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Detail with DOI (CrossRef)

Floating PV power generation to balance Brazil's electric system: A sustainable C-free power generation program

Uri Stiubiener, Allan Thomaz Stiubiener, Thadeu Carneiro da Silva

 DOI: [10.22161/ijaers.93.1](https://doi.org/10.22161/ijaers.93.1)

Page No: 001-017

Multicopper Oxidases Enzymes use and its Characteristics

R. Sahay

 DOI: [10.22161/ijaers.93.2](https://doi.org/10.22161/ijaers.93.2)

Page No: 018-025

Study of Water Discharge in Way Sikabiry Watershed, Liliboy Village, West Leihitu District, Central Maluku Regency

Rudi Serang

 DOI: [10.22161/ijaers.93.3](https://doi.org/10.22161/ijaers.93.3)

Page No: 018-026

State and Society in the Process of Formulating Public Policy of Education: Contributions of Stephen Ball

Danilo da Costa, Jonas Rodrigo Gonçalves, João Carlos Medeiros de Aragão

 DOI: [10.22161/ijaers.93.4](https://doi.org/10.22161/ijaers.93.4)

Page No: 027-034

Profile of hospitalizations of women with heart failure in public hospitals in the municipality of Macapá, Amapá, 2016 to 2021

Amanda Silva Arenhardt, Amanda Maria de Almeida Moreira, José Natanael Gama dos Santos, Hilton José Vaz, Thayana Sousa Silva, Lidiane Assunção de Vasconcelos, Luiz Euclides Coelho de Souza Filho, Claudia Damares Ribeiro Sousa, Paulo Victor Caldas Soares, Ralrizonia Fernandes Sousa, Luciano Gil Saldanha Torres, Jennyfer Karolaine dos Santos Lima, Layse da Silva Carvalho, Ronnes de Azevedo Dias, Ana Trindade Pereira, Bruno Rafael Ribeiro de Almeida, Danielle Rosa de Souza Penha Viana, Karina Faine da Silva Freitas, Brenda Beatriz Silva Monteiro, Lauricéia Valente de Oliveira, Mariana Valente de Oliveira, Leomeria Lima do Nascimento, Lilian Cristina Mainardes de Miranda, Larissa Pereira de Barros Borges, Lis Gomes Rodrigues, Naellem Jasmyne Batista Gomes, Leonardo Martins Silva, Jéssica Maria Lins da Silva, Ana Paula dos Reis Freire, Zara Fernanda Lima Martins dos Reis, Soraya Galvão Martins, Fernanda Silva do Monte, Laura de Fátima Lobato Silva, Juliana Rosario de Moraes, Yanka Macapuna Fontel, Eliana Maria dos Santos, Yasmin Martins de Sousa, Cristiane dos Santos Silva, Yasmin Pacheco Ribeiro, Michele de Pinho Barreiros, Márcia Cardoso Pimentel, Wanne Letícia Santos Freitas, Larissa Renata Bittencourt Pantoja, Nayana Carvalho Pereira, Charles Gabriel Santiago Telles, Carolina Marinho de Pina Carvalho, Aline Oliveira Gama, Samara Costa Fernandes, Suellen Patricia Sales da Costa Loureiro, Diego João de Lima Arrais, Tainá Sayuri Onuma de Oliveira, Helana Augusta Andrade Leal Dias, José Daniel Rodrigues dos Santos, Vitória Fernanda Valadares Coelho, Alda Lima Lemos, Patrícia da Silva Souza, Elizângela Serrão dos Santos, Rosineide Ribeiro da Costa Silva, Niceane dos Santos Figueiredo Teixeira, Anderson Lineu Siqueira dos Santos, Tatyellen Natasha da Costa Oliveira, Lucianne do Socorro Nascimento de Araújo, Luceme Martins Silva, Ana Caroline Guedes Souza Martins

 DOI: [10.22161/ijaers.93.5](https://doi.org/10.22161/ijaers.93.5)

Page No: 037-042

Impact of Coronavirus Disease (COVID-19) towards Hotel Tourism Industry

Nashirah Abu Bakar, Sofian Rosbi, Kiyotaka Uzaki

 DOI: [10.22161/ijaers.93.6](https://doi.org/10.22161/ijaers.93.6)

Page No: 043-050

Chlorpyrifos Toxicity in Sheep and Effect of Corchorus Olitorius

Almahdi Alzaroukh Jaber

 DOI: [10.22161/ijaers.93.7](https://doi.org/10.22161/ijaers.93.7)

Page No: 051-053

Challenges and Perspectives of Entrepreneurship in Nursing

Nayara Sousa de Mesquita, Pamela Nery do Lago, Marlene Simões e Silva, Juliana da Silva Mata, Natália Borges Pedralho, Merilaine Isabel dos Santos, Juliana Raquel Maciel do Nascimento, Liene de Fátima Carvalho, Sandra Patrícia Duarte, Simone Aparecida de Souza Freitas, Luciana Martins Ribeiro, Marília Antônia de Paula, Laiana Otto da Costa, Bianca Cristina Silva Assis Santiago, Fabíola Fontes Padovani, Mariana Regina Pinto Pereira, Maria Emília Lúcio Duarte, Priscila Tafuri de Paiva, Carla Renata dos Santos, João Batista Camargos Junior, Vinícius Martins Machado, Maria Ivanilde de Andrade, Edma Nogueira da Silva, Maria Fernanda Silveira Scarcella, Tatiana Lamounier Silva, Eliseu da Costa Campos, Francisco Hilângelo Vieira Barros, Flaviana Bento da Silva, Ana Rita Ferreira de Lucena, Suellen Batista Mariano de Deus, Leonardo Oliveira Silva, Marcelo Dangllys Duarte Fernandes, Adriana Simões Moreira Rocha, Fabiana Ribeiro da Silva Braga, Laise Cristina Pantoja Feitosa, Laura Thais de Oliveira Mena, Daiane Medina de Oliveira, Juliane Guerra Golfetto

 DOI: [10.22161/ijaers.93.8](https://doi.org/10.22161/ijaers.93.8)

Page No: 054-060

Mediation, ecology of knowledge and literature: A dialogue on the margins

Bernardo Gomes Barbosa Nogueira, Fernanda Nigri Faria

 DOI: [10.22161/ijaers.93.9](https://doi.org/10.22161/ijaers.93.9)

Page No: 064-065

Classification of hazardous areas - natural gas installations

Julio César de Almeida, Alexandre Pescador Sardá, Hermes Stefano Ferreira de Oliveira

 DOI: [10.22161/ijaers.93.10](https://doi.org/10.22161/ijaers.93.10)

Page No: 066-071

Reliability of prestressed concrete girders design: Comparison between NBR and Eurocode codes

Vinicius Heidtmann Avila, Mauro de Vasconcellos Real

 DOI: [10.22161/ijaers.93.11](https://doi.org/10.22161/ijaers.93.11)

