20controle%20das%20parcerias%20entre%20o%20estado%20e%20o%20terceiro%20setor%20e%20seus%20reflexos%20na%20concretiza%20c3%a7%c3%a3o%20dos%20direitos.pdf>.
- [11] Piovesan, F. (2005). Direitos humanos, o princípio da dignidade humana e a constituição brasileira de 1988. Revista dos Tribunais. Retrieved from <https://jus.com.br/artigos/31496/o-direito-fundamental-a-saude>.
- [12] Salzano, J. G. F. (2014). O direito fundamental à saúde mínimo: existencial e o conceito de reserva do possível. Revista Eletrônica. Retrieved from <https://jus.com.br/artigos/31496/o-direito-fundamental-a-saude>.
- [13] Machado, C. V, Lima, L. D. & Baptista, T. W. F. (2017). Políticas de saúde no Brasil em tempos contraditórios: caminhos e tropeços na construção de um sistema universal. Cad. Saúde Pública, 33 Sup 2, e00129616. Retrieved from <https://www.scielo.br/j/csp/a/HfmStkr5tNJKCCZW8qQdvz/?lang=pt&format=pdf>.
- [14] Brasil (2017b). A Legislação do SUS. Brasília. Retrieved from http://bvsm.s.saude.gov.br/bvs/publicacoes/progestores/leg_us.pdf.
- [15] Holanda, A. B. (2018). Dicionário Contemporâneo de Língua Portuguesa. [S. l.: s. n.]. Retrieved from <https://www.dicio.com.br/>.
- [16] Fundação Oswaldo Cruz. (s.d.). Descentralização. Retrieved from <https://pensesus.fiocruz.br/descentralizacao>.
- [17] Laboratório de Análises Clínicas Hilab. (2021). Humanização em saúde: o que é e quais são os princípios? Retrieved from <https://hilab.com.br/blog/o-que-e-humanizacao-em-saude/>.

Class Actions for a Writ of Mandamus Concerning Tax Matters in Brazil: Between Law and Political Philosophy

Renato Lopes Becho¹, Guilherme Paes de Barros Geraldini²

¹PhD in Law by Pontifícia Universidade Católica de São Paulo – PUC/SP (2000), visiting research at King’s College, London (2016). Professor of Law – PUC/SP. Federal Judge in São Paulo, SP, Brazil.

²Master in Law by Pontifícia Universidade Católica de São Paulo – PUC/SP (2018), Phd candidate at PUC/SP. Lawyer in São Paulo, SP, Brazil.

Received: 27 Jun 2022,

Received in revised form: 19 Jul 2022,

Accepted: 25 July 2022,

Available online: 31 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords—Brazil. Tax law, Class action for a writ of mandamus, Political Philosophy, Interdisciplinarity.

Abstract— This article aimed to analyze, exclusively from the point of view of Law, whether or not the judicial precedents from the Brazilian higher courts are sufficient to deal with the problems related to the use of class actions for a writ of mandamus concerning tax matters. Faced with a negative answer, the authors sought a multidisciplinary approach and found in Political Philosophy elements to broaden the debate and find more robust solutions to the problems presented. The first part of this analysis focuses on the Brazilian Supreme Court of Justice, which prescribes that lawsuits for a writ of mandamus seeking to assert the right of the taxpayer to tax offset must be filed together with prima facie evidence that the taxpayer is entitled to receive a tax credit, although the credit amount itself is not discussed at this stage of the lawsuit. Then, our research turned to the analysis of whether or not the content of these precedents is compatible with the specificities of class actions claiming several rights affected by a common question of law. To do so, we looked into the nature of trade associations and entities’ extraordinary standing to sue by substitution, which is inherent to class actions for a writ of mandamus, and the need for the common aspects of the dispute to prevail over its individual aspects. Otherwise, the collective relief granted in such class actions would be ineffective. The methodology used was analytical, comparing general objectives (indicated by Political Philosophy) and specific objectives of the legal system (related to Law) with statutes, jurisprudence and, mainly, precedents related to the theme. The conclusion of this analytical study between Law and Political Philosophy is that the limitations imposed by the judicial precedents from the Brazilian higher courts are not compatible with class actions for a writ of mandamus.

I. INTRODUCTION

It is known that, differently from the United States and the United Kingdom, there is no strong collectivist culture in Brazil, a fact that can be verified in the still meager role performed by collective lawsuits in our country. The problem, however, does not lie in the lack of

instruments to seek collective relief, but their poor application, which causes legal uncertainty around how they should be used.

In the Brazilian legal system, there are appropriate instruments aimed at the protection of collective rights pertaining to tax matters, such as the ordinary class

action and the class action for a writ of mandamus. However, the government's resistance to comply with the decisions arising from these actions—endorsed by complacent legislatures that create obstacles to the effectiveness of collective claims, such as those enshrined in Article 2-A of Law 9494/96, and a Judiciary that is reluctant to reject the application of such restrictions—leaves taxpayers with extreme legal uncertainty, and they often resort to individual lawsuits to claim their rights.

Among the many hurdles hindering effective collective relief in tax matters in Brazil, the application of Repetitive Theme¹ No. 118 of the Superior Court of Justice to class actions for a writ of mandamus has drawn attention. Repetitive Theme No. 118 prescribes that an action for a writ of mandamus aiming to assert a taxpayer's right to tax offset in case of overpayment must be accompanied by documentary, prima facie evidence of such overpayment capable of proving the petitioner's status as a tax creditor. Therefore, taxpayers wishing to file for a writ of mandamus to claim that the collection of a certain tax is illegal or unconstitutional and, consequently, to claim their right to offset any overpayment made in the past 5 years, must submit prima facie evidence of such payments at the moment of filing the application for the writ of mandamus. However, the requirement to submit evidence that the taxpayers are entitled to a tax credit in class actions for a writ of mandamus has been proving detrimental to the effectiveness of such a critical collective relief instrument.

To better illustrate the situation, let us take the hypothetical situation described below as an example.²

A trade association filed a class action for a writ of mandamus seeking a declaratory judgment that a certain tax liability does not exist because the assessment of such tax is illegal or unconstitutional. The association also asked the court to declare that its members are entitled to offset the amount paid in excess, respecting the statute of limitations. In his decision, the judge recognized that the collection was illegal or unconstitutional and declared that the petitioner is not mandated to pay such tax. However, the judge denied the right to tax offset because the trade association did not produce the proof of payment of the disputed tax made by its members or associates.

In this situation, one cannot help but wonder: was the judge right in his decision to follow Repetitive Theme No. 118 of the Superior Court of Justice and reject

the trade association's claim to have their member's right to offset recognized, on the grounds that they failed to submit proof of payment? In other words, is the Repetitive Theme in question applicable to class actions for a writ of mandamus? This is the question that this article intends to tackle and answer.

To that end, we will first analyze the content and background of Repetitive Theme No. 118 to identify the reasons why the Superior Court of Justice arrived at the conclusion that petitioners must prove their status as tax creditors when filing for a writ of mandamus. Subsequently, we will analyze the specifics around class actions for a writ of mandamus in order to determine if the requirement set forth in Repetitive Theme No. 118 is compatible with such procedural instrument. Our analysis will involve two fronts. The first concerns trade associations and entities' standing to sue to defend the interests of their members by means of a class action for a writ of mandamus. Investigating this element will allow us to conclude whether or not proof of a taxpayer's status as a tax creditor is requirable in cases of plaintiff substitution. The second front concerns the very procedural requirements of class actions whose subject matter is several rights with a common origin and their compatibility with the requirement set forth in Repetitive Theme No. 118.

We expect that the analysis of these elements will bring a satisfactory answer to the proposed question not only from a strictly legal point of view but facing the very ends that the State must pursue. Thus, while the answer may satisfy the legal system, it needs to be confronted with elements of Political Philosophy, in the terms that will be exposed. It is Political Philosophy that works with the general objectives of the State, while Law works on its specific microsystem, notably as an instrument for conflict resolution, using statutes, jurisprudence and precedents.

The methodology used was analytical, confronting general objectives, pointed out by Political Philosophy, and specific to the system, related to Law. All this has been done in order to find the best possible answer to satisfy greater social aspirations than the mere legal formalities that may be involved, regarding the use of class actions for a writ of mandamus concerning tax matters in Brazil.

¹ The Repetitive Themes are an attempt of summarizing the *ratio decidendi* of the leading cases ruled by the Brazilian Superior Court of Justice. After ruling a leading case, the Justices of Superior Court of Justice must summarize, in general terms, what has been decided and publish this summary it on their websites.

²Legal understanding under Repetitive Theme No. 118: "(a) In actions for a Writ of Mandamus compelling a court to declare the

right to tax offset, due to the recognition of such tax collection as illegal or unconstitutional, without the need to verify the respective amounts, prima facie evidence of the petitioner's status as a tax creditor shall be sufficient, since evidence of undue payment will be required later, at the administrative level, when the offset procedure is submitted to verification by the Tax Authorities."

II. REPETITIVE THEME NO. 118 AND THE NEED TO PROVE THE TAXPAYER'S STATUS AS A TAX CREDITOR

The applicability and the requirements related to suits for a writ of mandamus aiming at the declaration of the right to tax offset are the subject of an old discussion. However, it gained new attention with Controversy 43, which was submitted to the 1st Section of the Superior Court of Justice and analyzed by the Court from April 2018 through March 2019.³

In the long-gone 1990s, there was discussion about the applicability of a suit for a writ of mandamus to claim the right to tax offset in cases of undue payment. The dispute reached the Superior Court of Justice which, in view of its repeated precedent confirming the suit's applicability, issued Precedent No. 213 on October 2, 1998. Precedent No. 213 established that "a suit for a writ of mandamus constitutes an appropriate action to claim the right to tax offset."

The wording of the Precedent, however, turned out to be excessively broad and gave rise to a new dispute between the government and taxpayers. The government no longer challenged the applicability of actions for a writ of mandamus to claim a taxpayer's right to offset undue tax payments. It disputed, however, that this could be done without taxpayers proving their right to the full amount of credit claimed at the time of filing for the writ of mandamus.

The government's argument was that if prima facie evidence of the petitioner's right is required to apply for a writ of mandamus, then the petitioner should be mandated to submit, at the time of the application, evidence that they paid the tax in dispute. Otherwise, there would be no proof of undue payment and, consequently, there would be no liquidated and clear legal right to be protected by a writ of mandamus. Taxpayers, on the other hand, argued that there is no need to submit proof of undue tax payment at the time of the application, since the right to offset would be a logical consequence of the recognition of the illegality or unconstitutionality of the tax assessment, and the amount would only be determined at the administrative level after the mandamus becomes final and unappealable.

The discussion was once again taken to the Superior Court of Justice. On May 13, 2009, the Court heard Appeal No. 1.111.164/BA, which was the case representing the controversy, and established Repetitive Theme No. 118: "effective proof of overpayment or undue payment is

required for the purpose of claiming the right to tax offset in applications for a writ of mandamus."⁴

Once again, the wording of the decision was not sufficiently clear and discussions on the topic continued, until the Superior Court of Justice had to deliberate on the matter again in 2019. The Court analyzed Appeals No. 1.715.256/SP, 1.715.294/SP and 1.365.095/SP, as representatives of Controversy No. 43, to determine the scope of Repetitive Theme No. 118.

After the trial, the Superior Court of Justice explained the content of Repetitive Theme No. 118 as follows:

(a) In actions for a Writ of Mandamus compelling a court to declare the right to tax offset, due to the recognition of such tax collection as illegal or unconstitutional, without the need to verify the respective amounts, prima facie evidence of the petitioner's status as a tax creditor shall be sufficient, since evidence of undue payment will be required later, at the administrative level, when the offset procedure is submitted to verification by the Tax Authorities; and

(b) In actions for a Writ of Mandamus compelling a court to declare the specific amount to be offset, in which the petitioner claims to have a liquidated and clear legal right to a tax credit, or, in cases in which the court decision assumes that the offset would be confirmed by the relevant administrative authority, the taxpayer's credit must be quantified, and failure to submit sufficient evidence of the amounts unduly paid shall result in failure to submit prima facie evidence, which is imperative in actions for a writ of mandamus.

³ BRAZIL, Superior Court of Justice (1st Section). *Controversy 43*, May 18, 2018. Available at https://processo.stj.jus.br/repetitivos/temas_repetitivos/pesquisa.jsp. Accessed on January 11, 2021.

⁴ BRAZIL, Superior Court of Justice (1st Section). *Repetitive Theme 118*, May 25, 2009. Available at <https://bitly.com/gG8cJ>. Accessed on January 11, 2021.

The Superior Court of Justice ruled, therefore, that petitioners must prove their status as tax creditors in suits for a writ of mandamus seeking to assert the right to tax offset as a result of the recognition that the tax is not due because of illegality or unconstitutionality, although no judgment will be delivered on the amount of the credit itself. In other words, the Court decided that there is no need to enter in the docket all the documentary evidence of undue payment, but petitioners must prove that they are mandated by law to pay that specific tax and that the payment was made before the application.

Although there are fair reasons to criticize the Court's decision⁵, which will not be analyzed here so as to not overstep the scope of this article, the solution found by the Superior Court of Justice is feasible in individual actions for a writ of mandamus. In such individual suits, the petitioner is usually the holder of the right and, therefore, is able to produce the documentation required according to court precedents. However, in class actions, the solution found by the Court is absolutely inapplicable. Such is the object of our analysis henceforth.

III. CLASS ACTIONS FOR A WRIT OF MANDAMUS FILED BY TRADE ASSOCIATIONS OR ENTITIES FOR COLLECTIVE RELIEF IN TAX CLAIMS.

3.1. THE TRADE ASSOCIATIONS AND ENTITIES' STANDING TO SUE FOR A WRIT OF MANDAMUS: SUBSTITUTION, NOT REPRESENTATION

Legal relationships pertaining to tax matters involve, in most situations, several rights affected by a common question of law. As a result, disputes arising from such legal relationships can be protected by collective mechanisms, such as ordinary class actions and class actions for a writ of mandamus.⁶

The class action for a writ of mandamus, as well as the individual one, is provided for in the Federal Constitution of 1988 as a fundamental guarantee against

abuses by public authorities. Pursuant to Article 5, item LXX, of the Constitution, the class action for a writ of mandamus can be filed, among others, by "trade associations or entities legally constituted and in operation for at least one year to defend the interests of their members or associates."

Regulating such constitutional provisions, Law No. 12016/2009, in the main paragraph of Article 21, prescribes that these trade associations and entities may file for a writ of mandamus "to claim liquidated and clear legal rights of all or some of their members or associates, in accordance with their articles of association and provided that such rights are related to the association's or entity's purposes, and a *special authorization shall not be required to that end.*" Article 22 of Law No. 12016/2009 mandates that a court judgment on a class action for a writ of mandamus has *res judicata* effect "limited to the members of the group or category who were *substituted* with the petitioner."

Emphasis was placed on "special authorization shall not be required" and "substituted" because these excerpts are critical to understand whether Repetitive Theme No. 118 can be applied to tax class actions for a writ of mandamus. The two phrases show that, in class actions for a writ of mandamus, trade associations and entities act as substitutes, not as representatives, for their members or associates.

In individual lawsuits, usually the holder of the substantive right is the only person entitled to seek protection in court, under penalty of having the case dismissed for lack of standing.⁷ In class actions, on the other hand, usually persons or entities that are not part of the legal relationship pertaining to the substantive right in question have a legal standing to seek the protection of such right in court. Thus, in class actions, the holder of the right will, as a rule, be *represented* by or *substituted* with such person or entity.⁸

According to Chiovenda's classic lessons, there are situations in which the law allows someone to

⁵ Although the requirement of *prima facie* evidence of creditor status is formally correct, the fact that the petitioner is paid that tax is a logical result of their interest to sue. After all, if the petitioner had not made the payment, they have no interest to sue and the petition should be dismissed under Article 330, III, of the Code of Civil Procedure. Additionally, the existence of the tax liability and its amount will be calculated and verified by the Brazilian Federal Revenue Service, upon taxpayer's submission of the administrative offset request. Thus, there is no use or need to prove the taxpayer's status as a tax creditor.

⁶ According to: BUENO, Cassio Scarpinella. *Curso sistematizado de direito processual civil: direito processual coletivo e direito processual público*. 4th ed. São Paulo: Saraiva, v. 2, t. 3, 2014, p. 182. MAZZILLI, Hugo Nigro. *A defesa dos interesses difusos*

em juízo: meio ambiente, consumidor, patrimônio cultural, patrimônio público e outros interesses. 21st ed. São Paulo: Saraiva, 2008, pp. 708-709. MARINS, James. *Direito processual tributário brasileiro: administrativo e judicial*. 9th ed. São Paulo: Revista dos Tribunais, 2016, p. 687. FERREIRA NETO, Olsy da Silva. *Ações tributárias coletivas*. Porto Alegre: Sergio Antonio Fabris Editor, 2013, pp. 133-135.

⁷ Article 18, main paragraph, of the 2015 Code of Civil Procedure. No one can claim another's right in his or her own name, unless so authorized by law.