Page No: 072-081

Determination of Stiffness and Hardness of Glasses by using Acoustic Waves Testing

Álvaro Barbosa de Carvalho Júnior, Maurílio José Inácio, Adalto Soares da Fonseca Júnior, Geraldo Dias Pereira Júnior, Maria Helena Teles Lopes, Samara Guedes Ramos, José Higino Dias Filho, Mateus Souto Almeida

 DOI: [10.22161/ijaers.93.12](https://doi.org/10.22161/ijaers.93.12)

Page No: 082-090

Intracranial hemorrhage in the preterm infants: An integrative literature review

Daniel Lucas Costa Monteiro, Adrielly Cristiny Mendonça Fonseca, Hilane dos Santos Alves, Aline França Nunes, Adrianne Raposo Ponte, Francisco Miguel da Silva Freitas, Marivaldo de Moraes e Silva, Iasmim Rodrigues Salvador, Lorena Machado Freire de Carvalho, Luana Fernandes Coelho, Larissa Toledo Pancieri, Leila Assef Mendes, Vanessa Marques da Silva Creão, Thais do Socorro Botelho de Lima e Silva, Sara Mikhaela Costa Siufi, Fabiane da Costa Figueiredo, Samuel da Silva Ribeiro, Juliane Costa Santos, Lara Rosa Cardoso e Cardoso, Pedro Thiago Malcher de Amorim Dias, Antonio Aécio de Miranda Lima Junior, Ricardo Soares Coelho, Jakeline Lima da Costa Marchezini, Joaquim Pedro Júnior, Maria Caroline do Vale Souza, Victoria Moraes Perinazzo, Suyanne Lobato Rodrigues, Katharine Klicie Barros da Silva, Carolle Freitas Batalha, Dilena Maria Costa Monteiro

 DOI: [10.22161/ijaers.93.13](https://doi.org/10.22161/ijaers.93.13)

Page No: 091-098

Attitudinal Accessibility in Inclusive Education for Transdisciplinarity and Learning

Dayvison Bandeira de Moura, Raniere Marques de Melo, Rowayne Soares Ramos, Avaetê de Lunetta e Rodrigues Guerra, William Jônatas Vidal Coutinho, Elisenaide Bezerra Santos, Pedro Arthur de Melo Nascimento, Enéas Fábio Farias Neves, Edson de Lima Filho, Marcela Serafim Geraldo

 DOI: [10.22161/ijaers.93.14](https://doi.org/10.22161/ijaers.93.14)

Page No: 099-103

Clients' Perception about Self-Service in the Virtual Channels of a Banking Agency in the State of Tocantins

Kleber Augusto Buss, Rubia Caetano Cardoso, Cláudia da Luz Carvelli, Adonaldo Avelino de oliveira, Maria das Graças Bastos de Sousa, Rômulo Caldeira de Souza Maia, Jussara Resende Costa Santos, Alexandre Ribeiro Dias, Victor de Oliveira, Kattia Ferreira da Silva, Claudeilda de Morais Luna, Márillos Peres De Melo

 DOI: [10.22161/ijaers.93.15](https://doi.org/10.22161/ijaers.93.15)

Page No: 104-118

Management of the Sepsis Protocol: An integrative litera-ture review

Francisco Otávio Alves Cordeiro, Irna Carla Rosário Souza Carneiro, Heliana Helena de Moura Nunes

 DOI: [10.22161/ijaers.93.16](https://doi.org/10.22161/ijaers.93.16)

Page No: 119-125

Multi-objective optimization of parameters in drilling of natural fibre Composites (Kenaf) using Taguchi and Grey relational analysis

G Venkateswarlu

 DOI: [10.22161/ijaers.93.17](https://doi.org/10.22161/ijaers.93.17)

Page No: 126-132

Effects of eccentric exercises on tendinopathy of the shoulder rotator cuff: A systematic review

Livia Gomes de Oliveira, Taynara Dantas Batista, Francisco Elder Marinho Araújo Filho, Eros Silva Cláudio, Warly Neves de Araújo

 DOI: [10.22161/ijaers.93.18](https://doi.org/10.22161/ijaers.93.18)

Page No: 133-142

Socioeconomic and Environmental valuation of the Ecosystem Services: A Case Study of from Zoobotanical Park in Belém, Pará, Brazil

Antônio Cordeiro de Santana, Ádina Lima de Santana, Gilmara Maureline Teles da Silva de Oliveira, Rafael de Paiva Salomão, Ádamo Lima de Santana, Eder Silva de Oliveira, Washington Aleksander Savaris dos Santos

 DOI: [10.22161/ijaers.93.19](https://doi.org/10.22161/ijaers.93.19)

Page No: 143-155

The Feasibility of Tax Arbitration In The Brazilian Legal System

Rildo Mourão Ferreira, Rosângela de Paiva Leão Cabrera

 DOI: [10.22161/ijaers.93.20](https://doi.org/10.22161/ijaers.93.20)

Page No: 156-165

Defense Mechanism of the Immune System Against Hepatitis C Infection

Caroline de Souza Alovisei, Gislaïne dos Santos Rodrigues Vieira, Lucas Souza de Melo, Maria Clara Oliveira Fernandes, Cleber Queiroz Leite, Susanna Cristina de Carvalho Fernando, Marcela Fernandes Lúcio, Iasmin Kelly Echer Vieira Freitas, Poliana Alves da Silva, Julia Garcia Peres, Brian França dos Santos, Stefany Ohana Oliveira Costa Borges, Mariana Bezerra dos Santos

 DOI: [10.22161/ijaers.93.21](https://doi.org/10.22161/ijaers.93.21)

Page No: 166-169

Article Modelase by Fajate – Direct Sale and manufacture products directly from industry to consumer

Mariana Garcez Catarino

 DOI: [10.22161/ijaers.93.22](https://doi.org/10.22161/ijaers.93.22)

Page No: 170-175

Prevalence of Physical Inactivity and Associated Factors: A study with military policemen from Macapá-AP/Brazil

Hêule Nilton Santos de Oliveira, Demilto Yamaguchi da Pureza, Wollner Materko, Alisson Vieira Costa, Álvaro Adolf Duarte Alberto

 DOI: [10.22161/ijaers.93.23](https://doi.org/10.22161/ijaers.93.23)

Page No: 176-181

Uptake, distribution and biofortification of selenium in Acemella Oleracea (L.) R. K. Jansen

Eder Silva de Oliveira, Mario Lopes Silva Junior, Gilmara Maureline Teles da Silva de Oliveira, Ricardo Falesi Palha de Moraes Bittencourt, Antônio Cordeiro de Santana, Washington Aleksander Savaris dos Santos, Ítalo Marlone Gomes Sampaio, Hebe Morganne Campos Ribeiro, Letícia da Cunha Hungria

 DOI: [10.22161/ijaers.93.24](https://doi.org/10.22161/ijaers.93.24)

Page No: 182-193

The relation between the Environment and Pandemics

Maria Eurilene Almeida da Silva, Simone da Silva

 DOI: [10.22161/ijaers.93.25](https://doi.org/10.22161/ijaers.93.25)

Page No: 194-205

An integrated BSC-AHP approach to support the strategic management of small technology companies

Santiago Gomes da Silva, Alessandro Roberto Rocha, Fernando Nascimento Zatta, Diego Vieira dos Santos, Wellington Gonçalves

 DOI: [10.22161/ijaers.93.26](https://doi.org/10.22161/ijaers.93.26)

Page No: 206-216

The green corn development and yield on different summer soil covering plants in the organic no-tillage system

Aline Marchiori Crespo, Maurício Novaes Souza, Luiz Fernando Favarato, Rogério Carvalho Guarçoni, João Batista Silva Araújo, Otacílio José Passos Rangel, Jacimar Luis de Souza, Dalila da Costa Gonçalves

 DOI: [10.22161/ijaers.93.27](https://doi.org/10.22161/ijaers.93.27)

Page No: 217-225

The Influence of Bullying and Malocclusion on the Quality of Life of Adolescents

Ana Paula Barbisan Rodrigues, Augusto Alberto Foggiato, Douglas Fernandes da Silva, César Henrique Fukuji Fuziy, Acácio Fuziy

 DOI: [10.22161/ijaers.93.28](https://doi.org/10.22161/ijaers.93.28)

Page No: 226-244

Edu-communication in research groups in the North region of Brazil

Glauciene Dutra Silva, Rafael Ricardo Friesen, Wellen C. de A. Sousa e Silva, Leila Adriana Baptaglin

 DOI: [10.22161/ijaers.93.29](https://doi.org/10.22161/ijaers.93.29)

Page No: 245-253

Design of a Robotic Vehicle with Real-Time Video Streaming

Ezeofor Chukwunazo, Orakwue Stella, Ulasi Afamefuna

 DOI: [10.22161/ijaers.93.30](https://doi.org/10.22161/ijaers.93.30)

Page No: 254-261

Applicability of Information and Communication Technologies: Tics in the Teaching-Learning Process of Environmental Education

Yolanda Vitória Lima Pereira Maia, Marcos Victor do Carmo Loiola, Valdineide Reis de Sousa

 DOI: [10.22161/ijaers.93.31](https://doi.org/10.22161/ijaers.93.31)

Page No: 262-271

Linguistic problems caused by anatomical alterations of the hard palate of speakers with Down syndrome

Andreia de Melo Costa Ferraz, Carla Salati Almeida Ghirello-Pires

 DOI: [10.22161/ijaers.93.32](https://doi.org/10.22161/ijaers.93.32)

Page No: 272-276

A Machine Learning Approach on the Problem of Corruption

Luciano M. C. Doria, Felipe F. Doria, Paulo Figueiredo, Adilson Sampaio, Renelson Ribeiro Sampaio

 DOI: [10.22161/ijaers.93.33](https://doi.org/10.22161/ijaers.93.33)

Page No: 277-282

The Structuring of Goat and Sheep Farming in the Municipalities of the Hinterland of São Francisco Pernambucano

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

 DOI: [10.22161/ijaers.93.34](https://doi.org/10.22161/ijaers.93.34)

Page No: 283-292

Improved Hydrodynamic Efficiency of Kaplan Hydro Turbine through Varying Blade Number and Length

Olusegun Balogun, Victoria Alao, Babatope Pele, L.L Ladokun

 DOI: [10.22161/ijaers.93.35](https://doi.org/10.22161/ijaers.93.35)

Page No: 293-303

Marketing Communication Strategies: A Study in a Civil Construction Company in Gurupi - To

Daniela Bezerra dos Santos, Phamilla Lima Ribeiro, Eliza Magalhães do Prado, Euripedes Martins da Silva Junior, Patricia Pinheiro alves feitosa, Rubia Caetano Cardoso, Maria das Graças Bastos de Sousa, Claudeilda de Moraes Luna, Elizabeth Vieira dos Reis, Alessandra Martins Correia, Márlllos Peres De Melo

 DOI: [10.22161/ijaers.93.36](https://doi.org/10.22161/ijaers.93.36)

Page No: 304-315

Depression in the Pandemic: The Impacts on Mental Health During the COVID-19 Contagion in Brazil

Carlos Gabriel de Souza Soares, Eduardo Jorge Sant'Ana Honorato, Daniel Cerdeira de Souza, Alexandre Vilhena da Silva Neto, Angela Xavier Monteiro, Érica da Silva Carvalho, Kenne Samara Andrade Martins, Rômulo Chaves Pereira de Oliveira, Tirza Almeida da Silva, Luziane Vitoriano da Costa, Izi Caterini Paiva Alves Martinelli dos Santos, Sônia Maria Lemos

 DOI: [10.22161/ijaers.93.37](https://doi.org/10.22161/ijaers.93.37)

Page No: 316-325

Environmental Racism has Colour: A Look at the Fishing Territory

Fátima Cristina Cunha Maia Silva, Júlia Figueredo Benzaquen, Luciano Pires Andrade, Horasa Maria Lima da Silva Andrade

 DOI: [10.22161/ijaers.93.38](https://doi.org/10.22161/ijaers.93.38)

Page No: 326-333

Drought Diagnosis in the Municipality of Itaberaba-Ba and the Potential Impacts for Pineapple Growing

Marcos Antonio Cerqueira Santos, Marcos Victor do Carmo Loiola, Marcos Antônio Vanderlei Silva, Jairton Fraga Araújo, Fábio Del Monte Coccozza, Rubens Silva Carvalho

 DOI: [10.22161/ijaers.93.39](https://doi.org/10.22161/ijaers.93.39)

Page No: 334-343

Chinese Students' Dilemmas of Neoliberal Storm in Ivory Tower: A Top-down Reasoning and Bottom-up Solutions' Proposal

MA Yiran

 DOI: [10.22161/ijaers.93.40](https://doi.org/10.22161/ijaers.93.40)

Page No: 344-348

A Case Study of Teachers' Identity in Chinese Online Shadow Education Institutions

MA Yiran

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Page No: 349-362

Floating PV power generation to balance Brazil's electric system: A sustainable C-free power generation program

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**Keywords— Hybrid power generation,
Sustainable power generation, Floating
Power Plants, C-free energy, Energy Security.**

Abstract— The increase of greenhouse gases (GHG) in the atmosphere forces the power industry to reduce the use of fossils fuels, aiming a Carbon-free energy production. Wind and Solar power plants have been deployed to reduce GHG emissions. However, these technologies occupy big land extensions on a utility-scale. This suggests the use of open water surfaces to install large photovoltaic (PV) floating plants. In this paper, a country-size hydro-solar power generation model is proposed. PV is more predictable than wind power, which already enters the grid without dispatch. This research intends to evaluate if Hydroelectric Power Plants' (HPP) reservoirs can host, near their dams, PV Floating Power Plants (PV-FPP) sized to meet the hydro capacity. Then, use the synergy of hydro and solar sources to run a hybrid generation model. To achieve this goal, we established the state-of-the-art of floating PV generation in Brazil and the world from academic and technical literature. We identified and described the solar characteristics, calculate the PV potential, and simulate a hydro-solar model. This resulted that Brazil can replace its 2020 fossil thermal generation using 50% of the proposed hydro-solar model potential. This model on all country's HEPP can add 84.5 TWh/year to the electric system.