⁸ BUENO, Cassio Scarpinella. *Curso sistematizado de direito processual civil: teoria geral do direito processual civil*. 4th ed. São Paulo: Saraiva, 2010. pp. 400-402.

exercise someone else's rights *in the name of the holder* and others in which it allows someone to exercise someone else's rights *in their own name*. In the first situation, in which one acts in the name of others to defend their rights, there is procedural representation. In the second situation, in which one acts in their own name to defend the rights of others, there is procedural substitution.⁹

The main practical difference between these two legal concepts lies in the fact that in cases of representation, in which one acts in the name of others, authorization by the holder of the right is mandatory for the third party to appear in court. In cases of substitution, in which one acts in their own name, authorization is not required, after all, the third party is acting in their own name.¹⁰

Considering that Article 21 of Law No. 12016/2009 expressly states that no authorization is required for trade associations and entities to file a class action for a writ of mandamus to defend the interests of their members or associates, requiring only that their articles of association give permission to do so, one can only conclude that substitution is the mechanism that gives such entities standing to sue. After all, in these cases, the associations act in their own name—i.e., according to their institutional purposes—to assert other people's rights.

The conclusion that, in class actions for a writ of mandamus, associations have standing to sue by substitution, not by representation, is supported by Brazilian jurists. Hely Lopes Meirelles, for example, affirms that such actions “must always be filed by the eligible entity in its own name” “to assert the rights or prerogatives of its associates or affiliates.”¹¹ Similarly, Cassio Scarpinella Bueno maintains that “representation takes place whenever authorization is required to appear in court (Federal Constitution, Article 5, item XXI). When such authorization is not required, substitution is the mechanism used (for example, in the case provided for in Article 5, item LXX, b, of the Constitution).”¹² Also, James Marins asserts that “item LXX has nothing to do with representation, but rather with substitution, at the very least, or extraordinary standing to sue.” The author proceeds to criticize the need for a provision in the articles of association allowing the entity to file a class action for a writ of mandamus, as such

requirement set forth in Law No. 12016/09 is not supported by the Constitution.¹³ Eduardo Arruda Alvim echoes this understanding, stating that, for trade associations and entities to have the authority to seek collective relief for their associates via a writ of mandamus, “the convergence between the objectives pursued by the entity and the interests in dispute suffices.”¹⁴

Brazilian jurists are not the only ones who support the conclusion that, in class actions for a writ of mandamus, associations or entities have standing to sue by substitution, not representation. In addition to issuing Precedent No. 629, which states that: “authorization is not required for a trade association to file a class action for a writ a mandamus in favor of its associates,” the Federal Supreme Court expressly stated the following in the records of Appeal No. 573.232, which pertains to a matter of general repercussion:

3. Indeed, trade associations have standing to file lawsuits in favor of their associates as per Article 5, item XXI, of the Federal Constitution, and the unions' standing to sue is provided for in Article 8, item III, of the Federal Constitution. However, in the case of trade associations, the Constitution establishes a specific requirement as a condition for such lawsuits, which does not apply to unions, namely, that such associations must be “expressly authorized” to sue. *A different situation is that of class actions for a writ of mandamus, provided for in Article 5, item LXX, of the Federal Constitution, which do not require special authorization (individual or collective) from the substituted parties (Precedent No. 629 of the Federal Supreme Court),*

⁹ CHIOVENDA, Giuseppe. *Instituições de direito processual civil. Vol. II*. Campinas: Bookseller; 1998, pp. 300-302.

¹⁰ GRINOVER, Ada Pellegrini. Legitimação das associações às ações coletivas. representação ou substituição processual em face do princípio dispositivo e da teoria da asserção, March 2017, p. 3. Available at: <<https://goo.gl/daJjEk>>. Accessed on: January 12, 2020.

¹¹ MEIRELLES, Hely Lopes. *Mandado de segurança*. 29th ed. updated by Arnaldo Wald and Gilmar Ferreira Mendes. São Paulo: Malheiros, 2006. p. 25

¹² BUENO, Cassio Scarpinella. *O poder público em juízo*. 5th ed. São Paulo: Saraiva, 2009, p. 143

¹³ MARINS, James. *Direito processual tributário brasileiro: administrativo e judicial*. 9th ed. São Paulo: Revista dos Tribunais, 2016, p. 698.

¹⁴ ALVIM, Eduardo Arruda. *Mandado de segurança no direito tributário*. São Paulo: Revista dos Tribunais, 1997. pp. 355-356.

*even if the lawsuit relates only to the interests of some of the members or associates (Precedent No. 630 of the Federal Supreme Court and Article 21 of Law No. 12016/2009).*¹⁵

Having said that, one cannot help but wonder: if specific authorization from members or associates is not required even for the association to file a class action for a writ of mandamus, is it reasonable to require prima facie evidence that they are tax creditors? Is it reasonable to waive members' or associates' authorization to file a class action for a writ of mandamus, but to require that proof of payment of the tax in question be submitted together with the application?

The answer is certainly no. The requirement to prove the associates' or members' status as tax creditors is absolutely incompatible with the associations' standing to sue by substitution. If our legal system has authorized a certain entity to file a lawsuit to assert the rights of a third party without authorization from such third party, it does not make sense that this entity has to ask the substituted parties for proof of payment of the disputed tax, as this would ultimately mean authorization to file the application.

Therefore, one cannot escape the conclusion that the very mechanism chosen by the Brazilian legal system to give trade associations and entities standing to sue—by substitution, not representation—and seek collective relief for their associates or members through a class action for a writ of mandamus renders such action incompatible with Repetitive Theme No. 118 of the Superior Court of Justice. This conclusion becomes even clearer considering that the relief sought through a class action for a writ of mandamus, which is the protection of several rights that have a common origin, must necessarily be *generic*. Otherwise, the individual aspects of the dispute would prevail over shared ones and make collective relief simply ineffective. This is why the Brazilian legal system determines that judgments rendered in class actions seeking

the protection of several rights must be generic, allowing each person benefited by the judgment to pursue liquidation and execution individually.

3.2. GENERIC JUDGMENTS AND THEIR ENFORCEMENT

Law No. 12016/2009 contains only two articles—21 and 22—on collective applications for mandamus. It does not mean, however, that there are no important legal requirements in the Brazilian legal system for such instrument. As it is a collective procedural instrument, it must follow the rules that are part of the *collective procedural microsystem* in every matter that is not contrary to the specific provisions of such microsystem.

Jurists and courts widely recognize the existence of a collective procedural microsystem comprised, in particular, of Law No. 7347/85 (Public Interest Civil Action Law) and Law No. 8078/90 (Consumer Protection Code).

For example, Ada Pellegrini Grinover expressly states that the Public Interest Civil Action Law and the Consumer Protection Code must always be interpreted together, as these laws constitute the so-called “Brazilian collective procedural microsystem.”¹⁶ Similarly, Fredie Didier Jr. and Hermes Zaneti Jr. consider it possible to see the Consumer Protection Code as the “Brazilian Class Action Code,” as Title III of the Code harmonized the collective relief microsystem by changing the Public Interest Civil Action Law and unifying the provisions of the two laws on the protection of diffuse and collective rights.¹⁷ Ricardo de Barros Leonel also argues that the procedural rules of the Consumer Protection Code are applicable to all other collective relief cases.¹⁸ Specifically on class actions for a writ of mandamus, Cassio Scarpinella Bueno reminds us that Article 21 of the Public Interest Civil Action Law expressly provides that Title III of the Consumer Protection Code can be applied to diffuse, collective, and several rights, as appropriate.¹⁹

When it comes to court precedents, two of the main examples are the judgments rendered in Interlocutory Appeals to the Superior Court of Justice No. 1521617/MG²⁰

¹⁵ BRAZIL, Federal Supreme Court (Full Court). *Appeal to the Supreme Court No. 573.232*. Judge-rapporteur: Justice Ricardo Lewandowski. May 14, 2014. Available at <https://bitly.com/wMFyU>. Accessed on January 11, 2021.

¹⁶ GRINOVER, Ada Pellegrini. *Direito processual coletivo*. In: GRINOVER, Ada Pellegrini WATANABE, Kazuo; NERY JR, Nelson. *Código Brasileiro de Defesa do Consumidor: comentado pelos autores do anteprojeto*. Arts. 81 a 104 e 109 a 119. 10th ed. Rio de Janeiro: Forense, v. 2, 2011, p. 25.

¹⁷ DIDIER JR, Fredie; ZANETI JR, Hermes. *Curso de direito processual civil: processo coletivo*. 7th ed. Salvador: JusPodivm, 2012, p. 49-51.

¹⁸ LEONEL, Ricardo de Barros. *Manual do processo coletivo*. 4th ed. São Paulo: Malheiros, 2017, p. 163.

¹⁹ BUENO, Cassio Scarpinella. *Curso sistematizado de direito processual civil: direito processual público e direito processual coletivo*. 4th ed. São Paulo: Saraiva, 2014. p. 231.

²⁰ “CIVIL PROCEDURE. INTERLOCUTORY APPEAL. 2015 CODE OF CIVIL PROCEDURE. CITIZEN SUIT. ARTICLE 7 OF LAW NO. 8429/92. APPLICABILITY. [...] II - By virtue of the principle that compels the Court to fill in the gaps of the law, the Superior Court of Justice understands that Laws No. 4717/65, 7347/85, 8078/90 and 8429/92, among others, make up a collective procedural microsystem that aims at providing an appropriate, effective protection of the legal interests covered by them.”

and 1379659/DF²¹, recognizing the need for joint, supplementary and integrative application of the laws that make up the collective procedural microsystem.

Title III of the Consumer Protection Code provides, in Article 95, that “if the plaintiff’s claim is granted, the judgment shall be generic.”

In fact, Brazilian jurists understand that the best interpretation for this provision is that the judgment must be generic if the claim is too. If the petitioner can make a specific, determined claim, the judgment can also be so.²² However, as explained by Ricardo de Barros Leonel, as a rule, the claims stated in class actions dealing with several rights with a common origin, as is the case of class actions in tax matters, must be generic.²³ And this is due to the fact that, in the discovery and trial phases of the collective actions for the protection of several rights with a common origin, the collective aspects must necessarily prevail over the individual aspects. Otherwise there is no *superiority* of the collective relief over numerous individual reliefs, which is critical to maintain legal certainty and effectiveness.

Although Article 81, item III, of the Consumer Protection Code defines several rights as those arising from a common origin, having a common origin is not the only factor that makes individual substantive rights eligible for collective relief. More important than having a common origin is the need for collective aspects to *prevail* over individual aspects and for collective relief to be *superior* to individual relief in terms of justice and judgment effectiveness.²⁴

About this topic, Ada Pellegrini Grinover explains that prevalence and superiority can be equated with the legal possibility of the claim and the interest in the suit. According to the author, the prevalence of shared issues over individual ones can be interpreted as proof of the legal possibility of the claim because the Brazilian legal system does not have a mechanism for the collective protection of purely individual rights, but only for individual—or

several—rights affected by a common question of law. In turn, the superiority of collective over individual relief in terms of justice and effectiveness of the judgment can be equated with interest in the suit because the existence of more individual aspects than common ones would extinguish the interest and effectiveness of the collective action. That means to say that the suit would not be effective to settle the dispute.²⁵

Indeed, for a tax legal relationship to be eligible for protection through a class action for a writ of mandamus, first and foremost, the common aspects of the dispute must prevail over the individual ones. Thus, if the dispute concerns, for example, the size of a property for the purposes of calculating Real Estate Tax, or the tax category in which a certain manufactured product should be included, strictly speaking, such dispute would not be eligible for a class action. After all, the specific aspects of these cases prevail over their collective aspects. On the other hand, if the dispute arises, for example, from the incorrect application of a tax regulation by the tax authority, resulting in a tax overcharge, then, in general, the entire group of people who paid that tax is affected in a reasonably homogeneous way. In this situation, the common aspect of the dispute prevails over the individual ones. Additionally, in this case, a single class action judgment would be effective to settle the dispute in relation to all taxpayers substituted with the trade association or entity. That would avoid an overwhelming number of repetitive claims and conflicting decisions on similar individual cases. In the second scenario, the dispute would meet the prevalence and superiority criteria, and, therefore, would be eligible for collective relief mechanisms, with support in Political Philosophy (in the terms as will be seen below).

Due to the prevalence of collective aspects over individual ones, the relief sought in tax class actions, as well as their judgments, will be invariably generic, as per Article 95 of the Consumer Protection Code. The judgment

(BRAZIL. Superior Court of Justice (1ST Panel). *Interlocutory Appeal to the Superior Court of Justice No. 1521617/MG*. Judge-rapporteur: Justice Regina Helena Costa, May 16, 2017. Available at <https://bitly.com/ypNIY>. Accessed on January 11, 2021).

²¹ “CIVIL PROCEDURE. MISCONDUCT IN PUBLIC OFFICE. ACTIONS WITH RECOVERABLE LITIGATION COSTS BELOW 60 MINIMUM WAGES TO BE PAID BY THE UNION. COLLECTIVE RIGHTS MICROSISTEM. PROVISION FOR MANDATORY REVIEW IN THE CITIZEN SUIT ACT. ANALOGY. APPLICABILITY. [...] 2. It is clear that the law governing Citizen Suits (Law No 4717/65) can be used to regulate the collective procedural microsystem, and that it shall prevail over general provisions of the Code of Civil Procedure. The existence of procedural microsystems in our Legal System is recognized in several areas pertaining to collective rights, and their instruments can be used for the purpose of providing appropriate, effective relief. [...]” (BRAZIL. Superior Court of Justice (2nd Panel).

Interlocutory Appeal to the Superior Court of Justice No. 1379659/DF. Judge-rapporteur: Justice Herman Benjamin, March 28, 2017. Available at <https://bitly.com/2f3fz>. Accessed on January 12, 2021).

²² BUENO, Cassio Scarpinella. *Curso sistematizado de direito processual civil: direito processual coletivo e direito processual público*. 4th ed. São Paulo: Saraiva, v. 2, t. 3, 2014, p. 222.

²³ LEONEL, Ricardo de Barros. *Manual do processo coletivo*. 4th ed. São Paulo: Malheiros, 2017, p. 499.

²⁴ GIDI, Antonio. *A class action como instrumento de tutela coletiva de direitos: as ações coletivas em uma perspectiva comparada*. São Paulo: Revista dos Tribunais, 2007, pp. 160-161.

²⁵ GRINOVER, Ada Pellegrini. Da defesa do consumidor em juízo. In: GRINOVER, Ada Pellegrini; WATANABE, Kazuo; NERY JR, Nelson. *Código Brasileiro de Defesa do Consumidor: comentado pelos autores do anteprojeto*. Arts. 81 a 104 e 109 a 119. 10th ed. Rio de Janeiro: Forense, v. 2, 2011, p. 133.

will thus establish only the existence of credit, but not the credit amount.

In this regard, Ricardo de Barros Leonel's lessons are accurate:

“a condemnatory judgment on several claims with a common origin establishes, in general terms, the defendant's liability for damages caused to the plaintiffs in the circumstances described in the claim [...] making liquidation imperative, in most cases. In the liquidation phase, the aggrieved party must prove that an individual damage was caused, the causal link between the damage and the situation or action described in the judgment, and the amount of such damage.”²⁶

The logic behind class actions seeking the protection of several rights with a common origin, therefore, is that, in the discovery and trial phases of the suit, the common aspects of the dispute are taken into account, and individual aspects take a secondary role. In the liquidation and execution phase, the opposite happens: individual aspects prevail over shared ones.²⁷ Thus, after the generic judgment is rendered, the aggrieved party must prove that there is a causal link between their situation and that described in said judgment, as well as the amount lost due to the illegal actions taken by the defendant, as recognized in the judgment.

Due to this logic, in our opinion, only after this point must evidence of the substituted party's status as a tax creditor be required, as such evidence will prove the existence of a causal link between the situation experienced by the substituted party and the situation generically described in the judgment. Therefore, equipped with the court's decision that a certain tax is undue, the taxpayer should appear before the Federal Revenue Service of Brazil, and, after proving their status as a tax creditor, apply for the offset of the undue tax at the administrative level.

In other words, in class actions, including for a writ of mandamus, considering that the claim and judgment are usually generic, evidence of tax creditor status should not be required at the time of the application, pursuant to Repetitive Theme No. 118. Requiring such evidence would place a higher emphasis on the individual

aspects of the dispute to the detriment of the shared aspects, which is why it should not be required at the time of application, but only after the judgment is rendered, in the phase of liquidation and execution.

Thus, considering that tax offsets can be requested out of court, it is our understanding that such evidence should only be presented at the administrative level. In other words, taxpayers should prove the origin of the credit, demonstrating their status as a creditor, upon requesting the recognition of the credit and subsequent offset by the Federal Revenue Service.

Alternatively, in case the recognition of credit is denied by the Federal Revenue Service, each taxpayer benefiting from the decision rendered in the class action can seek the liquidation and execution of the judgment. In this case, the taxpayers can submit to the competent court, under Articles 97 and 98 of the Consumer Protection Code, proof of payment of the tax, proving their status as creditors and requesting the confirmation of such status. Subsequently, they will be able take the court's decision to the administrative level and pursue the relevant offset. It is in this context that Political Philosophy brings important argumentative reinforcement.