I. INTRODUCTION

• Background

At the start of the XXI century, the world faces significant energy challenges. Energy demand grows all over the world, as the population growth increases the use of air conditioners (refrigeration and heating), appliances, communication technologies, electric cars, and much other electric equipment. Additionally, changes in consumer habits, stemming from new technologies and new mentalities, are diversifying the profile of energy consumption, which is boosting the electricity consumption *per capita* ([1], [2], [3]). Electricity is one of the driving forces of the economic development of society [4].

Brazil has a well-balanced source system to supply its energy demand. 48.4% of Brazilian energy comes from non-fossil sources. When considering only electricity this number reaches 84.8% [5].

Despite having a well-diversified electrical matrix, based on hydroelectricity, this source represented 65% of all power plants as shown in Fig.1 [6], to supply its population for the coming years, Brazil needs to expand its power generation and electrical infrastructure capacity.

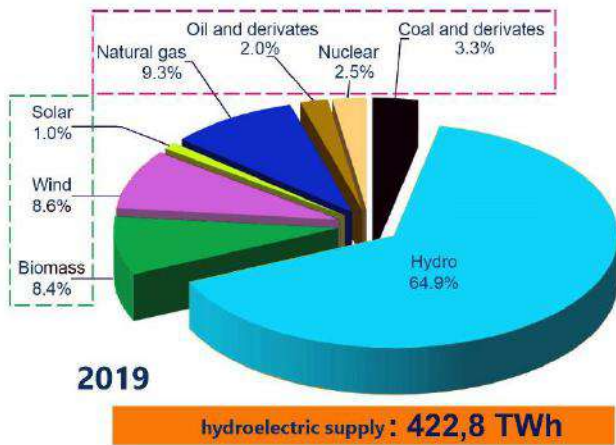


Fig.1: Electric power by source
(Adapted from EPE-BEN 2021)

The growth of the demand can not be followed by new HPP, which will drive an increase in the share of thermal power plants (TPP). According to the Geographic Information Database (SINDAT), Brazil's Hydro-Electric Power Plants (HPP) current installed capacity is 101,862 MW. Alongside, Brazil imports 7,000 MW from Paraguay (generated by the Itaipu Bi-National HPP), counting with a total hydropower capacity of 108 GW.

The higher instantaneous demand of 90,525 MW was recorded in 2019, January 31st at 15:30. This means that HPP installed capacity already exceeds the maximum demand. Under optimal conditions, Brazil could have 100% of the electricity generated by a non-polluting, renewable source. The country's electricity consumption in 2019 totaled 536 TWh [7].

Despite the small consumption decrease in 2020 (530 TWh), due to the SARS COVID19 pandemic, the economic normalization points to an increase in power consumption. Looking forward, the foreseen consumption for 2030 varies from 680 to 812 TWh depending on economic scenarios [8].

Far away from the consumption centers, some new hydroelectric dams projects are being developed in the north region (Amazon). This region is considered an extremely high priority for conservation and the environment license process is very sensible. The HPP will not go along with the demand increase.

To cover the large extension of its territory Brazil implemented a 127,000 km power transmission base-grid (138 kV to 750 kV) as shown in Fig.2

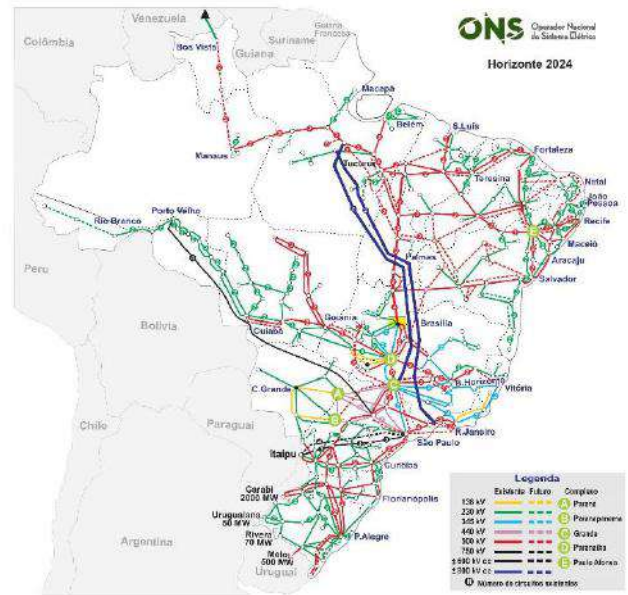


Fig.2: The Brazilian power transmission network
(Source: ONS)

This transmission network, the National Integrated System (SIN), with the additional recent 9,500 km-600 kV, and 9,200 km-800 kV High Voltage Direct Current (HVDC) lines¹, drives the power to the consumption centers, balancing seasonality and climate effects on hydropower production in the north and the south. This network must be expanded to 184,000 km to meet the foreseen demands of 2025 [9]. However, if the new power generation will be near consumption centers, this expansion will be less costly.

Thus renewable energy sources, like wind and solar, are evaluated to attend growth of electricity demand and reduce transmission lines expansion needs. A rising number of small and medium-sized distributed systems, domestic and industrial, are expected to be increasingly present in countries with high rates of solar radiation all year round, including Brazil.

• The problem

HPP are dependent on water storage in their reservoirs. Drought periods directly affect their ability to run at nominal capacity ([10], [11], [12]). The current HPP generation does not cover power demand. Lost hydro-power production must be replaced with other resources to meet demand [10]. Restrictions of the HPP require the activation, and dispatch, of TPP [13]. The historical water storage level in HPP reservoirs since 1931 is shown in Fig.3 [14]. Drought periods are highlighted.