IV. A THEME OF POLITICAL PHILOSOPHY: THE JUSTICE MANAGEMENT

In several parts of the world, the issue of procedural management, or the efficient administration of justice, came into the agenda. Paul Martens, president emeritus of the Constitutional Court of Belgium, prefaced the book *Le Nouveau Management de La Justice et L'Indépendance des Juges*, referring to Political Philosophy, on the one hand, and jurisprudence, on the other. On this side (jurisprudence) are the classic legal categories, such as discussions about the effectiveness and validity of the rule and the independence of judges; while on the other side (Political Philosophy) issues of collection management, litigation costs, Judiciary budget, etc., effects of the “voice of Anglo-Saxon economic realism”, in the words of the jurist. He critically stated:

With the irruption of management in the administration of public affairs, a new type of normativity is creeping into the work of judges. Management obeys another logic, pursues other ends, introduces other

²⁶ LEONEL, Ricardo de Barros. *Manual do processo coletivo*. 4th ed. São Paulo: Malheiros, 2017, p. 499.

²⁷ LEONEL, Ricardo de Barros. *Manual do processo coletivo*. 4th ed. São Paulo: Malheiros, 2017, p. 501.

parameters. Axiologically neutral, it is – at least in appearance – not the bearer of an ideology to which another could be opposed. It is slyly, without displaying any pretensions other than quantitative, that he could insidiously summon justice to sacrifice his humanist ends on the grounds that they are unproductive.²⁸

For our part, we understand that Political Philosophy applied to Justice Management does not need to be opposed to Law. The search for legal interpretation can consider the managerial effects of choices, in order to obtain the best social benefit. In the specific case discussed in this article, the removal of limitations for the use of the class actions for a writ of mandamus concerning tax matters illustrates well how it is possible to reconcile the interests of taxpayers and the State's, providing tools for judges to resolve issues of merit for the largest number of taxpayers with lower burden for the Judiciary, which is possible with the smallest number of lawsuits.

In fact, the concerns expressed by the Brazilian National Council of Justice – CNJ in the annual report Justice in Numbers add to the arguments presented here.²⁹

V. CONCLUSION

This article aimed to analyze whether the limitations imposed by the judicial precedents from the Brazilian higher courts on the use of class actions for a writ of mandamus in tax matters meet the social objectives aimed both by Law and Political Philosophy. In order to contextualize the problem, Repetitive Theme n° 118 of the Brazilian Superior Court of Justice was explored as an example

To that end, we first looked into the content and background of Repetitive Theme No. 118. Such analysis allowed us to observe that the discussions regarding the possibility of claiming a taxpayer's right to

offset tax overpayment by means of mandamus is old and has been developing in an inconsistent way. First, Precedent No. 213 established in 1998 that “a suit for a writ of mandamus constitutes an appropriate action to claim the right to tax offset.”³⁰ Due to this precedent, the government no longer challenged the applicability of an action for a writ of mandamus to claim a taxpayer's right to offset undue payments of taxes and started to require prima facie evidence of such payments. The discussion was once again taken to the Superior Court of Justice, which heard Appeal No. 1.111.164/BA, in 2009, and established Repetitive Theme No. 118: “effective proof of overpayment or undue payment is required for the purpose of claiming the right to tax offset in applications for a writ of mandamus.” However, the issue continued to spark controversy and, in 2019, the Superior Court of Justice had to rule on the issue again for the third time. This time, the Court explained that, when seeking solely a declaratory judgment on the right to offset, with no judgment on the credit amount, taxpayers only need to prove their status as tax creditors. Proof of the specific amount that was overcharged is not required at the time of application.

An analysis of the background of Repetitive Theme No. 118, however, revealed that the solution found by the Superior Court of Justice takes into account only aspects inherent to individual suits and completely ignores the specifics of class actions for a writ of mandamus.

To prove this statement, the article investigated two aspects inherent to such class actions in tax matters.

The first concerns trade associations and entities' standing to sue—by substitution, not representation—to defend the interests of their members by means of a class action for a writ of mandamus. It was demonstrated that, in collective procedural law, the plaintiff usually has extraordinary standing to sue. This means that, in collective actions, as a rule, the holder of the right to sue is not the holder of the substantive right in dispute. The legal system gives a third party extraordinary standing to sue to claim the rights of others. However, there are situations in which such party acts in someone else's name, and others in which the party acts in its own name. In the first case, the mechanism allowing the third party to sue in the name of

²⁸ *Préface. Le Nouveau Management de La Justice et L'Indépendance des Juges.* Coord. Benoit Frydman e Emmanuel Jeuland. Paris: Dalloz, 2011. p. 2. Our free translation. In the original: “Avec l'irruption du management dans l'administration de la chose publique, c'est un nouveau type de normativité qui s'insinue dans le travail des juges. Le management obéit à une autre logique, poursuit d'autres fins, introduit d'autres paramètres. Axiologiquement neutre, il n'est – du moins en apparence – pas porteur d'une idéologie à laquelle on pourrait en opposer une autre.

C'est sournoisement, sans afficher de prétentions autres que quantitatives, qu'il pourrait insidieusement sommer la justice de sacrifier ses fins humanistes au motif qu'elles sont improductives”
²⁹ BRAZIL, National Council of Justice. *Justice in numbers 2021.* Brasília, DF, 2021. Available at <https://bitly.com/NIFRqC>. Accessed on July 23, 2022.

³⁰ BRAZIL, Superior Court of Justice (1st Section). *Precedent 213*, September 23, 1998. Available at <https://bitly.com/Dskw5>. Accessed on January 11, 2021.

others is representation, and authorization from the holder of the substantive right to be represented in court is mandatory. In the second case, the mechanism is substitution: the third-party files the collective lawsuit in its own name and does not need authorization from the holder of the substantive right.

As explained throughout the article, the Brazilian legal system gives trade associations and entities standing to file class actions for a writ of mandamus to assert the liquidated and clear legal rights of their members or associates without their specific authorization. Thus, when filing a class action for a writ of mandamus, trade associations and entities act in their own name to claim the rights of others as substitutes for the holders of the right, not representatives.

In view of these findings, one can conclude that the requirement of presenting prima facie evidence of the taxpayers' status as tax creditors when filing for a writ of mandamus—i.e. proof of the disputed payment by the substituted parties—goes against the non-requirement of authorization for trade associations or entities to bring class actions claiming the rights of their members or associates. After all, the only lawful way for trade associations or entities to have access to proof of payment of the disputed tax by their members or associates is requesting such documents from them, which is equivalent to requesting their authorization to file a lawsuit. Therefore, applying Repetitive Theme No. 118 to class actions for a writ of mandamus would create an exceptional, unlawful situation in which the entity would have extraordinary standing to sue by representation, not by substitution.

The article also shed light on another reason why Repetitive Theme No. 118 cannot be applied to class actions for a writ of mandamus: the fact that, in the discovery and trial phases of the collective actions for the protection of several rights with a common origin, the collective aspects must prevail over the individual aspects of the claim. By definition, several rights are individual and have common characteristics, which authorize their protection through collective relief. If individual characteristics prevail over the shared characteristics of these rights, there is no sense in claiming them through a collective instrument, under penalty of rendering such claim

ineffective. The requirement to submit prima facie evidence the taxpayer's status as a tax creditor places emphasis on very individual characteristics of the dispute, which must be analyzed in the phases of liquidation and execution of the judgment, not in the discovery and trial phases.

In view of the above, to objectively answer the question proposed in the introduction of this article, Repetitive Theme No. 118 was defined based on individual suits for a writ of mandamus and cannot be applied to class actions, otherwise it could render such actions ineffective. Evidence that each of the substituted parties are tax creditors and that they are covered by the collective judgment can and must be submitted, but only later, in the phases of liquidation and execution of the judgment.

In practical terms, such evidence should only be required for the recognition of the credit by the Federal Revenue Service, under the terms of Article 101 of Normative Instruction No. 1717/2017³¹, since that is the moment when the agency requests the submission of a court decision stating that the taxpayer is a creditor of the Federal Revenue Service.

A feasible alternative—although unnecessary from a judicial economy standpoint—would be allowing taxpayers covered by the collective judgment to enforce it, under Articles 97 and 98 of the Consumer Protection Code, upon submission of proof of payment of the tax, proving their status as creditors and requesting the confirmation of such status. Subsequently, they would be able take the court's decision to the administrative level and pursue the relevant offset.

The removal of the aforementioned limitation for the use of class actions for a writ of mandamus in tax matters meets the parameters of Political Philosophy, notably the search for greater social pacification at the lowest possible cost to the public coffers, which reinforces the importance of the search for interdisciplinary elements for solving legal problems.

REFERENCES

- [1] ALVIM, Eduardo Arruda. *Mandado de segurança no direito tributário*. São Paulo: Revista dos Tribunais, 1997.

³¹ "Article 101. The request for credit recognition shall be granted by the Tax Auditor of the Federal Revenue Service of Brazil, upon confirmation that:

I - the taxpayer is the plaintiff in the lawsuit;

II - the action refers to a tax administered by the Federal Revenue Service;

III - the court decision is final and unappealable;

IV - the request was formalized within a period of five (5) years from the date in which the court decision becomes final and

unappealable or from the date of the confirmation of abandonment of the execution of the judgment; and

V - if the credit is declared in an enforceable court decision, a court of justice has confirmed the abandonment of the execution of the judgment and the assumption of all costs and attorneys' fees related to the execution process, or a personal declaration of non-execution of the judgment has been presented before a Federal Court with a court certificate attesting to it;"

- [2] BRAZIL, National Council of Justice. *Justice in numbers 2021*. Brasília, DF, 2021. Available at <https://bitly.com/NIFRqc>. Accessed on July 23, 2022.
- [3] BRAZIL, Superior Court of Justice (1st Section). *Controversy 43*, May 18, 2018. Available at https://processo.stj.jus.br/repetitivos/temas_repetitivos/pesquisa.jsp. Accessed on: January 11, 2021.
- [4] BRAZIL, Superior Court of Justice (1st Section). *Precedent 213*, September 23, 1998. Available at <https://bitly.com/Dskw5> Accessed on: January 11, 2021.
- [5] BRAZIL, Superior Court of Justice (1st Section). *Repetitive Theme 118*, May 25, 2009 Available at <https://bitly.com/gG8cJ> Accessed on: January 11, 2021.
- [6] BRAZIL. Superior Court of Justice (2nd Panel). *Interlocutory Appeal to the Superior Court of Justice No. 1379659/DF*. Judge-rapporteur: Justice Herman Benjamin, March 28, 2017. Available at <https://bitly.com/2f3fz>. Accessed on: January 12, 2021.
- [7] BRAZIL. Superior Court of Justice (1st Panel). *Interlocutory Appeal to the Superior Court of Justice No. 1521617/MG*. Judge-rapporteur: Justice Regina Helena Costa, May 16, 2017. Available at <https://bitly.com/ypNIY>. Accessed on: January 11, 2021.
- [8] BRAZIL, Federal Supreme Court (Full Court). *Appeal to the Federal Supreme Court No. 573.232*. Judge-rapporteur: Justice Ricardo Lewandowski. May 14, 2014. Available at <https://bitly.com/wMFyU>. Accessed on: January 11, 2021.
- [9] BUENO, Cassio Scarpinella. *Curso sistematizado de direito processual civil: direito processual coletivo e direito processual público*. 4th ed. São Paulo: Saraiva, v. 2, t. 3, 2014.
- [10] BUENO, Cassio Scarpinella. *Curso sistematizado de direito processual civil: teoria geral do direito processual civil*. 4th ed. São Paulo: Saraiva, 2010.
- [11] BUENO, Cassio Scarpinella. *O poder público em juízo*. 5th ed. São Paulo: Saraiva, 2009.
- [12] DIDIER JR, Fredie; ZANETI JR, Hermes. *Curso de direito processual civil: processo coletivo*. 7th ed. Salvador: JusPodivm, 2012.
- [13] FERREIRA NETO, Olsy da Silva. *Ações tributárias coletivas*. Porto Alegre: Sergio Antonio Fabris Editor, 2013.
- [14] CHIOVENDA, Giuseppe. *Instituições de direito processual civil. Vol. II*. Campinas: Bookseller; 1998.
- [15] GIDI, Antonio. *A class action como instrumento de tutela coletiva de direitos: as ações coletivas em uma perspectiva comparada*. São Paulo: Revista dos Tribunais, 2007.
- [16] GRINOVER. Ada Pellegrini. Da defesa do consumidor em juízo. In: GRINOVER. Ada Pellegrini; WATANABE, Kazuo; NERY JR, Nelson. *Código Brasileiro de Defesa do Consumidor: comentado pelos autores do anteprojeto*. Arts. 81 a 104 e 109 a 119. 10th ed. Rio de Janeiro: Forense, v. 2, 2011.
- [17] GRINOVER. Ada Pellegrini. Direito processual coletivo. In: GRINOVER. Ada Pellegrini WATANABE, Kazuo; NERY JR, Nelson. *Código Brasileiro de Defesa do Consumidor: comentado pelos autores do anteprojeto*. Arts. 81 a 104 e 109 a 119. 10th ed. Rio de Janeiro: Forense, v. 2, 2011.
- [18] GRINOVER, Ada Pellegrini. Legitimação das associações às ações coletivas. representação ou substituição processual em face do princípio dispositivo e da teoria da asserção, March 2017, p. 3. Available at: <<https://goo.gl/daJjEk>>. Accessed on: January 12, 2020.
- [19] LEONEL. Ricardo de Barros. *Manual do processo coletivo*. 4th ed. São Paulo: Malheiros, 2017.
- [20] MARINS, James. *Direito processual tributário brasileiro: administrativo e judicial*. 9th ed. São Paulo: Revista dos Tribunais, 2016.
- [21] MARTENS, Paul. *Préface. Le Nouveau Management de La Justice et L'Indépendance des Juges*. Coord. Benoit Frydman e Emmanuel Jeuland. Paris: Dalloz, 2011.
- [22] MAZZILLI, Hugo Nigro. *A defesa dos interesses difusos em juízo: meio ambiente, consumidor, patrimônio cultural, patrimônio público e outros interesses*. 21st ed. São Paulo: Saraiva, 2008.
- [23] MEIRELLES, Hely Lopes. *Mandado de segurança*. 29th ed. updated by Arnaldo Wald and Gilmar Ferreira Mendes. São Paulo: Malheiros, 2006.

Gender Inequality: An obstacle to sustainable development

Maria Auxiliadora Tavares da Paixão, Profa. Dra. Lucia Marisy Souza Ribeiro de Oliveira, Profa. Dra. Luciana Souza de Oliveira, Timnada Paixão Fagundes Pereira

Received: 11 Jun 2022,

Received in revised form: 04 Jul 2022,

Accepted: 10 July 2022,

Available online: 31 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article under
the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *gender inequality; sustainable development; SDGs; labor market; globalization.*

Palavras-chave— *desigualdade de gênero; desenvolvimento sustentável; ODS; mercado de trabalho; globalização.*

Palabras clave— *desigualdad de género; desenvolvimiento sustentable; ODS; mercado de trabajo; globalización.*

Mots-clés— *inégalité entre les sexes ; le développement durable; ODD ; marché du travail; mondialisation.*

Abstract— *This article addresses gender inequality, placing it in the context of contemporary society, influenced by neoliberal capitalism, which privileges the culture and way of life of the white population as a universal value. It points out that the deep origins of material inequalities between men and women go beyond mere arbitrarily motivated discrimination by gender, reaching social structures through which capitalist societies shaped human activity, both in the market and in the family, ignoring the advances made by legal instruments. It also highlights that sustainability must go beyond the management of human resources, including issues related to the population that suffers from socio-environmental injustices due to racial, ethnic or gender reasons and the urgent need for the broad recognition that women are an essential part of sustainability and the resolution of several problems that affect contemporary societies.*

Resumo— *Este artigo aborda a desigualdade de gênero, situando-a no contexto da sociedade contemporânea, influenciada pelo capitalismo neoliberal, que privilegia a cultura e o modo de vida da população branca como valor universal. Aponta que as origens profundas das desigualdades materiais entre homens e mulheres estão além da mera discriminação motivada arbitrariamente pelo gênero, alcançando estruturas sociais pelas quais as sociedades capitalistas moldaram a atividade humana, tanto no mercado como na família, ignorando os avanços obtidos pelos instrumentos jurídicos. Destaca ainda que a sustentabilidade deve ir além da gestão dos recursos humanos, incluindo questões referentes à população que sofre com injustiças socioambientais devido a razões raciais, étnicas ou de gênero e a necessidade urgente do reconhecimento amplo de que as mulheres são parte essencial para a sustentabilidade e a resolução de diversos problemas que acometem as sociedades contemporâneas.*

Resumen— *Este artículo aborda la desigualdad de género, situándola en el contexto de la sociedad contemporánea, influenciada por el capitalismo neoliberal, que privilegia la cultura y forma de vida de la población blanca como un valor universal. Señala que los orígenes profundos de las desigualdades materiales entre hombres y mujeres van más allá de la mera discriminación de género arbitrariamente motivada. Llegando a las estructuras sociales a través de las cuales las sociedades capitalistas moldearon la actividad humana, tanto en el mercado como*

en la familia, desconociendo los avances de los instrumentos jurídicos. También destaca que la sustentabilidad debe ir más allá de la gestión de los recursos humanos, incluyendo temas relacionados con la población que sufre injusticias socioambientales por razones raciales, étnicas o de género y la urgente necesidad del amplio reconocimiento de que las mujeres son parte esencial de la sustentabilidad y la resolución de diversos problemas que afectan a las sociedades contemporáneas.

Resumée— *Cet article aborde l'inégalité entre les sexes, en la situant dans le contexte de la société contemporaine, influencée par le capitalisme néolibéral, qui privilégie la culture et le mode de vie de la population blanche comme valeur universelle. Il souligne que les origines profondes des inégalités matérielles entre les hommes et les femmes sont plus qu'une simple discrimination sexuelle motivée par l'arbitraire. atteindre les structures sociales à travers lesquelles les sociétés capitalistes ont façonné l'activité humaine, tant sur le marché que dans la famille, ignorant les avancées des instruments juridiques. Il souligne également que la durabilité doit aller au-delà de la gestion des ressources humaines, y compris les questions liées à la population qui souffre d'injustices socio-environnementales pour des raisons raciales, ethniques ou de genre, et le besoin urgent d'une large reconnaissance que les femmes sont un élément essentiel de la durabilité et de la résolution des divers problèmes qui affectent les sociétés contemporaines.*

I. INTRODUCTION

In place of the so-called studies on women, gender studies emerged in the 1970s, initially in the field of Social Sciences and today approached by several other areas of knowledge, as they are the same interdisciplinary, whose objective is to break with the tendency to seek in biological determinism the explanation for the inequalities between men and women, thus promoting, among other things, the overcoming of the theories of sexual roles and the complementarity of the sexes. Therefore, analyzing gender inequalities consists of understanding the relationships between men and women in different spaces of society.

The concept of gender used here does not follow a single theoretical perspective, and can be directed to three different axes:

- a. The origins of patriarchy to justify the submission of women to men by the need that the latter has to transcend himself through the reproduction of the species;
- b. The subordination of women from the angle of historicity, explaining the inequalities between the sexes from the point of view of productive relations;
- c. The foundations of the French Psychoanalyst School, which is based on language, communication, interpretation and representation of the genre, not only referring to

written and verbal language, but also including symbolism and meanings.

From this direction, the definition of the classic theorist Elisabeth Souza Lobo (1991) was taken, where gender is a category of social relationship that crosses history and the social fabric, institutions and mentalities, theories about family, market of work, citizenship, political parties, social movements and subjectivities, in the perspective of understanding the social meaning of female work and the insertion of women in the market for the production of goods and services, where they acquire a new identity and discover themselves as a person in the interaction with the other, in a relationship of reciprocity and exchange.

In this sense, the analysis of gender inequalities consists of identifying how the relationships between men and women are constituted in terms of the distribution of power or, what is the social equivalence between male and female genders. Both official statistics brought by the IBGE – Instituto Brasileiro de Geografia e Estatística, as well as studies carried out at the academy, show the existence of inequalities between men and women, exemplified by the low political representation of women in parliament; low salaries compared to men who have the same level of education and hold identical positions in organizations; the trivialization of violence against women and the feminization of poverty, in addition to the double

working day, when they enter the salaried market, when they return from formal work, they start another domestic journey, preparing meals, cleaning the house, taking care of the children, guiding the school tasks.

This energy expenditure generates negative impacts on their physical and mental health, preventing them from taking care of themselves, doing leisure activities, recovering physical stress through rest, eating properly and sleeping for the time recommended by the World Organization of health, which requires a rethinking of this gender inequality, in order to reduce such inequities, because gender differences are predominantly of social and structural origin, so that man, as a category, has more social power than the woman, also as a category.

On the subject, the classic author Saffioti (1992) emphasizes the fundamental role of "power" institutions in legitimizing sexual stereotypes. She says that "The role of religious, educational and juridical doctrines has always been to affirm the meaning of masculine and feminine, built within power relations" (1992). From this perspective, the notion of biologically determined sexes should be abandoned, where the man is endowed with the so-called virile qualities, such as courage, strength, sexual vigor, greater capacity to enter the better paid professions, while the woman presents herself as fragile, incapable of assume command positions and equipped for the activities of caring for the home, family and the elderly.

The 1988 Federal Constitution guarantees equal rights for men and women, with special emphasis on the labor sphere. Since then, public policies have been created to combat discrimination and prevent the female workforce from being purposefully segregated or disqualified, however, despite the legal and normative achievements, gender discrimination continued to manifest itself in different ways in Brazil (Hirata, 2007).

During the Vargas era, there were important advances with significant repercussions on women's emancipation with maternity protection and equal labor rights for men and women and the fight against discrimination in employment; the prohibition for the employer to adopt admission criteria based on sex, skin color and marital status; and guaranteed the right to retirement for

women after 30 years of contribution.

It is clear that such advances in Brazil were due to the conventions of the International Labor Organization, especially numbers 100 and 111, which deal with equal pay for men and women workers and equal treatment in employment, and of which the Brazil is a signatory and that contributed to the confrontation of obstacles faced by

women (MARTINS, 2009). As Bourdieu (2011) states, the work that suits women is still situated in the extension of domestic functions: teaching, care, service. Perhaps for this reason, the growth of women's participation in the formal job market since the 1970s, although it has significantly modified their role in the family environment and in society, even contributing to the configuration of new family models, has not changed in the same way. proportion to their social and identity representation, still associated with domestic, educational and assistance tasks in the family environment, and with "female" occupations in the work environment, which, in practice, are similar jobs, because, despite requiring knowledge and specific technical skills such as care practices that involve the worker emotionally.

Labor legislation to protect women's work has extended maternity leave from 90 to 120 days, without prejudice to employment and salary, including for domestic, independent and rural workers (LOPES, 2006). Another significant innovation in the field of social rights was the guarantee of the pregnant woman's employment from the confirmation of pregnancy until five months after delivery, prohibiting her dismissal during this period. Among many other advances, the articles that authorized the husband's interference in the adult woman's employment contract were removed from the CLT - Confederation of Labor Laws (Law 7.855/89).

It can be seen, therefore, that the equality of rights between the genders is not resolved simply through legislative texts that announce a new reality. There is a distance between fact and law, because, in reality, the facts that generate the exclusion of women in society are rooted in the essence of society's patriarchal culture, which imposes the recognition of a set of values, beliefs and attitudes, in such a way that the man considers himself, by the simple nature, superior to the woman. This leads to the social construction of law and politics by instituting two situations: a visible one, which is the so-called equality of all before the law; another, invisible, which is effective inequality. However, what must be sought is equality through inequalities. And, for this to come to fruition, it is important to bring to light for reflection, that inequality is not universal and homogeneous, as some desecrate, but dynamic and continuous, because it runs through various social aspects in which the different collective groups of women, depending on a greater or lesser intensity of oppression.

From a sociological point of view, patriarchy constitutes the basis of exclusion, that is, the set of mechanisms that are rooted in the structure of a society, from which certain people or groups are rejected or

despised from their full participation in culture, in economy and politics of the society in which they live.

Despite the struggles for gender equality, undertaken by urban and rural feminist movements; the development of policies for equality in the world of work; the expressive insertion and participation of workers in the service sector, identified by different studies as one of the great employers in the Brazilian urban economic scenario; the analysis reveals, through processes of "feminization and feminization of professional occupations," a persistent sexual division of labor (YANNOULAS, 2011; 2013).

Given this, the question is: what explains the permanence of wage disparity and female occupational segregation in Brazilian society, despite constitutional advances?

A ready answer to this question does not exist, however, Sorj (2001) considers some assumptions, such as: the changes that have taken place in the labor market in relation to the increase in women's participation stem from a set of changes suffered by Brazilian society such as the reduction of fecundity; the number of formal marriages; the increase in unmarried women; increase in the elderly population with a strong female presence; higher life expectancy for women compared to men; expansion of schooling; reduction in family size, economic-financial globalization, reducing barriers to the movement of capital on a world scale; productive restructuring, with the introduction of the flexible accumulation model; and the technological revolution with the convergence of communications, telecommunications and information technology, without which the phenomena of accelerating production, circulation and consumption times and the compression of space would not have been possible.

The author recalls that in the world of work, social inequalities are structured not only from the division between owners of the means of production and holders of the workforce, but also between genders, occupations, qualifications, productive sectors and formal and informal labor markets and that the explanation for the permanence of these phenomena must also be sought in historical-structural characteristics of Brazilian society and in an interrelated set of demographic, social, economic, political and cultural changes, largely related to the more recent structural transformations, which took place after the crisis of capitalism in the 1970s.

Therefore, thinking about social transformation involves transgressing the norms of behavior, domination and power imposed by society on genders, which does not mean the exclusion of the masculine, but thinking about men and women from the relational character of power, where the themes equality and inequality can be reflected

in several aspects. But this is not a simple task, because breaking with cultural paradigms requires time and political-social training, in addition to the institutionalization of legal norms and their operation, which has not been satisfactorily occurring in Brazil.

Even in the case of women who manage to penetrate the corporate world, the presence of discriminatory mechanisms can be seen. It is rare for women in these large corporations to reach the highest hierarchical positions - a phenomenon known as the "glass ceiling," as such positions are usually reserved for men.

This article aims to prove that the fight against gender discrimination through labor legislation has not been able to eliminate inequalities between men and women in the world of work, but also to point out initiatives to promote gender equity, requiring organizations to break in their sexist culture.

II. GENDER EQUALITY AND THE SDGs – SUSTAINABLE DEVELOPMENT GOALS

The Sustainable Development Goals (SDGs) are the United Nations' universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity (2030 AGENDA).

In 2015, the United Nations (UN) outlined objectives, targets and indicators for this action, drawing up 17 goals to be met by the Nations by 2030, hence the name Agenda 2030.

Goal number 5 – GENDER EQUALITY, focuses on equality between women and men and the empowerment of all girls and women for a better world. As already mentioned in this article, it is possible to see advances in gender relations in all parts of the world, however, according to the UN document - United Nations, one billion women and girls aged 15 and over are illiterate. And more girls than boys are out of school. Poverty also has a woman's face: between the ages of 25 and 34, women are 25% more likely to live in extreme poverty than men. As for child marriage, around 12 million girls are married before the age of 18 annually worldwide (2030 AGENDA).

UN Women put the gender issue in perspective in the report Gender equality: women's rights in review 25 years after Beijing, highlighting the inequities suffered by women, especially black women, emphasizing that the development of any country depends on the fair distribution of benefits or of responsibilities between men and women, according to their differences and respective needs. Equal rights in marriage; in access to education; in job and income opportunities; in a life free from poverty,

according to the second article of the Universal Declaration of Human Rights which says: “everyone is capable of enjoying the rights and freedoms set forth in this Declaration, without distinction of any kind [...]”. Thus, it is necessary to end all forms of discrimination and all forms of violence against women and girls, as written in the first goals of SDG 5,

since development and democracy in the country will not be consolidated until this social discrepancy is resolved.

Claiming their place in the debate on sustainable development and in the decisions to be taken, women opened space for the discussion of the development model that was then implemented in the 70s and 80s of the last century, denouncing its environmental and also social unsustainability, gaining strength articulation of peasant women in the struggle for agrarian reform; the struggle for equal rights by the women's collective of the Landless Rural Workers Movement and others that were consolidated over time.

In the Beijing platform in the 1990s, the participation of women in the environmental debate was strongly defended, as they are, due to their essence as caregivers, the best to implement any actions that benefit future generations and, ultimately, societies as a whole. a whole (UN Women, 1995). The text says:

“As consumers, producers, educators and responsible for the care of their families, women play an important role in promoting sustainable development through concern for the quality and sustainability of life for current and future generations “(UN WOMEN, 1995).

Thus, women became the main instrument for the implementation of actions and policies against the degradation of the environment, against poverty, against child malnutrition, against illiteracy and the low access of children to school education and against the great controllable epidemics. around the world. At the national level, there have been advances and setbacks, as already explained in this text, however, thinking about women and the environment necessarily involves the struggle for land, because it is about territories that the environmental dispute takes place, emphasizing the omission of the state in the demarcation of indigenous lands, quilombolas and populations of African origins.

Despite the struggles, women's autonomy has a long way to go, as it largely depends on the recognition of their contribution to sustainable economic and social development, as protagonists in transformations, capable of interfering in public policies.

By sustainability, what is being considered here is the ability of a process or form of resource appropriation to continue to exist for a long period of time. It is a concept linked to sustainable development, that is, “development that meets current needs without compromising the ability of future generations to meet their own needs” (CMMMD, 1991). Sustainability not as a way of doing, but as a way of being.

In this perspective, a feminine look is essential within the environmental sphere, with a view to providing a critical look at the social origins of environmental problems that affect, in a non-homogeneous way, different human groups and communities, particularly women. The role that women have been playing in agroecological production systems cannot be ignored, where the binomial woman - environment is a sine qua non condition for the theme of sustainability.

At the Second International Conference on Women (1980), in Copenhagen, something very relevant was the recognition that women were never on the sidelines of the socio-economic process of their countries, but, on the contrary, were always “integrated”, only under conditions unequal, and it is up to development policies to lay their foundations on the promotion of women as an unequal subject and not a needy subject. However, five years later, at the third International Conference held in Nairobi, Kenya, it was found that most of the problems discussed in Copenhagen remained unchanged, questioning the validity of these meetings (DI CIOMMO, 1999).

On sustainability, Ignacy Sachs (2002), proposes the dimensions that must be taken into account for its effectiveness:

1. Social – Fair income distribution, full employment with decent quality of life and equal access to social resources and services by women.
2. Cultural – Balance between respect for tradition and innovation and self-confidence, combined with openness to the world.
3. Preservation of the potential of natural capital in its production of renewable resources and limiting the use of non-renewable resources.
4. Environmental – Respect for the self-purification capacity of natural ecosystems.
5. Territorial – Balanced urban and rural configurations, with improvement of the urban environment, overcoming inter-regional disparities and environmentally sound development strategies for ecologically fragile areas.
6. Economic - Balanced economic development, with food security, modernization of production instruments,

autonomy in scientific and technological research and national sovereignty.

7. National Policy – Universal appropriation of human rights and social cohesion.

8. International Policy – Guarantee of peace and promotion of international cooperation, based on the principle of equality and precaution in the management of the environment and natural resources; in the protection of biodiversity; in controlling climate change, as a common heritage of humanity.

By emphasizing these dimensions, Sachs makes it clear that, in order to achieve sustainability, we must value people, their customs and knowledge. It is evident that a holistic view of society's problems must be taken, in addition to focusing only on the management of natural resources. In this sense, several emerging issues arise that converge several challenges, for example, combating hunger, the right to land for landless workers and indigenous people, environmental justice in relation to minorities and gender issues. It is a much deeper thought, which aims at a true metamorphosis of the current civilization model.

Therefore, thinking about sustainable development with a gender perspective implies formulating intervention proposals based on equity between women and men and carrying out proposals for institutional change with a more egalitarian and democratic objective.

The review of the reality of gender in countries such as Cuba, Brazil and Mexico, found some similarities and some differences in projects financed by international organizations developed by them. According to the publication of the results of the "Cuba, Mujeres y Hombres y Desarrollo Sostenible" Project, financed by the UNDP, women proved to be excellent administrators of natural resources, but few participate actively in decision-making processes around environmental issues at the local and regional; in Mexico, the Programa de Innovación Agropecuaria Local, women are more aware of the usefulness of medicinal and ornamental plants, the diversity of seeds and the planting of home gardens, while men are more knowledgeable about forest resources and forestry activities for commercial purposes, as well as in relation to large-scale food planting. In the three countries (Cuba, Brazil and Mexico), there was an inequality in the distribution of domestic tasks. While the woman is responsible for taking care of the children, the elderly and the sick, in addition to all the other duties of the house, the man is responsible for the major decisions, the resulting exercise of power, the ownership of land and the administration of finances.

As the Inter-American Institute for Cooperation on Agriculture (IICA) states, "working with a gender approach means considering the needs and interests of different groups of women (peasants, indigenous people, quilombolas, salaried workers, unpaid family workers, youth, etc.), in the formulation and execution of policies, programs and projects that take into account access, use and control over productive resources, with a view to transforming power relations, because the contribution of women is eminent in the advances made in the country in all dimensions, but this recognition is still largely obscured.

In the same direction, Barbosa (2012) states that the role of women has not only been to manage the education and training of children, youth and adults; the role of women is also to support the economy, lead in education, research, technology, innovation and socio-economic development in the Region. According to him, sustainability is a process that brings together a set of rationally developed productive activities; privileges human beings and nature, and then considers profits and increasing wealth.