¹ <http://www.ons.org.br/paginas/sobre-o-sin/o-sistema-em-numeros>

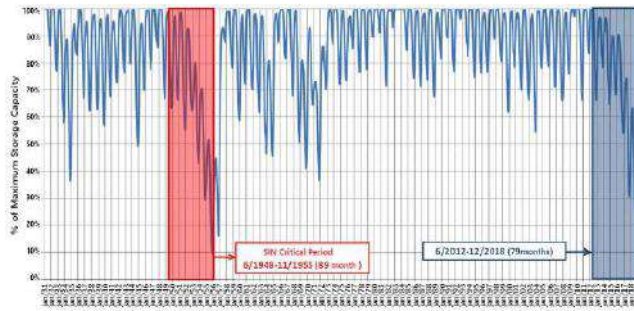


Fig.3: Water storage capacity
(Adapted from ONS-PEN 2019)

The current drought period is still ongoing. The Southeast/Midwest regions hold 70% of the country's water storage capacity. This region's storage capacity reached an even more critical level (less than 26%) during 2021. The historical (minimum water storage average ever recorded) is 19% [15].

The water storage levels on December 31st, 2021 were the highest since 2017 due to the exceptional rains, but still below 55% in every region and the country's average was only 33% [16]:

Region	Storage
North	54.67%
Northeast	52.33%
Southeast/Midwest	25.58%
South	42.79%

The global warming scenario points to prolonged and severe drought periods ([17], [18], [12], [19], [20]), which will increase the share of TPP. Even replacing solid and liquid fuels with natural gas (which is cleaner) TPP will emit GHG. For instance, unburned methane slip is 28 times more harmful than CO₂ ([22], [23], [24], [25], [26], [27]). Glasgow Climate Change Conference (COP-26, 2021) resolutions pointed to the need to combat methane emissions but did not establish numerical goals.

The average GHG emissions per MWh is about 690 kg in Germany [28] and 710 kg in the USA [29]. Low-quality coal firing produces up to 1,400 kg/MWh.

In Brazil, due to less efficient gas cleaning devices, this amount is higher, but there is a leak of datum, so the same average value is considered.

In light of this scenario, and the global claim to reduce GHG emissions [30], a new model is required for power generation. This new model should use the available renewable energy sources.

Objectives

The Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change, at its 21st session in Paris in December 2015 (COP21) [30], called for the transition to an energy system with net-zero carbon emissions by around 2050. As a first step of the transition to a C-free program, the hybrid power generation model will be designed to reach 100% of hydro capacity without non-renewable sources. Transmission network issues and restrictions are not considered.

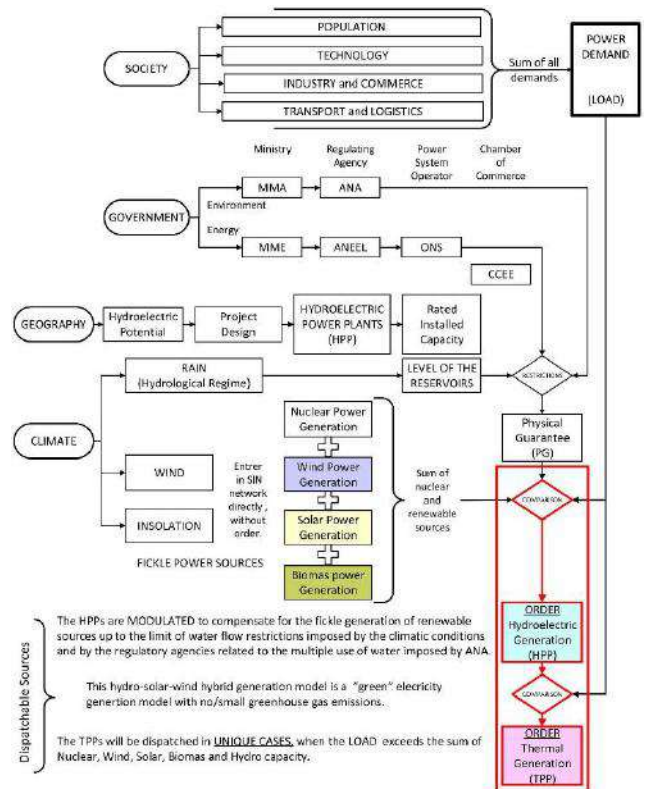


Fig.4: C-free power generation flowchart

We suppose that the power grid will grow, step-by-step, following the country's power demand growth. Then, the hybrid generation capacity will increase to meet the grid size. The flowchart in Fig.4 represents the proposed power generation model.

This article presents the result of research on the feasibility of changing the currently used hydrothermal model by a new hydro-wind-solar model using PV-FPP on HPP waters, focused only on the power generation of Brazil's existing electrical system. To find out and analyze possible issues related to this transition, and propose answers to them, the below steps were performed:

- i. identification of the consumption peaks and periods in which they occur;
- ii. identification of the power generation by source;
- iii. identification of the HPP and the water restrictions in Brazil ;
- iv. review of the state-of-the-art of Wind and PV power generation;
- v. review the geophysical characteristics of Brazil and their suitability for using renewable energy sources for power generation;
- vi. identification of Wind and PV potential;
- vii. simulation of the hydro-wind-solar model behavior and its potential to reduce the need to use other energy sources to meet Brazil's electric system (SEB) demand.

A working hypothesis is that non-dispatchable sources (wind and solar) have priority in power-grid supply. Dispatchable sources will balance the power to demand. The HPP will be modulated to supply power, up to their restriction limit, and the TPP will only be dispatched under exceptional, specific and unforeseen conditions.

This approach can aid the actions of the National Electric System Operator (ONS) to ensure operational flexibility for the entire electric system, adequate electromechanical inertia, environmental sustainability, and storage capacity, drastically reducing GHG emissions.

II. METHOD

To achieve this objective, first, the governmental, industrial and academic literature was reviewed to establish the "state of the art" of wind and solar-PV energy generation in Brazil and worldwide. Second, the authors focused on Brazil's geophysical condition and the existing electrical power generation and transmission infrastructure. We assumed the two working hypotheses described hereafter:

1. Non-dispatching energy sources (Wind and Solar) have priority to feed the grid. Hydro will balance to demand.

$$E_{Total} = (E_W + E_{PV}) + \Lambda_{(E_W + E_{PV})}^D E_H ;$$

Where $D = \text{Demand}$ (1)

Note: E_W and E_{PV} are fickle, and so is D .

This equation can also be written as:

$$E_H = (D + E_{Lost}) - E_N - E_{Bio} - \underbrace{(E_W + E_{PV})}_{fickle} (2)$$

Where: D is the demanded load and E_{Lost} is the energy lost in the transmission network (SIN).