Furtado and Teixeira (2009) show that women experience more strongly the need to define their citizenship, looking for the right scenario to develop their individuality, while fighting to protect what they consider the fundamental nucleus of their existence: the air, the water and soil, to which he links his life, his work, his dreams. So it's time to wake up and agree that investing in women is a great catalyst for sustainable development.

Women's groups themselves admit that struggles in defense of participation and equality will only materialize when the transformation of unequal patterns of gender and class, rooted in cultural models, such as patriarchal, bourgeois and sexist culture takes place.

The role of women in relation to political dimensions, national and international, is highlighted by Maathai and Robinson (2010):

The absence of women, particularly in the Southern hemisphere, from national and international discussions and decision-making on climate change and development must change. The battle to protect the environment isn't just about technological innovation - it's also about empowering women and their communities to hold their governments accountable for results. They can also help ensure that other powerful actors, such as the private sector, are also held accountable. To make a real difference,

women need greater access to the education, resources and new technologies needed to plan for adaptation in response to environmental change. Climate change mitigation and adaptation strategies must be developed with women, not for them, and women must participate alongside men at all stages of policy decisions regarding climate and development.

III. METHODOLOGY

The research that supported this article was descriptive in nature, as it sought to present some aspects of inequality in the various dimensions between men and women in Brazil and in other parts of the world. For that, the theories of classical and post-modernist authors were used, among which, Bruschini and Lombardi (2002), Bruschini (2007), Hirata and Kergoat (2007), Abramo (2007), Cappellin (2008), Souza -Lobo (2011), Melo and Di Sabbato (2011), Saffioti (2013), Barbosa (2014), Abreu, Hirata and Lombardi (2016), whose studies analyze the sexual division of labor and the reproduction of gender inequalities in the world of work and in the family. Also, an attempt was made to relate women's participation in sustainable development, in order to establish a balance between the productive forces of a globalized society, based on objective 5 of the 2030 Agenda, which deals with the theme.

IV. SOME CONSIDERATIONS

The concept of gender created by the feminist movement and later adopted by various sociological currents is relatively new and has contributed greatly to denaturalizing inequality between women and men, stating that the construction of being feminine and being masculine is not biological, but social and cultural.

The power relations that prevent women from reaching the highest decision-making positions in organizations and even within the family, create a scenario of imbalance in society, negatively impacting the process of development and consolidation of democracy. The equal participation of women in decision-making is not only a basic requirement of justice, but a necessary condition for their interests to be taken into account and the incorporation of their point of view in the search for equality, development and peace, according to the Art. 183 of the Platform for World Action, approved in Beijing, by 189 countries.

The development of equality between men and women in today's societies demands, therefore, a double intervention: in the structures of society itself and in the legal-political forms of action, since it is impossible for women to exercise their roles fully, without being granted rationality and authority. It is useless for women to be considered free and equal if they occupy, in the face of patriarchal society, an inferior social status, which positions them only as an oppressed social group.

In view of this, it is essential that the required transformations be carried out, so that material equality is materialized in the principle of equal opportunities, through policies that go from the mere enunciation of the principle of equality before the laws to the field of real equality between women and men. What must be sought is the granting of full citizenship to women, transforming the concept of political representation, through parity democracy, so that true egalitarian politics can concretely promote equality between the sexes, compensating for the historical discrimination against the person of the woman, to put an end to the privileges directed exclusively to men, the result of a patriarchal conception that still persists in several public and private institutions. As can be seen, gender and race inequalities are structuring axes of the matrix of social inequality in Brazil, which, in turn, is at the root of the permanence and reproduction of situations of poverty and social exclusion. Therefore, facing these inequalities means dealing with a structural characteristic of Brazilian society, whose transformation is essential for overcoming the deficits in decent work that currently exist, as well as for the effective fulfillment of the Millennium Development Goals.

REFERENCES

- [1] ABRAMO, Laís Wendel. **A inserção da mulher no mercado de trabalho: uma força de trabalho secundária?** 2007. 328 p. Tese (Doutorado em Sociologia) – Universidade de São Paulo, São Paulo, 2007.
- [2] BARBOSA, Ana Luiza Neves de Holanda. **Participação feminina na força de trabalho brasileira: evolução e determinantes.** In: CAMARANO, Ana Amélia (Org.). *Novo regime demográfico: uma nova relação entre população e desenvolvimento?* Rio de Janeiro: Ipea, 2014, p. 407-442.
- [3] BRASIL. Ministério do Trabalho e Emprego. **Relação Anual de Informações Sociais (RAIS) 2015.**
- [4] BRASIL. **Constituição da República Federativa do Brasil, 1988.**
- [5] BOURDIEU, Pierre. **A luta das classificações.** In: *A distinção: crítica social do julgamento.* São Paulo: Edusp; Porto Alegre: Zouk, 2007.
- [6] BOURDIEU, Pierre. **A Dominação Masculina.** 10ª ed. Rio de Janeiro: Bertrand Brasil, 2011

- [7] BRUSCHINI, Cristina. **Gênero e trabalho no Brasil: novas conquistas ou persistência da discriminação?** (Brasil, 1985/95). In: ROCHA, Maria Isabel Baltazar da (Org.). *Trabalho e gênero: mudanças, permanências e desafios*. Campinas: Abep, Nepo/Unicamp e Cedeplar/UFMG, São Paulo: Editora 34, 2000.
- [8] BRUSCHINI, Cristina; LOMBARDI, Maria Rosa. **Instruídas e trabalhadeiras: trabalho feminino no final do século XX.** *Cad. Pagu*. Campinas, n. 17-18, 2002.
- [9] BRUSCHINI, Maria Cristina Aranha. **Trabalho e gênero no Brasil nos últimos dez anos.** *Cad. Pesquisa*. São Paulo, v. 37, n. 132, p. 537-572, 2007.
- [10] CAPPELLIN, Paola. **As desigualdades impertinentes: Telhado, paredes ou céu de chumbo?** *Rev. Gênero*. Niterói, v. 9, n. 1, 2008.
- [11] CMMD (COMISSÃO MUNDIAL SOBRE O MEIO AMBIENTE E DESENVOLVIMENTO). *Nosso futuro comum (Relatório Brundtland)*. 2. ed. Rio de Janeiro: FGV, 1991.
- [12] DI CIOMMO, R. C. **Ecofeminismo e Educação Ambiental**. São Paulo: Editorial Cone Sul, Editora UNIUBE, 1999.
- [13] HIRATA, Helena; DEBERT, Guita Grin. **Apresentação.** *Cad. Pagu*. Campinas, n. 46, p. 7-15, abr. 2016.
- [14] HIRATA, Helena; KERGOAT, Danièle. **Novas configurações da divisão sexual do trabalho.** *Cad. Pesquisa*. São Paulo, v. 37, n. 132, dez. 2007.
- [15] INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA – IBGE. **Censo Demográfico 2010. Estatísticas de Gênero: População economicamente ativa** IBGE, 2010.
- [16] LISBOA, T. K.; LUSA, M. G. **Desenvolvimento sustentável com perspectiva de gênero – Brasil, México e Cuba: mulheres protagonistas no meio rural**. *Estudos Feministas*, Florianópolis, v. 16, n. 3, p. 871-887, set./dez. 2010.
- [17] LOPES, Cláudio Bartolomeu. **Trabalho Feminino em Contexto Angolano: um possível caminho na construção de autonomia.** Dissertação (Mestrado em Serviço Social) - Pontifícia Universidade Católica de São Paulo, São Paulo: PUC São Paulo, 2010.
- [18] MAATHAI, W.; ROBINSON, M. **Women Can Lead the Way in Tackling Development and Climate Challenges Together.** *Huffington Post*, 2010.
- [19] KERGOAT, Danièle. **O cuidado e a imbricação das relações sociais.** In: ABREU, Alice Rangel de Paiva; HIRATA, Helena; LOMBARDI, Maria Rosa. *Gênero e trabalho no Brasil e na França: perspectivas interseccionais*. São Paulo: Boitempo, 2016, p. 17-26.
- [20] Kergoat D. **Relações sociais de sexo e divisão sexual do trabalho.** In: Lopes MJM, Meyer DE, Waldow VR, organizadores. *Gênero e saúde*. Porto Alegre: Artes Médicas; 1996. p.19-28. 2. Soihet R. *História das mulheres e história de gênero um depoimento*. *Cadernos Pagu*. 1998; (11): 77-87. 3.
- [21] ONU MULHERES. **Declaração e Plataforma de Ação da IV Conferência internacional sobre a Mulher.** In: CONFERÊNCIA DAS NAÇÕES UNIDAS SOBRE A MULHER – AÇÃO PARA A IGUALDADE, O DESENVOLVIMENTO E A PAZ, 4., 1995, China, Pequim. Anais... Pequim: ONU Mulheres, 1995.
- [22] PLATAFORMA DE DIREITOS HUMANOS. **Relatorias em direitos humanos – Informe 2012-2014.** I. Ed. Curitiba-PR: Terra de Direitos, 2015.
- [23] SACHS, I. **Caminhos para o Desenvolvimento Sustentável.** Rio de Janeiro: Garamond, 2002.
- [24] SAFFIOTI, Heleieth Iara Bongiovani. **Rearticulando gênero e classe social.** In: COSTA, A. de O., BRUSCHINI, C. (orgs.) *Uma questão de gênero*. Rio de Janeiro: Rosa dos Tempos, p.183-215, 1992
- [25] SAFFIOTI, Heleieth Iara Bongiovani; ALMEIDA, S. S. **Violência de Gênero: poder e impotência.** Rio de Janeiro: Revinter, 1995.
- [26] SAFFIOTI, Heleieth Iara Bongiovani. **A mulher na sociedade de classes: mito e realidade.** 3. ed. São Paulo: Expressão Popular, 2013.
- [27] SORJ, Bernardo. **A nova sociedade brasileira.** 2ª ed. Rio de Janeiro: Zahar, 2001.
- [28] SOUZA-LOBO, Elizabeth. **A classe operária tem dois sexos: trabalho, dominação e resistência.** 2. ed. São Paulo: Editora Perseu Abramo, 2011.
- [29] UN WOMEN. *Progress of the World's Women 2015-2016 – Transforming Economies, Realizing Rights*. New York: United Nations, 2015.
- [30] YANNOULAS, Silvia Cristina. **Introdução: Sobre o que nós, mulheres, fazemos.** In: YANNOULAS, Silvia Cristina (Coord.). *Trabalhadoras: Análise da Feminização das Profissões e Ocupações*. Brasília: Editorial Abaré, 2013, p. 31-65.
- [31] YANNOULAS, Silvia Cristina. **Feminização ou feminilização?** Apontamentos em torno de uma categoria. *Temporalis*. Brasília (DF), ano 11, n. 22, p. 271-292, jul./dez. 2011.

New Educational Technologies Available on the Internet as Pedagogical Support in Contingent Remote Learning

Novas Tecnologias Educacionais Disponíveis na Internet Como Suporte Pedagógico no Ensino Remoto Contingenciado

José Evandro da Silva Figuerêdo¹, Francisca Laudeci Martins Souza², Maria Eirilúcia Cruz Macedo³

¹Mestre em Desenvolvimento Sustentável – UFCA. Professor do Centro Universitário Vale do Salgado Univs

²Professora Doutora do Mestrado em Desenvolvimento Sustentável – UFCA

³Professora do Centro Universitário Vale do Salgado - Univs

Received: 26 Jun 2022,

Received in revised form: 15 Jul 2022,

Accepted: 22 July 2022,

Available online: 31 July 2022

©2022 The Author(s). Published by AI
Publication. This is an open access article under
the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— *Pandemic, Education, Remote
Teaching, Technologies.*

Palavras-chaves— *Pandemia, Educação,
Ensino Remoto, Tecnologias.*

Abstract— *Due to the spread of the new coronavirus (SARS-Cov-2), in mid-2020, face-to-face activities in educational institutions around the world were immediately suspended as a way to maintain social distance and prevent the spread of the virus. as soon as possible. the public health emergency was triggered. Faced with the promulgation of new ordinances by the Ministry of Education and Health, there was an orientation and, at the same time, permission, in the sense that educational institutions across the country use remote methodologies for the continuity of the school year. Among the transformation segments, education had to adapt radically to these resources. This reality demanded that education professionals have skills that were not mandatory until then, because even those who did not work with Digital Information and Communication Technologies (TDIC) started to use them. In this sense, the objective of the present study was to understand how teachers acted to make distance learning viable in the region of Crajubar Ceará, in 2020, during the period of the COVID-19 pandemic.*

Resumo— *Devido à disseminação do novo coronavírus (SARS-Cov-2), em meados de 2020, as atividades presenciais em instituições de ensino espalhadas pelo mundo foram imediatamente suspensas como forma de manter distância social e prevenir a disseminação do vírus. assim que possível. a emergência de saúde pública foi acionada. Diante da promulgação de novas portarias pelo Ministério da Educação e Saúde, houve uma orientação e, ao mesmo tempo, permissão, no sentido de que instituições de ensino de todo o país utilizem metodologias remotas para a continuidade do ano letivo. Entre os segmentos de transformação, a educação teve que se adaptar radicalmente a esses*

recursos. Essa realidade exigia que os profissionais da educação tivessem competências até então não obrigatórias, pois mesmo aqueles que não trabalhavam com Tecnologias de Informação e Comunicação Digitais (TDIC) passaram a utilizá-las. Nesse sentido, o objetivo do presente estudo foi compreender como os professores atuaram para viabilizar o ensino a distância na região de Crajubar Ceará, em 2020, durante o período da pandemia COVID-19.

I. INTRODUÇÃO

Com a pandemia causada pelo SARS-CoV-2, um volume enorme de instituições de ensino no mundo se viu na obrigação de suspender suas atividades educacionais. Alunos e alunas, protagonistas fundamentais no processo educacional, viram-se, de um momento para outro, tendo que passar a estudar dentro de um contexto de excepcionalidade, e alternativas passaram a ser adotadas com o objetivo de reduzir o prejuízo educacional e a preservação do direito à educação.

No Brasil, 81,9% dos alunos da Educação Básica deixaram de frequentar as instituições de ensino. São cerca de 39 milhões de pessoas. No mundo, esse total soma 64,5% dos estudantes, o que, em números absolutos, representa mais de 1,2 bilhão de pessoas (UNESCO, 2020).

As alternativas quanto ao que fazer para tentar dar continuidade às atividades escolares preservando o distanciamento social que, por hora, não permite a realização de aulas presenciais, têm sido bastante controversas e suscitado debates no campo educacional que mobilizam educadores, gestores, estudantes, famílias, especialistas em educação, entidades do setor empresarial e o Estado, em todas as suas instâncias. E a polêmica, fundamentalmente, gira em torno da adoção de modalidades de “ensino remoto” como alternativa para a continuidade às atividades fora do ambiente escolar.

Busca-se entender, quais as principais as tecnologias educacionais encontradas na internet que ajudam no ensino remoto, causado pela dinâmica da pandemia. Objetiva-se neste contexto, apresentar algumas dessas tecnologias educacionais disponíveis, discutir pedagogicamente a sua viabilidade e analisar a sua efetividade na dinâmica do ensino remoto. Nos últimos anos, diversas alternativas tecnológicas, como também a ampliação do acesso à instrumentos e ferramentas tecnológicas como *smartphone*, *tablets* e computadores e o acesso à internet, abrangido no mundo, apresentam-se com razoável viabilidade para possibilitar uma política pública de manutenção das portas escolares abertas, ainda que de forma virtual.

A metodologia utilizada para o desenvolvimento do atual trabalho é a revisão bibliográfica, que irá analisar

os dados de maneira quantitativa e qualitativa, com ênfase em acervos de credibilidade nacional e internacional

Em decorrência desse fato, diversos países têm dialogado com as possibilidades e mecanismos para que se preserve o convívio escolar e as conexões escolares, apesar da distância. As ferramentas e os instrumentos tecnológicos, juntamente com a internet transformaram-se nos essenciais pilares potencializadores de iniciativas utilizadas pelo setor educacional, a fim de se manter a equidade de conexão com o conhecimento.

II. NOVAS TECNOLOGIAS EDUCACIONAIS DISPONÍVEIS NA INTERNET QUE VIABILIZAM SUPORTE PEDAGÓGICO NO ENSINO REMOTO CONTINGENCIADO

O cenário global do ensino mudou drasticamente nos últimos meses devido à disseminação do novo coronavírus (também conhecido como SARS-Cov-2). O surto do coronavírus tornou-se uma grande perturbação para as instituições de ensino em todo o país, com a maioria das instituições cancelando aulas presenciais e passando para instruções somente remotas.

O mundo moderno, através das mídias digitais, tem oferecido novas formas de comunicação, interação e processos de ensino e de aprendizagem. A forma como as pessoas aprendem, assim como o cotidiano da sociedade, vem passando por processos de transformações. Segundo Dias (2012), a sociedade da aprendizagem e do conhecimento em rede exige a participação ativa, individual e coletiva, só possível através do alicerce da fluência digital, que envolve a fluidez na criação e no desenvolvimento de processos de aprendizagem.

O uso das ferramentas tecnológicas na educação deve ser visto sob a ótica de uma nova metodologia de ensino, possibilitando a interação digital dos educandos com os conteúdos, isto é, o aluno passa a interagir com diversas ferramentas que o possibilitam a utilizar os seus esquemas mentais a partir do uso racional e mediado da informação.

É perceptível o esforço de adaptação e aprendizagem para o “novo normal”. Existe uma necessidade iminente em dominar as ferramentas *on-line*.

Neste momento de hiperconexão e altamente digital, encontrar novos meios de comunicação que atraiam estudantes para mantê-los ativos em seus estudos é de extrema importância.

A internet vem ocupando espaços variados no processo ensino-aprendizagem, encurtando as barreiras físicas e culturais. Nela, outras possibilidades começaram a se abrir, além das linhas tradicionais da comunicação mediada por computador. O seu principal diferencial em relação às mídias tradicionais é a possibilidade de produzir experiências interativas.

Novos projetos educacionais podem ser viabilizados para o uso de tais recursos.

Porém, não basta reproduzir o modelo tradicional de ensino.

2.1 Plataformas AVA: interatividade e gerenciamento

Os Ambientes Virtuais de Aprendizagem (AVAs) são softwares utilizados para gerenciamento do processo de ensino e aprendizagem que permitem a administração das funcionalidades comuns aos softwares de comunicação, mediada por computador e métodos utilizados em cursos oferecidos de forma on-line.

Esse ambiente pode ser descrito com base nas escolhas pedagógicas que o sustentam, bem como de seus componentes tecnológicos, sendo que em um AVA o professor-tutor, o aluno, o grupo e seus respectivos recursos são subsistemas em interação que podem ser orientados para o desenvolvimento de novos conhecimentos.

Como modalidade educacional na qual a mediação didático-pedagógica, nos processos de ensino e aprendizagem, ocorre por utilização de meios tecnológicos da informação e comunicação através da participação democrática nos processos de ensino e aprendizagem em rede, envolvendo estudantes e profissionais da educação (professores, tutores e gestores), que desenvolvem atividades educativas em lugares e/ou tempos diversos.

A educação remota, também, é uma opção para quem está presente e ausente no mercado de trabalho, em busca de uma segunda graduação ou de treinamento mercadológico por ser uma proposta eficiente, econômica e rápida, ao oferecer a mesma qualidade e validade do curso presencial.

As ferramentas tecnológicas na sociedade vêm se expandido e sua inserção no processo de aprendizado vem se tornando uma estratégia no planejamento educacional tanto nas escolas como no aprendizado independente da sala de aula.

E na opinião de Coelho e Tedesco (2017) para que ocorra a promoção da aprendizagem colaborativa é essencial que haja interação entre as pessoas, e, por sua vez,

a interação tem sido dificultada pela falta de pistas sociais na comunicação mediada pelo computador, sendo essa uma lacuna de estudo.

A esse respeito é preciso considerar que:

Os resultados dessas pesquisas apontam para a importância de aumentar e manter um elevado nível de percepção da presença social no ambiente virtual. Quanto maior nível de presença social, maior a interação entre alunos e tutores, melhor a percepção de aprendizagem, maior a familiaridade com o ambiente virtual, menor a evasão, melhor a avaliação final do aluno e, sobretudo, maior o nível de satisfação dos estudantes com os cursos (COELHO; TEDESCO, 2017, p.617).

O uso da internet e dos AVA na escola é exigência da cibercultura, entendida aqui como um novo ambiente comunicacional-cultural que surge com a expansão do uso de computadores no início do século XXI, ganhando um novo espaço de sociabilidade, organização, informação, conhecimento e de educação (SILVA, 2005).

Nos AVAs, o professor é o mediador do conhecimento através de chats on-line, aulas interativas, tira dúvidas, fórum de discussões, utilizando dispositivos conjuntivos, como fóruns, Wikis, chats, e dispositivos emissores, como vídeos, textos e slides. Diante de todas estas possibilidades de interação os estudantes realizam o seu autoestudo e o professor torna-se mediador entre o sujeito que aprende e os conteúdos trabalhados. Estes conteúdos são necessários ao aprendizado à distância, que segundo Santos (2003):

A aprendizagem mediada pelo AVA pode permitir que através dos recursos da digitalização várias fontes de informação e conhecimento possam ser criadas e socializadas através de conteúdos apresentados de forma hipertextual, mixada, multimídia, com recursos de simulações. Além do acesso e possibilidades variadas de leituras o aprendiz que interage com o conteúdo digital poderá também se comunicar com outros sujeitos de forma síncrona e assíncrona em modalidades variadas de interatividade: um-um e um-todos, comuns das mediações estruturadas por suportes como os impressos, vídeos, rádios, TV, e principalmente, todos-todos, própria do ciberespaço (SANTOS, 2003, p.4).

As metodologias ativas surgiram como uma forma de otimizar e tornar mais lúdica e atrativa a utilização dos AVA. Dentre as metodologias ativas podemos citar: o ensino híbrido que é um programa de educação formal onde o aluno aprende, em uma localidade física fora de sua residência e outra on-line (CHRISTENSEN; HORN; STAKER, 2013); sala de aula invertida que se concentra no ambiente virtual com informações básicas e deixa para aula presencial as atividades criativas e supervisionadas

(SOUZA; LOPES, 2015); aprendizagem baseada em projetos, gamificação, dentre outras.

Diante do exposto, estão relacionados no Quadro 1 os principais e os mais importantes Ambientes Virtuais

de Aprendizagens (AVAs) identificados e coletados da internet, os quais tem o objetivo de viabilizar o gerenciamento do processo de ensino e aprendizagem da instituição e a gestão da vida escolar do aluno.

Quadro 1– Principais Plataformas AVA para suporte educacional disponíveis na Internet

PLATAFORMAS	DESCRIÇÃO / FUNCIONALIDADE	ACESSO
MOODLE	Sistema de gerenciamento de livre apoio a aprendizagem, que oferece a possibilidade de disponibilizar cursos e treinamentos de forma on-line, executado num ambiente virtual. A plataforma oferece muitos recursos disponíveis: Gerenciamento de alunos, frequência e notas.	https://moodle.org/?lang=pt_br
	Disponibilização de testes, tarefas, fóruns, avaliação, etc.	
CANVAS	Permite que as instituições construam os seus ambientes virtuais de aprendizagem de forma customizada, atendendo às suas necessidades e desafios exclusivos. A solução facilita o processo de ensino, eleva o nível da aprendizagem e elimina os problemas de suporte e da manutenção de tecnologias tradicionais.	https://www.instructure.com
LMS ESTÚDIO	Sistema de fácil gerenciamento, com visual elegante e profissional, é a plataforma para quem deseja criar, vender e ensinar cursos <i>on-line</i> , ela possui diversos recursos de ensino, como vídeos na plataforma, vídeos ao vivo, download de materiais, questionários etc,	https://lmsestudio.com.br/
TELEDUC	Desenvolvido pela Unicamp, o Teleduc tem como principal objetivo dar suporte aos professores no quesito de sua formação à informática educativa. Funcionalidade simples e fácil, inclusive para aquelas pessoas que não têm conhecimento de informática ou computação.	http://teleduc4.multimeios.ufc.br/
AULANET	Criado pela PUC do Rio de Janeiro, tem como principal missão a administração dos cursos à distância em um ambiente colaborativo e educativo para os usuários. A interatividade é a principal ferramenta do AulaNet, a qual busca a interação dos alunos e docentes.	https://www.eduweb.com/
E-PROINFO	Desenvolvido pelo MEC, oferece uma gama de utilização para auxiliar na complementação de aulas presenciais e ensino à distância também. Geralmente é mais utilizado pelas instituições de ensino público. Alia a tecnologia com a educação.	http://e-proinfo.mec.gov.br/
EADBOX	Plataforma para criar cursos on-line com a marca da instituição, gerenciar pagamentos e interagir com os alunos. Permite a transmissão de videoaulas ao vivo. Emite relatórios métricos. Ele não é gratuito, mas permite 15 dias de teste grátis.	https://eadbox.com/
EDOOLS	Suas características são: Autonomia para alterar o que desejar pela API de integração; Relatórios personalizados e automatizados; Divisão por módulos: conteúdo, gestão, engajamento e extensão; Criação de um sistema de gamificação; Verificação do progresso dos alunos; Criação de fóruns para discussão com os usuários; Chats em tempo real; totalmente responsivo.	https://www.edools.com/

BLACKBOARD	Criado em 1997, a plataforma possibilita manter uma relação produtiva e interativa entre professores e alunos para cursos on-line. Utilizada não só por instituições de ensino, mas também por empresas e por setores públicos. O <i>software</i> permite personalização por curso e não é necessário ter um conhecimento especializado em HTML.	https://www.blackboard.com/pt-br
DOKEOS	Trata-se de um suíte de aprendizagem com quatro componentes: AUTOR para construir conteúdo de <i>e-learning</i> , LMS para controlar a interação com os aprendizes, LOJA para vender um catálogo de cursos, e AVALIAÇÃO para avaliação e certificação. Plataforma: <i>Cross-platform</i> . Linguagens de programação: PHP, JavaScript, HTML5.	https://www.dokeos.com/
SAKAI	Desempenha um papel central e crítico na estratégia de serviços de tecnologia de aprendizagem em várias instituições de ensino em todo mundo. Possibilita desenvolver um currículo de aprendizagem dinâmico e interativo. Foca em projetos potenciais, tornando possível, assim, metodologias e colaborações ativas permanentes.	https://www.sakailms.org/
BRIGHTSPACE	Reúne todas as ferramentas de ensino mais inovadoras do mercado em uma única plataforma, incluindo tecnologias de aprendizagem tradicionais da Internet, dispositivos móveis, análises preditivas, aprendizagem adaptativa, ferramentas sociais e de colaboração, MOOCs (Cursos On-line Abertos e Massivos) ou Cursos Livres e um ecossistema de serviços e soluções.	https://www.d2l.com/pt-br/
ECOLLEGE	Fornecedor de <i>software</i> e serviços de <i>e-Learning</i> para instituições de ensino secundárias e pós-secundárias e pertence à Pearson PLC. Oferece uma variedade de cursos de aprendizagem on-line interativo de alta qualidade, disponível qualquer momento através acesso à internet de banda larga.	https://www.ecollege.ie/
LYCEUM	Concentrado na utilização de tecnologia de ponta voltada ao setor educacional, o Lyceum proporciona maior fluidez nos processos das instituições de ensino. Possibilita, por exemplo: Gestão acadêmica dos alunos; Secretaria acadêmica virtual; Divulgação de notas e faltas; Atendimento aos estudantes; Unificação das informações etc..	https://www.lyceum.com.br/

Fonte: Elaboração própria.

2.2 Webconferência: múltiplas possibilidades

A tecnologia de webconferência é um meio de comunicação que permite que usuários conectados compartilhem recursos visuais e de áudio em tempo real. Também permite que usuários registrados transmitam arquivos, slides, imagens estáticas e texto através da plataforma utilizada (como *desktop* e *Web*) (KRUTKA; CARANO, 2016).

À medida que a disponibilidade de largura de banda, as redes e a velocidade dos computadores aumentaram dramaticamente nos países desenvolvidos e na maioria dos países em desenvolvimento, o uso de videoconferência se tornou mais viável e realista para organizações profissionais, distritos escolares e universidades.

No entanto, sistemas de videoconferência síncronos podem não necessariamente fornecer o conjunto necessário de resultados de aprendizagem e uma pedagogia aprimorada para os usuários, o que coloca novos desafios para o ensino superior (LEWIS; O'ROURKE; DOOLY, 2016).

Existem diferentes modalidades de sistemas de videoconferência que podem oferecer diferentes experiências e resultados de aprendizado. Os principais sistemas conhecidos na literatura são: VCM, VCI e VCW.

O VCM é um tipo de videoconferência que oferece a um grupo de pessoas vários canais de comunicação para discutir e aprender sobre questões relevantes e resolver determinados problemas de aprendizagem. O VCM suporta vários modos de interação, incluindo: muitos para muitos,

um para muitos, muitos para um e um para um (LEWIS; O'ROURKE; DOOLY, 2016).

Já o VCI trata-se de uma modalidade de videoconferência que requer configurações ambientais fixas e configuração avançada para manter a interação entre instrutor e alunos. Esse tipo de serviço oferece suporte à interação um para muitos, onde os instrutores ministram seus cursos para os alunos em tempo real (LEWIS; O'ROURKE; DOOLY, 2016).

Por fim, o VCW é uma modalidade de videoconferência que permite que alunos e instrutores de diferentes lugares participem de discussões na *Web* (usando modos de interação semelhantes ao VCM), e é um meio

particularmente popular para promover a comunicação entre os alunos e seus instrutores e que ganhou muita visibilidade mundial durante o surto da COVID-19 (LEWIS; O'ROURKE; DOOLY, 2016).

À luz desses critérios, estão dispostos no Quadro 2 as principais e mais importantes ferramentas de webconferência identificadas e coletadas da internet, as quais tem o objetivo de viabilizar o ensino remoto contingencial, permitindo o diálogo on-line do ensino-aprendizagem. No entanto, a literatura atual não distingue claramente o impacto de cada tipo de videoconferência na aprendizagem dos alunos em um contexto escolar.

Quadro 2– Principais aplicativos de Webconferência disponíveis na Internet

FERRAMENTA	DESCRIÇÃO / FUNCIONALIDADE	ACESSO
ZOOM	Utilizada nas reuniões do mundo corporativo, cresce para fins pedagógicos. Na versão gratuita podem entrar até 100 alunos e permanecer logadas por 40 minutos. Nessa tecnologia o professor e seus alunos podem conectar-se para um rápido bate papo, com orientações ou mesmo alinhamentos.	https://zoom.us/pt-pt/meetings.html
GOOGLE MEET	Serviço de comunicação por vídeo desenvolvido pelo Google. É um aplicativo de webconferência baseado em padrões que usa protocolos próprios de transcodificação de vídeo, áudio e dados. O sistema permite a comunicação entre o Meet e outros dispositivos e <i>software</i> de webconferência.	//meet.google.com/
SKYPE	Permite comunicação pela internet através de conexões de voz e vídeo. O <i>Skype</i> foi lançado no ano de 2003. Em 2005 foi vendido para a empresa <i>eBay</i> e pertence, desde maio de 2011, à Microsoft.	s://www.skype.com/pt-br/
MICROSOFT TEAMS	Comunicação de forma on-line entre professores e alunos disponibilizado pela Microsoft. A plataforma oferece um plano gratuito para webconferências com até 300 pessoas, além de armazenar até 10 GB de arquivos por equipe e mais 2 GB por usuário.	https://www.microsoft.com/pt-br/microsoft-365/microsoft-teams/free
EZTALKS	Permite a participação de até 100 alunos em videoconferências, com duração máxima de 45 minutos. O app requer instalação do programa e possibilita a realização de aulas remotas, <i>webinars</i> e até treinamentos, com gravação das apresentações, compartilhamento de tela, enquetes, controles de áudio, vídeo e agendamento.	/www.eztalks.com/
WHATSAPP	É uma multiplataforma de mensagens instantâneas e chamadas de voz para smartphones. Além de mensagens de texto, os professores e alunos podem enviar imagens, vídeos e documentos em PDF, além de fazer ligações grátis por meio de uma conexão com a internet.	/www.whatsapp.com