2. Photovoltaic power plants (PVPP) will be designed to a peak power equivalent to the rated power of the HPP, not to exceed transmission lines capacity. W. Fang et al. (2017) also recommend this criterion [31].

$$Max.P_{PV} = P_H \leq \text{Grid Capacity} \quad (3)$$

Once the country's energy demand and generation were investigated, the contribution of renewable energies was evaluated with a focus on PV generation, terrestrial and floating. The method consists of six steps:

1. Determining the area to be covered by the photovoltaic arrays S_{PV} to meet the working hypotheses in each installation, this surface is also called "Solar Area". S_{PV} is obtained from Eq. (4) where $Max.P_{PV}$ is the peak power of PVPP, and μ_{PV} is the power density.

$$S_{PV} = \frac{Max.P_{PV}}{\mu_{PV}} \quad (4)$$

Note: Even though PV-FPP has a power density larger than on-land PVPP and occupies less area, in this article the same power density was considered. The parameter $\mu_{PV} = 1 \text{ MW}/10,000 \text{ m}^2$ [32] is a conservative value ([33], [34], [35], [36]).

2. Simulate the hypothetical PV-FPP power output, using formulas to stipulate the radiation hourly profile (\bar{H}) in the summer, and the resulting PV power generation (P_{PV}). Eq.(5), based on the Rayleigh formula (which is used for wind speed simulation), was adapted for the photovoltaic generation and used to simulate the P_{PV} from sunrise during seven hours. Sunrise (h_0) was considered to be at 8 a.m. h_0 is the start simulation time.

$$P_{PV}(h)_{h_0}^{(h_0+7)} = K \times \frac{2 \times (h-h_0)}{c^2} \times \exp \left[-\frac{(h-h_0)^2}{c} \right] \quad (5)$$

Where: h is the hour, $c=6$, and K is a coefficient to obtain the results in P.U. (we used: $K=1.15 \times \bar{H}$).

After seven hours, PPV was adapted to decreasing luminosity using the Eq.(6):

$$P_{PV}(h)_{(h_0+8)}^{(h_0+12)} = \frac{P_{PV}(h-1)}{2^{(h-(h_0+7))}} \quad (6)$$

During the night, PPV is considered null (Eq.(7)).

$$P_{PV}(h)_{(h_0+13)}^{(24)} = P_{PV}(h)_{(0)}^{(h_0)} = 0 \quad (7)$$

3. Modulate HPP power to the local established value as per Eq.(1). HPP modulation results in non-turbocharged water, which can be temporally stored upstream of the HPP. This extra water is considered as a "virtual battery" [37]. The virtual battery may be used for additional hydroelectric power according to the HPP's convenience; during low/no irradiation times, or contribute to the reservoir's level restoration during drought periods. HPP's turbocharging should

respect the environmental impacts of the river’s water flow, so the authorized daily flow should not exceed the restrictions established by the authorities.

- Obtain the expected annual energy generation for each PVPP (E_{PV}) from Eq.(8), where \bar{H} is the annual average of the nearby measured daily solar radiation (in kWh/m².day), η_{PV} is the nominal efficiency of the PV panels and PR is the performance ratio of the PVPP².

$$E_{PV} = 365 \times \bar{H} \times \eta_{PV} \times PR \times S_{PV} \quad (8)$$

After calculation of the energy to be generated by the PV arrays, the hybrid system was compared to the HPP alone. Doing this for each HPP individually and then results were aggregated to get a country image to assess whether this model can replace the current hydrothermal model, avoiding the use of TPP.

- For the floating installations, check if the reservoir can host PV-FPP of this size. Floating installations will be placed near HEEP dams on the reservoir’s surface. The percentage of coverage $C(\%)$ is obtained from Eq.(9), where (S_R) is the reservoir’s total surface.

$$C(\%) = 100 \times \frac{S_{PV}}{S_R} \quad (9)$$

III. POWER DEMAND

The Brazilian Ministry of Mines and Energy (MME) found that the temperature is what most influences power consumer habits during the day [38]. As the heat is more intense in the late morning and early afternoon, peaks in electricity consumption are currently recorded in this period and during the summer [39].

Fig.5 shows the electrical load curves of the highest consumption day in the winter (upper), and in the summer (lower), from 2000 to 2015, indicating the official rush time [40]. From 2016 this data is collected by ONS and published in a daily online report on its website [41].

The current power consumption peak have been occurring in the summer between noon and 4 p.m., and not more during the historical rush time from 6 pm to 9 p.m. Maximum recorded power demand in Brazil occurred in 2019, January 30th, at 3 p.m., and the value was 90,525 MW [42]. Over the last 20 years, power consumption has increased by 86% in rush time, and 105% in the afternoon new-peak time, surpassing the traditional rush-time peak during the summer. Maximum evening consumption is currently even lower than the 9 a.m. demand.

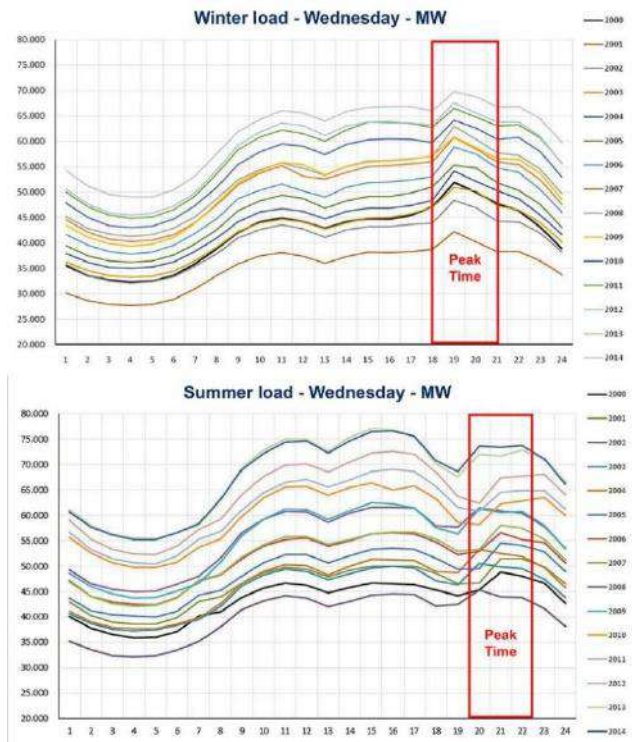


Fig.5: Load curves - 2000 to 2015

(Adapted from EPE, 2015)

The new peak time coincides with the highest daytime radiance, pointing to the solar source as an alternative option to mitigate the peak demand [43].

IV. POWER GENERATION

Distributed Generation (DG)

In Brazil, distributed power generation is defined in Article 14 of Law N° 5.163/2004. The net-metering concept and consumption compensation were established in the country in 2012. Brazil's National Electric Agency (ANEEL) is responsible for regulating the SEB.

Net-metering was made official by the ANEEL's Normative Resolution (REN) N° 482/2012 and was updated through REN N° 687/2015 [44]. This regulation was updated again by Law N° 14.300 from January, 6th 2022.

Two DG categories are regulated as follows:

- micro-generation: electric power system, with an installed capacity less than or equal to 75 kW.
- mini-generation: electric power system with an installed capacity greater than 75 kW and less than or equal to 3 MW when not dispatchable, and to 5 MW when dispatchable.