INSTAGRAM	O Instagram também oferece o serviço de videoconferência. A novidade foi lançada em maio de 2018 durante a F8, evento corporativo do <i>Facebook</i> e desde então é possível realizar chamadas com grupos de até quatro estudantes, por meio das mensagens diretas.	http://www.instagram.com
MESSENGER	O Messenger também oferece chamadas de vídeo, porém, para até seis alunos ao mesmo tempo. Integrado ao <i>Facebook</i> , a ferramenta contempla funções como um avatar que reproduz os movimentos que se faz frente à câmera.	https://play.google.com/
TELEGRAM	Ficou muito conhecido em 2016, quando a Justiça Federal determinou que o WhatsApp saísse do ar. Baseado em <i>cloud</i> desenvolvido para garantir velocidade e segurança, o app permite ao professor a realização de vídeo chamada com apenas um único aluno.	https://web.telegram.org/
GOTOMEETING	Para usar, o professor precisa apenas se cadastrar no site e criar uma sala de reunião e já poderá enviar o <i>link</i> para os alunos. Dentre os benefícios oferecidos pelo app estão o compartilhamento de tela, bate-papo, gravação de reuniões etc..	https://www.gotomeeting.com/pt-br
GOOGLE DOO	Aplicativo de reunião on-line, simples e prático. Ele não é destinado para grandes reuniões, então não oferece recursos avançados, apenas o que é preciso para uma interação educacional. Enquanto o professor não atende a videochamada, o aluno pode ver sua imagem em tempo real.	https://duo.google.com
BLUEJEANS	Com recursos avançados e integração o Blue Jeans pode ser usado no ensino remoto. Os participantes não precisam baixar o app, nem ter uma conta para entrar na reunião, e ele se integra com o <i>Facebook</i> e o <i>Slack</i> para facilitar ainda mais o início das videochamadas.	https://www.bluejeans.com/
JOIMME	Aplicativo também utilizado para eventos educacionais, embora não tenha um grande limite de participantes. Com ele, os alunos não precisam ter conta, nem baixar o app para entrar na reunião, basta compartilhar seu <i>link</i> personalizável. É possível participar da reunião com áudio por VoIP.	https://www.join.me/pt
TEAMLINK	Tanto os participantes, como o anfitrião, precisam ter o app para participar das reuniões, o login pode ser feito pelo Google. Mesmo o plano gratuito, permite reuniões com até 300 participantes. É permitido dar um nome para cada aula, agendar e compartilhar o convite externamente.	https://www.teamlink.co/
CISCOWEBER	A ferramenta tem o maior limite de participantes e um dos únicos em que se pode criar enquetes. Ele integra com várias plataformas como o <i>Trello</i> , <i>Twitter</i> , <i>Docs</i> , <i>Calendário</i> e <i>Outlook</i> , para iniciar videoconferências a partir de qualquer lugar sem muito trabalho.	http://www.webex.com
JUSTALK	App que permite entrar em videoconferências com até 16 alunos no Android e 50 no iPhone. O objetivo desse aplicativo é tornar as conversas de vídeo mais descontraídas. O programa conta com ferramentas que permitem desenhar, mudar o fundo do vídeo ou inserir adesivos.	https://justalk.com/lang/pt
KEEP CALM	App de videoconferência que busca levar praticidade aos usuários. O professor cria sua sala de aula e envia o link	https://apps.apple.com/

	para os alunos. Basta baixar o aplicativo, sem a necessidade	
	de fazer qualquer cadastro ou assistir a publicidades. O <i>videochat</i> em grupo suporta até 12 alunos.	
WHEREBAY	Disponível tanto em computadores quanto smartphones, é reconhecido por ser um dos mais fáceis de usar. O <i>Whereby</i> permite fazer conferências em vídeo ou áudio, além de ter integração com o YouTube e possibilidade de compartilhar a tela do seu computador.	https://whereby.com/
SLACK	Para reuniões por áudio e conversas em vídeo em dupla no plano grátis. Para ter acesso à possibilidade de realizar videoconferências, é necessário aderir ao plano pago.	https://slack.com/intl/pt-br/
BIGBLUEBUTTON	O app possibilita colocar um quadro branco virtual, mostrado a todos os estudantes. Não há limites para participantes em vídeo. Enquanto o serviço de internet aguentar, pode-se colocar quantos alunos ou auxiliares quiser. Ele é gratuito e em código aberto.	bigbluebutton.org/
LIFESIZE	A empresa estadunidense oferece videoconferência por aplicativo no celular ou computador, voltado para grandes ou pequenas reuniões. Além do programa, também oferece câmeras e microfones para captação de áudio e imagens com mais qualidade para a reunião.	://www.lifesize.com/pt
TELEPOR	O funcionamento do Teleport é semelhante ao de outros serviços do segmento. Para participar de uma videoconferência, basta clicar no <i>link</i> enviado pelo professor da aula. Durante o encontro <i>on-line</i> , é possível compartilhar a tela do computador e conversar com os alunos.	://www.teleport.com.br/
JITSI MEET	Plataforma 100% de código aberto, gerenciada por comunidades em todo o mundo. Para ter acesso a essa ferramenta de videoconferência, basta que o professor acesse meet.jit.si ou faça o download de um dos aplicativos móveis para Android ou iOS.	https://meet.jit.si/
ZOHOMEETING	Oferece ferramentas para reuniões e webinars. É possível participar de qualquer lugar com áudio, vídeo, controle de outro dispositivo e compartilhamento de tela em tempo real. O professor deve enviar convites por email com todas as informações necessárias para os alunos.	https://www.zoho.com/pt-br/meeting/
SYMPLA	Garante diversos benefícios como a integração com o <i>Google Analytics RD Station</i> , distribuição de certificados, personalização da URL do evento, suporte multilíngue. Pode-se tratar de uma integração com a plataforma Zoom, seus eventos podem caber até mais de 300 alunos.	://www.sympla.com.br/
LINE	O Line, a exemplo de outros apps como o <i>Skype</i> , surgiu como uma ferramenta de videochamadas. Ele permite chamadas entre duas pessoas, mas também em grupos. Assim como <i>Skype</i> , <i>FB Messenger</i> e <i>Whatsapp</i> , ele permite comunicação por texto e envio de imagens e documentos.	://line.me/pt- BR/

Fonte: Elaboração própria

2.3 Metodologias ativas: potencializando o ensino-aprendizagem

Conforme Alava (2002), se o aparecimento das tecnologias digitais provocou paixão e entusiasmo, as práticas reais estão bem longe do esperado. As tecnologias serviram muitas vezes para renovar os ‘velhos’ métodos pedagógicos. Os novos meios oferecidos aos formadores exigem que a instituição, o formador e o conjunto de atores sociais se apoderem dessas inovações técnicas para evoluir em suas práticas.

Nesse cenário, deve-se proporcionar mudanças mais concretas, pois “se espera que os alunos sejam proativos, deverão ser adotadas metodologias em que os alunos se envolvam em atividades cada vez mais complexas, em que tenham que tomar decisões e avaliar os resultados, com apoio de materiais relevantes” (MORAN, 2015, p.17).

Segundo Mattar (2017, p. 21), a educação deve supor atividade e ‘aprender fazendo’ por parte dos alunos, o que cria um espaço para que eles possam assumir mais responsabilidade sobre seu processo de aprendizagem, tendo o professor como um guia.

Nesse contexto, o autor apresenta outras metodologias que podem ser empregadas, como as seguintes:

a) Sala de aula invertida: metodologia que inverte o processo da aula tradicional, pois o professor disponibiliza o material num ambiente virtual de aprendizagem para que

os alunos possam ter acesso ao conteúdo e realizar uma certa tarefa antes do encontro presencial em sala de aula;

b) Gamificação: metodologia em que os alunos possuem liberdade para traçar os próprios objetivos de aprendizagem da maneira que preferirem. O principal desafio seria que eles tenham controle de seu processo de aprendizagem num sistema dinâmico e explorável;

c) Aprendizagem Baseada em Problemas: normalmente a problematização do conteúdo a ser estudado parte da observação de uma realidade em que o aluno está inserido e alguns pontos-chaves são levantados e questionados;

d) Aprendizagem Baseada em Projetos: método no qual os alunos se envolvem num processo rigoroso a um determinado tema, trabalhando por certo período de tempo, de forma colaborativa e buscando investigar de forma contínua a uma questão ou desafio complexo.

Existem outras metodologias bem interessantes que podem se aproveitar das novas tecnologias e enriquecer o processo de ensino-aprendizagem. Mas consideramos que a experimentação desses métodos citados acima, são mais do que suficientes para que possamos inovar na educação.

Estão dispostos no Quadro 3, a seguir, as principais e mais importantes ferramentas tecnológicas que dão suporte as metodologias ativas. Esses *softwares* foram identificados e coletados da internet, e têm o objetivo de auxiliar os professores no ensino remoto contingencial, gerando um ambiente de ensino-aprendizagem otimizado e potencializado.

Quadro 3 – Principais estratégias e recursos tecnológicos para suporte pedagógico disponíveis na Internet

FERRAMENTA	DESCRIÇÃO / FUNCIONALIDADE	ACESSO
KAHOOT	Plataforma de aprendizado baseada em jogos, usada como tecnologia educacional em escolas e outras instituições de ensino. Seus jogos de aprendizados são testes de múltipla escolha que permitem a geração de usuários e podem ser acessados por meio de um navegador da <i>Web</i> ou do aplicativo <i>Kahoot</i> .	https://kahoot.com/
SOCRATIVE	Aplicativo que permite que professor e alunos possam interagir, a partir do smartphone, tablet ou computador. Permite dinamizar a aplicação de atividades em sala de aula ou como tarefa extraclasse. Os alunos podem responder as questões a partir de seus aparelhos, contanto que disponham de uma conexão internet.	www.socrative.com/
QUIZCREATOR	Ferramenta ideal para educadores e profissionais que desejam criar quizzes com diversas opções e recursos. Com esse programa, é possível criar quizzes em flash em poucos minutos e com elementos multimídia para testes on-line. Utiliza um padrão de layout e permite a edição e criação de novos modelos de quiz.	w.quiz-creator.com/

PLICKERS	Ferramenta disponível na versão web e aplicativo para dispositivos móveis, de administração de testes rápidos, que permite o professor escanear as respostas e conhecer em tempo real o nível da turma quanto ao entendimento de conceitos e pontos-chaves de uma aula.	https://get.plickers.com/
PADLET	Trata-se de uma ferramenta on-line que permite a criação de um mural virtual dinâmico e interativo para o registro e compartilhamento de conteúdo. Os professores podem pedir para o estudante publicar suas atividades, como lista de exercícios, resenhas e ou uma explicação em áudio.	https://pt-br.padlet.com/
EASYLMS	Ajuda o professor a recuperar o controle da sua estratégia de ensino na sua aula remota. É um lugar centralizado para criar e compartilhar testes e aulas e analisar os resultados dos seus alunos. Sistema de gestão de aprendizagem on-line que se adapta às atividades pedagógicas.	https://www.easy-lms.com/pt/recursos/item12787
MENTIMETER	Recurso digital para criar interações em tempo real, como enquetes, nuvem de palavras ou coleta de perguntas. O grande benefício do Mentimeter é criar interações para grandes grupos de alunos e tornar isso visível para todos.	www.mentimeter.com/
POOL EVERYWHERE	Plataforma baseada na Internet para os ensinos fundamental e médio, ONGs e ensino superior que ajudam o professor a personalizar apresentações com perguntas, convidar os alunos a se envolver através de SMS ou páginas e gerar relatórios.	https://www.polleverywhere.com/
GENIALLY	Recurso digital que permite criar materiais educativos interativos. Para começar a criar conteúdo que pode simplesmente clicar sobre a caixa “Criar um novo genialy” ou mover em toda a largura da página pelas diferentes abas no topo: cartazes, apresentações, documentos, correios e outros.	https://www.genial.ly/
WORDWALL	Ferramenta de Aprendizagem interativa, composta por uma coleção organizada de palavras que são exibidas em grandes letras visíveis em uma parede, quadro de avisos ou outra superfície de exibição na sala de aula. Recursos/aplicação: jogos de vocabulário, fonética	https://wordwall.net/pt
GOCONQR	Intuitivo e simples, o GoConqr é uma ferramenta idealizada com intuito de haver interação, visualização e acompanhamento dos trabalhos e atividades educacionais, gerenciando as horas dedicadas a cada atividade do dia e analisar onde é preciso dedicar mais esforço.	//www.goconqr.com/pt-BR
OBS STUDIO	Programa permite realizar transmissões ao vivo em plataformas de lives. O OBS Studio é um programa utilizado para transmissão de vídeo ao vivo na Internet, sendo possível incluir múltiplas câmeras, trilha sonora, efeitos visuais e textos nas lives.	s://obsproject.com/pt-br

FREE ON-LINE SCREEN	Entre as opções gratuitas e simples de usar, este APP é ótima solução para produzir vídeos. Pode-se gravar vídeo e áudio através da sua webcam ou configurar as opções de entrada de áudio para usar um microfone externo.	https://www.apowersoft.com/free-on-line-screen-recorder
SCREEN GRABBER PRO	Recomendado como o melhor software de gravação de tela de desktop. É uma ferramenta simples e direta para produzir vídeos usando webcam com áudio de alta qualidade. O software permite a gravação em regiões específicas da tela cheia.	https://acethinker.com/desktop-recorder
FLASHBACK	Aplicativo de gravação de tela eficaz, simples de usar e multifuncional. Gratuito, ele captura a tela nos formatos Flash ou AVI, incluindo áudio. Programa perfeito para produzir vídeos para web.	https://www.flashbackrecorder.com/express/
BLACKBOARD COLLABORATE	Ferramenta tecnológica de webconferência é capaz de reproduzir uma sala de aula tradicional para uso de metodologias ativas, só que em um ambiente virtual. O professor pode usar quadro branco e ministrar para 40 alunos conectados simultaneamente.	https://blackboard.grupoa.com.br/
FLIPGRID	Muito intuitiva na qual o professor gera um link, lança um desafio ou uma pergunta e envia para os estudantes. Com o link gerado, o estudante tem a oportunidade de produzir e compartilhar pequenos vídeos de até 2 minutos.	https://info.flipgrid.com/
SCHOOLGY	Serviço de rede social e ambiente de aprendizagem virtual para escolas K-12 e instituições de ensino superior que permite aos usuários criar, gerenciar e compartilhar conteúdo acadêmico. O Schoology é um LMS (Learning Managing System) que funciona em jeito de timeline, com uma interface que se assemelha um pouco ao facebook.	www.schoology.com/
GOOGLE CLASSROOM	Sistema de gerenciamento de conteúdo para escolas que procuram simplificar a criação, a distribuição e a avaliação de trabalhos. Plataforma do Google permite que alunos e professores tenham aulas virtuais.	https://classroom.google.com/
GOOGLE FORM	Aplicativo de gerenciamento de pesquisas lançado pelo Google. Os usuários podem usar o Google Forms para pesquisar e coletar informações sobre outras pessoas e podem ser usados para questionários e formulários de registro. Escolha entre várias opções de perguntas, de múltipla escolha a listas suspensas e escalas lineares.	https://www.google.com/intl/pt-BR/forms/about/
GOOGLE DOC	Ferramenta gratuita, que permite construir textos de maneira colaborativa, editando, adicionando comentários e enviando feedback em tempo real. O Documentos Google dá vida aos seus documentos	https://www.google.com/intl/pt-BR/docs/about/
	com ferramentas de edição e estilo para facilitar a formatação de textos e parágrafos.	

YOUTUBE	<p>Plataforma de compartilhamento de vídeos com sede em San Bruno, Califórnia. O serviço foi criado por três ex-funcionários do PayPal - Chad Hurley, Steve Chen e Jawed Karim - em fevereiro de 2005.</p> <p>YouTube é um site de compartilhamento de vídeos enviados pelos usuários através da internet.</p>	<p>www.youtube.com/</p>
ME SALVA	<p>Trata-se de curso on-line focado no aprendizado dos alunos. Os nossos estudantes contam com as melhores ferramentas e conteúdo. O aplicativo começou em 2012 e, desde então, mais de 20 milhões de pessoas já foram impactadas por nosso canal do YouTube.</p>	<p>www.mesalva.com/</p>
CLASSMARK	<p>Criador de questionários educacionais e uma solução de teste on-line personalizável e fácil de usar para negócios, treinamento e avaliação educacional com testes e questionários avaliados instantaneamente, economizando horas de papelada.</p>	<p>https://www.classmarker.com/</p>
PROPROFS	<p>Personaliza questionários adequados à necessidade dos alunos. Produz testes a qualquer hora.</p> <p>Disponibiliza relatórios e análises. Com mais de 100 configurações, torna-se software perfeito para criar e entregar exames e testes on-line.</p>	<p>https://www.proprofs.com/quiz-school/</p>
MIRO	<p>Plataforma on-line que permite a construção de mapas mentais, diagramas e quadros com notas, em tempo real e em compartilhamento com outros alunos.</p> <p>Adaptável para as necessidades, idéias e projetos.</p>	<p>https://miro.com/</p>
COMIC STRIP	<p>Sistema para quadrinhos para Android, storyboards e memes. O criador de quadrinhos para Android.</p> <p>Aplicação de quadrinhos em cada quadro para criar uma sensação real de quadrinhos. Permite o compartilhamento.</p>	<p>https://play.google.com/store/apps/</p>
PIXTON	<p>Ferramenta on-line que permite a criação de histórias em quadrinhos. Possui uma grande variedade de cenários, objetos e personagens. Não há necessidade de instalar nada no computador. A plataforma permite escolher personagens, cenários e adicionar balões de conversas.</p>	<p>https://www.pixton.com/br/</p>
ANIMAKER	<p>Software de animação de vídeo DIY. O software é baseado em nuvem e foi lançado em 2014. Ele permite aos usuários criar vídeos animados usando personagens e modelos pré-criados.</p>	<p>https://www.animaker.co/</p>
CANVA	<p>Plataforma de design gráfico que permite aos usuários criar gráficos de mídia social, apresentações, infográficos, pôsteres e outros conteúdos visuais. Está disponível on-line e em dispositivos móveis e integra milhões de imagens, fontes, modelos e ilustrações.</p>	<p>https://www.canva.com/pt_br/</p>

Fonte: Elaboração própria

Conforme exposto, tais ferramentas, em conjunto com as metodologias do docente, podem contribuir efetivamente para a sua prática pedagógica no âmbito da instituição e fora dela. Portanto, para o uso dessas

tecnologias nas escolas é importante que haja um aprofundamento do conhecimento e alargamento da experiência.

Conforme Vilaça e Araújo (2016, p.165), “ao falar

de educação escolar e o uso de novas tecnologias deve-se levar em conta a relação que há entre comunidade, alunos e professores por meio dessas ferramentas, enfatizando que seu uso não é indiferente às suas vivências e saberes construído”.

Os docentes no âmbito da instituição fazem o uso dos recursos metodológico, utilizando experiências obtidas na sua vida profissional e pessoal e isso de certa maneira contribui para valorizar o processo de ensino e aprendizagem dos alunos.

É imperioso que a humanidade esteja pronta para aprender, ensinar e se adaptar ao novo (FURLAN; NICODEM, 2017). A tecnologia está sempre produzindo artefatos e ferramentas novas e se modificando, traz melhorias para os seus usuários.

As Tecnologias Digitais se formam em um reforço de modo vital na educação atual, pois tem como objetivos e funções instruir os estudantes, colaborar com a pedagogia metodológica dos professores e valorizar o trabalho dos gestores, ente outros benefícios.

III. CONSIDERAÇÕES FINAIS

As consequências decorrentes da pandemia da COVID-19 produziram enorme mudança no trabalho docente e na educação como um todo, gerando transformações emergenciais e exigindo fóruns para reflexões acerca de sua organização, do papel do professor e dos alunos, bem como nas responsabilidades dos governos e gestão frente às políticas educacionais.

A sala de aula é um ambiente educacional em que ocorre a aprendizagem de todos os envolvidos, dessa forma, para que isso aconteça no ensino, os professores estão sempre procurando por práticas pedagógicas mais inovadoras. Nessa concepção foi pensado na inclusão de tecnologias nas salas de aulas, mas isso já era um desafio, uma vez que as escolas não tinham planejado a implantação desses recursos que são modernos e diferentes dos tradicionais. De acordo com Pedró (2016) em todo o mundo foram feitos esforços para a mudança do ensino e a aprendizagem que parecem não obter bons resultados, porque a escola ainda é muito parecida com a que se tinha vinte anos atrás. O uso das tecnologias no processo de ensino e aprendizagem se dará para o cenário da atualidade sob o manuseio dos diferentes recursos e dispositivos digitais, que existem para fomentar o acesso à educação de qualidade aos indivíduos (Brandão & Vargas, 2016).

As competências desenvolvidas pelos professores durante o processo de mudança de uma sala de aula presencial (tradicional) para aula a distância utilizando as

TIC, são caracterizadas por pedagógicas, tecnológicas, profissional e metodológicas, no entanto, o que se destaca, diz respeito, justamente às competências tecnológicas, talvez pela necessidade de aprender de forma imediata, limitada ao tempo mínimo para aplicabilidade no contexto educacional em tempos de isolamento social devido a pandemia do novo corona vírus.

Similarmente, os docentes mudaram o jeito de ministrar as aulas, por meio dos recursos tecnológicos disponíveis no ambiente social, como os notebooks, celulares, whatsapp, youtube, data show, e assim por diante, buscando inovar com as metodologias ativas, ao mesmo tempo com as atividades pedagógicas tradicionais. Essas tarefas demandam um tempo maior para o planejamento pedagógico, sendo percebido que esses aspectos vêm sendo debatidos e pesquisados na atualidade, podendo ter algumas situações a serem solucionadas nas questões tecnológicas.

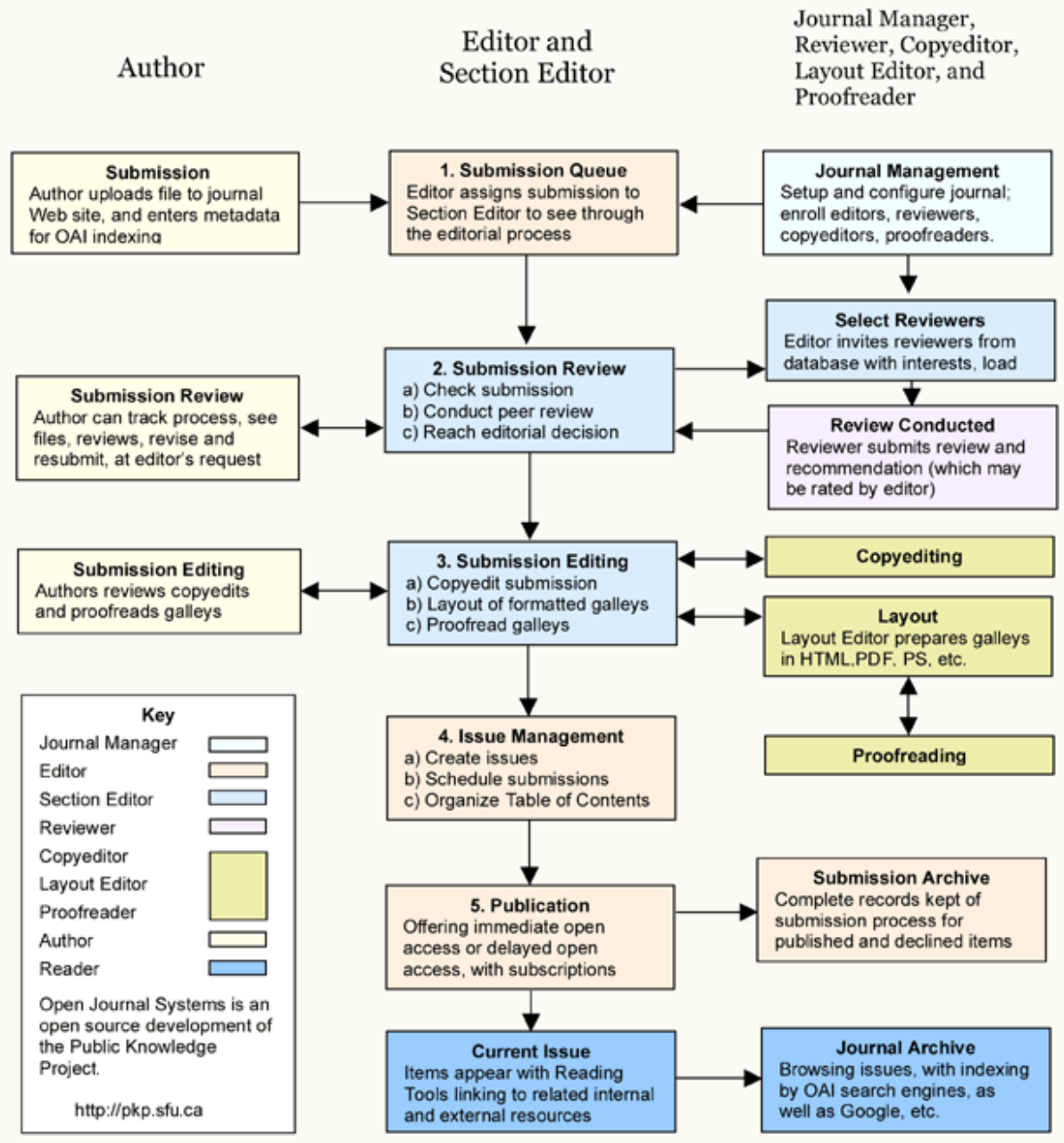
Diante do exposto, as perspectivas das práticas educacionais remotas para os docentes do ensino, desde a educação infantil até a educação superior, revelam que, mesmo que existam muitas barreiras e principalmente uma precisão contínua de adequação a nova ferramenta de ensino, a maioria dos docentes visualiza as atividades de ensino remoto como positivas e em suma a maioria tem buscado se adequar.

REFERÊNCIAS

- [1] ALAVA, S. et al. (Org.). **Ciberespaço e formações abertas: rumo a novas práticas educacionais?** Porto Alegre: Artmed, 2002.
- [2] ALMEIDA JUNIOR, S. et al. Dissemination of knowledge and scientific production in professionalizing courses: A report of experience. **Pubsaúde**, n. 2, p. 1-8, set. 2019.
- [3] AUGUSTO, C. B.; SANTOS, R. D. (Org.). **Pandemias e Pandemônio no Brasil**. São Paulo: TirantloBlanch, 2020.
- [4] BACICH, L. Ensino híbrido: muito mais do que unir aulas presenciais e remotas. **Inovação na educação**. 06 jun. 2020. Disponível em: <https://lilianbacich.com/2020/06/06/ensinohibrido-muito-mais-do-que-unir-aulas-presenciais-e-remotas/>. Acesso em: 03 set. 2020.
- [5] BEZERRA, I. M. P. State of the art of nursing education and the challenges to use remote technologies in the time of corona virus pandemic. **Journal of Human Growth and Development**, São Paulo, v. 30, n. 1, p. 141-147, 2020.
- [6] BRASIL. **Portaria nº 2.117, de 6 de dezembro de 2019**. Dispõe sobre a oferta de carga horária na modalidade de Ensino a Distância - EaD em cursos de graduação presenciais ofertados por Instituições de Educação Superior - IES pertencentes ao Sistema Federal de Ensino. Disponível em: <https://www.in.gov.br/en/web/dou/-/portaria-n-2.117-de-6-de-dezembro-de-2019-232670913>. Acesso em: 21

- out.2020.
- [7] BRASIL. **Portaria nº 343, de 17 de março de 2020**. Dispõe sobre a substituição das aulas presenciais por aulas em meios digitais enquanto durar a situação de pandemia do Novo Coronavírus - COVID-19. 2020a. Disponível em: <http://www.in.gov.br/en/web/dou/-/portaria-n-343-de-17-de-marco-de-2020-248564376>. Acesso em: 15 jul. 2020.
- [8] BRASIL. **SINAES: bases para uma nova proposta de avaliação da educação superior**. Brasília, DF: INEP, 2003.
- [9] CARNIELLO, M F.; MOTA, H. A. Educomunicação: um estudo das práticas nas salas de aula. **REU**, Sorocaba, SP, v. 43, n. 2, p. 351 – 371, dez. 2017.
- [10] CASSIDY, E. **Como encontrar e visualizar dados de satélites de dióxido de nitrogênio**. 2020. Disponível em: <https://earthdata.nasa.gov/learn/articles/feature-articles/health-and-air-quality-articles/find-no2-data>. Acesso em: 10 set. 2020.
- [11] CEARÁ. **Cresce número de cearenses com nível superior**. Disponível em: <https://www.ceara.gov.br/2021/03/25/cresce-numero-de-cearenses-com-nivel-superior/>. Acesso em: 25 maio 2021.
- [12] CHRISTENSEN, C.; HORN, M.; STAKER, H. **Ensino híbrido: uma inovação disruptiva. uma introdução à teoria dos híbridos**. Maio de 2013. Disponível em: https://porvir.org/wp-content/uploads/2014/08/PT_Is-K-12-blended-learning-disruptive-Final.pdf. Acesso em: 17 set. 2020.
- [13] COSTA, S. M. **A influência dos recursos tecnológicos no processo de ensino aprendizagem**. 2014. 43f. Trabalho de Conclusão de Curso (Especialização em Fundamentos da Educação: Práticas Pedagógicas Interdisciplinares) – Universidade Estadual da Paraíba, Sousa, 2014.
- [14] DIAS, P. Comunidades de educação e inovação na sociedade digital. **Educação Formação e Tecnologia. Educação, Formação & Tecnologias**, Portugal, v. 5, n. 2, p. 4-10, dez. 2012.
- [15] FURLAN, M. V. G; NICODEM, M. F. M. A importância das tecnologias de informação e comunicação no ambiente escolar. **Revista Eletrônica Científica Inovação e Tecnologia**, Medianeira, v. 8, n. 16, 2017.
- [16] IMBERNÒN, F. **Qualidade no ensino e formação do professorado: uma mudança necessária**. Tradução: Silvana Cobucci Leite. São Paulo: Cortez, 2016.
- [17] JUNGES, F. C.; KETZER, C.; OLIVEIRA, V. M. Formação continuada de professores: Saberes ressignificados e práticas docentes transformadas. **Educação & Formação**, Fortaleza, v. 3, n. 3, p. 88-101, 2018.
- [18] LEWIS, T.; O'ROURKE, B.; DOOLY, M. Innovation in language learning and teaching– Online intercultural exchange. **Innovation in Language Learning and Teaching**, v. 10, n. 1, p. 1-5, 2016.
- [19] MATTAR, J. **Metodologias ativas para a educação presencial, blended e a distância**. São Paulo: Artesanato Educacional, 2017.
- [20] MORAN, J.; MASETTO, M. T.; BEHRENS M. A. **Novas tecnologias e mediação pedagógica**. Campinas: Papirus, 2000.
- [21] MORAN, J. **Mudando a educação com metodologias ativas**. 2015. Disponível em: http://www2.eca.usp.br/moran/wp-content/uploads/2013/12/mudando_moran.pdf. Acesso em: 18 set. 2020.
- [22] REIS, L. G. **Produção de Monografia da teoria à Prática: O Método Educar pela pesquisa (MEP)**. 4. ed. Brasília: Senac-DF, 2012
- [23] RIBAS, D. A docência no ensino superior e as novas tecnologias. **Revista Eletrônica LatoSensu**, São Paulo, v. 3, n. 1, p. 1-16, 2008.
- [24] ROTHAN, H. A.; BYRAREDDY, S. N. The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. **Journal of Autoimmunity**, feb. 2020.
- [25] SANTAELLA, L. Gêneros discursivos híbridos na rede na era da hipermídia. **Bakhtiniana**, v.9, n. 2, p.206-216, São Paulo, ago./dez. 2014.
- [26] SANTOS, B.S. **A cruel pedagogia do vírus**. Coimbra, Portugal: Edições Almedina, 2020. 32 p. Disponível em: <https://www.cpalsocial.org/documentos/927.pdf>. Acesso em: 12 set. 2020.
- [27] SANTOS, É. O. Ambientes Virtuais de Aprendizagem: por autores livres, plurais e gratuitos. **Revista FAEBA**, Salvador, v.12, n.18, 2003.
- [28] SILVA, A. P. S. **Diagnóstico do uso das TDICS nas escolas públicas da zona urbana do**
- [29] SILVA, M. Internet na escola e inclusão. In: ALMEIDA, M. E. B.; MORAN, J. M. (Org.). **Integração das tecnologias na educação: salto para o futuro**. Brasília, DF: Ministério da Educação, 2005. p.62-69.

OJS Editorial and Publishing Process



~JAERS Workflow~

Important links:

Paper Submission Link:

<https://ijaers.com/submit-paper/>

Editorial Team:

<https://ijaers.com/editorial-board/>

Peer Review Process:

<https://ijaers.com/peer-review-process/>

Publication Ethics:

<https://ijaers.com/publication-ethics-and-publication-malpractice-statement/>

Author Guidelines:

<https://ijaers.com/instruction-to-author/>

Reviewer Guidelines:

<https://ijaers.com/review-guidelines/>

Journal Indexed and Abstracted in:

- Qualis-CAPES (A2)-Brazil
- Normatiza (Under Review- Ref.020191511)
- NAAS Score: 3.18
- Bielefeld Academic Search Engine(BASE)
- Aalborg University Library (Denmark)
- WorldCat: The World's Largest Library Catalog
- Semantic Scholar
- J-Gate
- Open J-Gate
- CORE-The world's largest collection of open access research papers
- JURN
- Microsoft Academic Search
- Google Scholar
- Kopernio - powered by Web of Science
- Pol-Index
- PBN(Polish Scholarly Bibliography) Nauka Polaska
- Scilit, MDPI AG (Basel, Switzerland)
- Tyndale University College & Seminary
- Indiana Library WorldCat
- CrossRef DOI-10.22161/ijaers
- Neliti - Indonesia's Research Repository
- Journal TOC
- WIKI-CFP
- Scinapse- Academic Search Engine
- Mendeley-Reference Management Software & Researcher Network
- Dimensions.ai: Re-imagining discovery and access to research
- Index Copernicus Value(ICV): 81.49
- Citeseerx
- Massachusetts Institute of Technology (USA)
- Simpson University (USA)
- University of Louisville (USA)
- Biola University (USA)
- IE Library (Spain)
- Mount Saint Vincent University Library (Halifax, Nova Scotia Canada)
- University Of Arizona (USA)
- INDIANA UNIVERSITY-PURDUE UNIVERSITY INDIANAPOLIS (USA)
- Roderic Bowen Library and Archives (United Kingdom)
- University Library of Skövde (Sweden)
- Indiana University East (campuslibrary (USA))
- Tilburg University (The Netherlands)
- Williams College (USA)
- University of Connecticut (USA)
- Brandeis University (USA)
- Tufts University (USA)
- Boston University (USA)
- McGill University (Canada)
- Northeastern University (USA)
- BibSonomy-The blue social bookmark and publication sharing system
- Slide Share
- Academia
- Archive
- Scribd
- ISRJIF
- Cite Factor
- SJIF-InnoSpace
- ISSUU
- Research Bib
- infobaseindex
- I2OR
- DRJI journal-repository



AI Publication

International Journal of Advanced Engineering Research and Science (IJAERS)

104/108, Sector-10, Pratap Nagar, Jaipur, India