² A typical Crystalline Si - PV panel has a power density of 150 W/m²

Micro-, and mini-, distributed generation systems (MMDG) are in a significant expansion all over Brazil. Scenarios for the next 10 years forecast 16.8 to 35.8 GW, as shown in Fig.6 [45], depending on electricity price, political issues, and taxation.

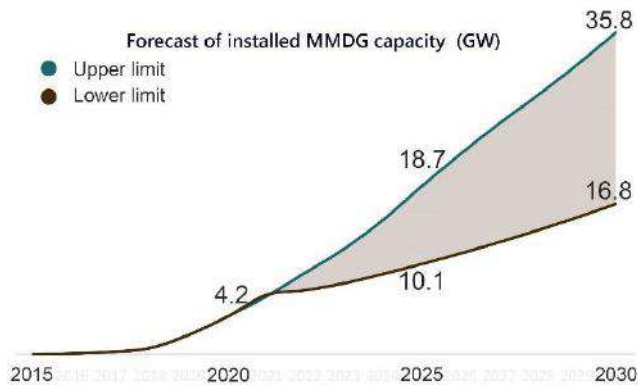


Fig.6: MMDG expansion
(Adapted from PDE2020)

MMDG are characterized as the production of electricity for own consumption. They promote power auto-supply and reduce the load on the SIN transmission lines and the associated losses. In 2019 MMDG contributed with 2.0 TWh to overall energy consumption [46]. It was expected to double the PV energy production in two years and overtake 4.0 TWh in 2021. Solar PV energy is the fastest-growing energy source, reaching the installed capacity of 9.0 GW in February 2022, from more than 817,000 grid-connected active installations (99.9% of it - PV) [47]. More than 1,000,000 consumers are receiving electricity credits through net metering.

Centralized Generation

Alongside the MMDG, the additional large utility-scale hydro, thermal, wind, and solar power plants will be required to attend to the country's energy demand. Utility-scale plants are centralized power generation systems.

- *Nuclear*

The nuclear complex of Angra dos Reis is located in Rio de Janeiro, Southeast Brazil. It consists of two reactors, Angra I and II, with a net output of 1.9 GW connected to SIN's power grid shown in Fig.2. From 2015 to 2020 nuclear power plants (NPP) generated more than 14 TWh every year. Maximum generation occurred in 2019 - 19.1 TWh. In 2021 nuclear power plants (NPP) generated 13.2 TWh.

Angra III, construction ongoing, will increase the nuclear capacity to 3.3 GW. This is the slowest growing power industry in Brazil. In addition to those already mentioned, there are no plans to build new facilities.

- *Wind*

Onshore wind power generation is predominant in the Northeast (85%) and South regions. These 2 regions have different climates and different wind regime behavior. There are 789 wind power plants (WPP) in operation, totaling more than 10,000 wind turbines, with a total capacity of 21 GW [48].



Fig.7: Wind power plant

(Source: diariodonordeste.com.br)

Brazil occupies the 7th position in the 2021 - Onshore Ranking of the Global Energy Council (GWEC) and is the third country that installed the most wind systems in 2020 [49].

- *Solar*

Utility-scale concentrated solar power plants (CSPP), for commercial use, are not yet installed in Brazil. These systems use mirrors or lenses to concentrate a large area of sunlight onto a receiver. The concentrated light is converted to heat a working fluid that drives a turbine connected to an electrical power generator.

Photovoltaics directly converts sunlight to electricity. There are 5,144 PVPP in operation with a total capacity of 4.6 GWp. Another 94 are being erected to increase capacity to 8.4 GWp [48].



Fig.8: São Gonçalo Solar Park

(Source: ecodebate.com.br)

Fast-growing industry, in 2015 PVPP generated 21 MWh to the overall energy supply; in 2021: 6.9 TWh.

The largest PVPP in Brazil is São Gonçalo Solar Park - PI, with an installed capacity of 475 MWp, in operation since January 2020. Fig.8 is a partial view of this solar installation.

Table 1 lists the bigger operating PVPP installed in Brazil nowadays:

Table 1: PVPP in Brazil

PVPP	Localization	State	Area (ha)	Capacity (MWp)
São Gonçalo Power Plant	São G. do Gurguéia	PI	2.000	475
Pirapora Power Plant	Pirapora	MG	1.500	321
Nova Olinda Power Plant	Ribeira do Piauí	PI	1.350	292
Ituverava Solar Park	Tabocas do Brejo Velho	BA	1.350	292
Lapa Solar Complex	Bom Jesus da Lapa	BA	700	158
Juazeiro	Juazeiro Central PV	BA	700	156
Guaimbê PVPP	Guaimbê	SP	700	50
Apodi PVPP	Quixeré	CE	600	132
Paracatu	Paracatu Solar Park	MG	600	132
Total			9.500	2.008

Land occupancy by PVPP is 3 to 5 ha/MWp. Large utility-scale PVPP will require big areas. The utility-scale solar generation comes with a sizable land requirement, depending on the topography of the available site. Densely populated regions, with the highest power demand (Southeastern Brazil), do not have adequate land for these installations, thus they should be located far from the consumption centers.

• *Thermal*

TPP uses fuel combustion to produce heat, then converted to mechanical energy, then converted to electricity.

There are 3,103 TPP in operation with a total capacity of 46 GW. Another 58 are under erection, and 68 more will start erection works soon [48].

From 2015 to 2020 TPP were ordered to generate in every year 60 to 70 TWh to complement the power generation when other sources did not match the demand.

TPP were responsible for 21.6% of the overall energy supply in 2019 as shown in Table 2 [48].

Table 2: TPP per fuel type

Thermal 2020	Energy (TWh)	%	% of total electricity
Biomass	56,167	43%	9,0%
Natural gas	53,464	41%	8,6%
Coal and Derivatives	11,946	9%	1,9%
Oil derivates	7,745	6%	1,2%
Subtotal	129,322	100%	20,8%

(Adapted from EPE-BEN 2021)

Burning fuels have a substantial carbon footprint. The fuel used can be coal, heavy oils, diesel, gas, or biomass. All of them emit atmospheric pollutants like GHG and particulate matter during the combustion process.

Currently, energy-related GHG emissions, mainly from fossil fuel combustion for heat supply, electricity generation, and transport, account for around 70% of total emissions including carbon dioxide, methane, and some traces of nitrous oxide.

TPP are not eco-friendly facilities. Energy production released to the atmosphere 27.7% of the overall country's CO₂ emissions in 2020, totaling 384,279,528 tons [50].

• *Hydro*

The Brazilian hydroelectric long-term potential is 176 GW; currently, 108 GW are operational. The available inventoried potential is 68 GW. Out of these, 52 GW are for HPP bigger than 30 MW projects and the other 16 GW are for small hydroelectric power plants (SHPP) [51] which have special regulations by paragraph §3 of Article 10 of REN N° 687/2015 [44]. There are 426 SHPP already in operation.

Itaipu is a bi-national 14 GW power plant owned by Brazil and Paraguay (Fig.9). Although not the largest installed capacity in the world, it holds the record of the highest annual energy production. It serves as the major load peaking and frequency regulation power plant in Brazil's power grid.



Fig.9: HPP Itaipu-Binational

According to ANEEL's Power Generation Database (SIGA) [48] besides Itaipu, there are 218 operating HPP in Brazil. From those, 164 HPP contribute to SIN; 72 have reservoirs and 88 are run-of-the-river HPP.

The power plants, grouped by hydrographic basins, are shown in the SIN's HPP Schematic Diagram - Horizonte 2021-2025 [52], which is not available in English. This diagram clearly shows the HPP sequences that benefit, in cascade, from the same water flow [52]. The level of any reservoir, and the flow restrictions, affect the operation of all downstream power plants.

HPP are able to increase power output to maximum plant capacity within minutes of starting [10]. They can be adjusted to balance the grid's power demand. The National Operator of the Electric System (ONS) operates the country's power system by dispatching HPP and TPP according to forecasts of reservoirs levels and economic criteria.

▪ *Offshore*

Brazil has a 7,367 km oceanic coast [53]. Brazil's offshore wind-fields map, indicating the average wind speeds, divided by bathymetric bands, is shown in Fig.11 [51].

Gross evaluation of Brazil's offshore wind power potential point to be 6,150 TWh/year [51]. This tremendous potential is not yet explored. Despite having a strong synergy with Oil & Gas Upstream technology, offshore wind power plants projects are just starting and are dependent on a complex, and partially undefined, licensing process.

Until January 2021, Brazil had only 6 projects for offshore wind farms with environmental licensing underway at The Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), [54]: Caucaia~Parazinho-Iparana (310 MW)-CE, Asa Branca I (400 MW)-CE, Pilot Plant-RN (5 MW), Jangada (3 GW)-CE, Maravilha (3 GW)-RJ and, Aguas Claras (3 GW)-RS. Altogether, these projects have a power capacity of circa 10 GW, all of which are in the preliminary licensing phase.

Wind farms' feasibility depends on sea depth and waves shape in every local.

Offshore wind power potential is estimated according to the distance from the shore as follows: 0-10 km=57 GW; 10-50 km=202 GW; 50-100 km=255 GW and, 100-200 km=1,266 GW [55].

Oceanic solar farms are still under research, not yet technically developed. Several issues like corrosion, wave profiles and mooring challenge are still being studied.

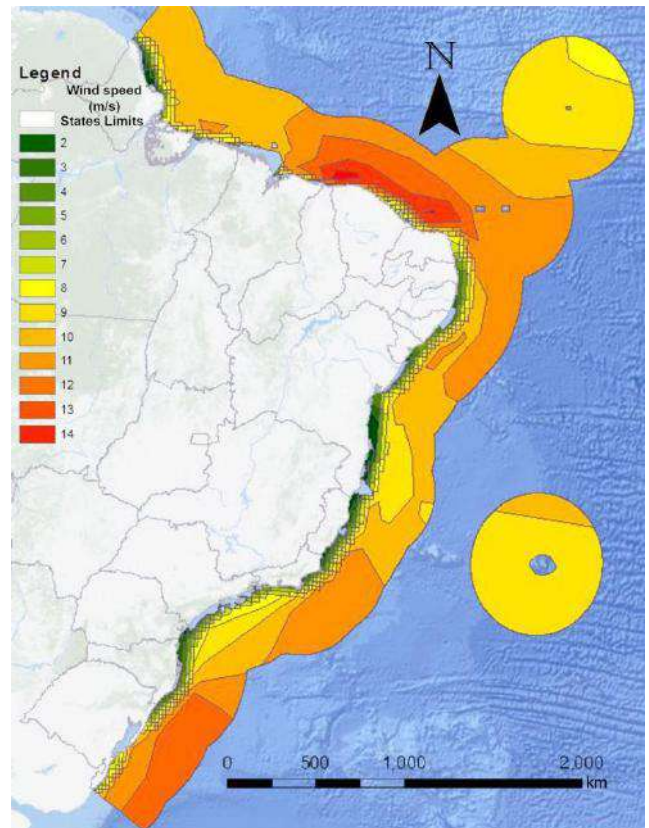


Fig.10: Offshore wind fields
(Adapted from EPE,2018)

V. GEOPHYSICAL CHARACTERISTICS

Brazil is a country with continental dimensions located in South America. Its territorial extension is 8.5 million km² [56] most of it in the tropical and subtropical range, between the Ecuador Line and the Tropic of Capricorn. The extreme points of the Brazilian territory are shown in Table 3.

Table 3: Brazil's extreme limits

	Point	Place	State	Border	Latitude	Longitude
NORTH	Sestentrional	Ailã river Source	RO	Guiana	05° 16'19" N	60° 12'45" W
SOUTH	Meridional	Arroio Chuí	RS	Uruguay	33° 45'07" S	53° 23'50" W
EAST	Oriental	Ponta do Seixas	PB	Ocean	07° 09'18" S	34° 47'34" W
WEST	Occidental	Moa river Source	AC	Peru	07° 32'09" S	73° 59'26" W

Distance North-South: 4,395 km ; Distance East-West: 4,320 km

Southeastern Brazil has an area of 924,000 km² and a population of 85 million inhabitants [56], 40% of the population consumes 60% of the country's electricity [57]. This is the most power-demanding region ([46], [56]) and

has the highest population concentration. Actions to increase energy generation in this region can reduce losses and the need to expand the energy transmission infrastructure.

Rain forests and large rivers mostly cover the North Region. In this region, population concentration is low, and the infrastructure is poor. The exceptional wind conditions along the Northeast seashore attract private equity investments in WPP. Most of the new WPP are being erected in this region. The South Region also has very good wind conditions, however with a smaller potential.

- **Wind**

Wind speeds over 7 m/s at 50-150 m above ground enable WPP to generate power at commercial conditions. Along the Northeast Brazilian seashore, excellent wind conditions encouraged the installation of the main wind farms in the country. The South region has completely different wind behavior, much more turbulent and variable.

WPP are already providing 10% of the country's power. Fig.11 shows the existing wind farms and typical wind speeds at 50 m height, pointing to the potential of WPP.

Seasonality records show that winter months (June to September) have more wind generation than summer months (December to March) in Brazil ([57], [58]). Wind production decreases as air is hotter, peak production often occurs at night time, between midnight and 5 a.m. On an hourly scale, typical wind profiles are dependent on local conditions.

The new CEPEL's Wind Atlas (2017) shows local profiles covering all of Brazil's territory [59]. On a sub-hourly scale, wind power production is absolutely random and not predictable [60].

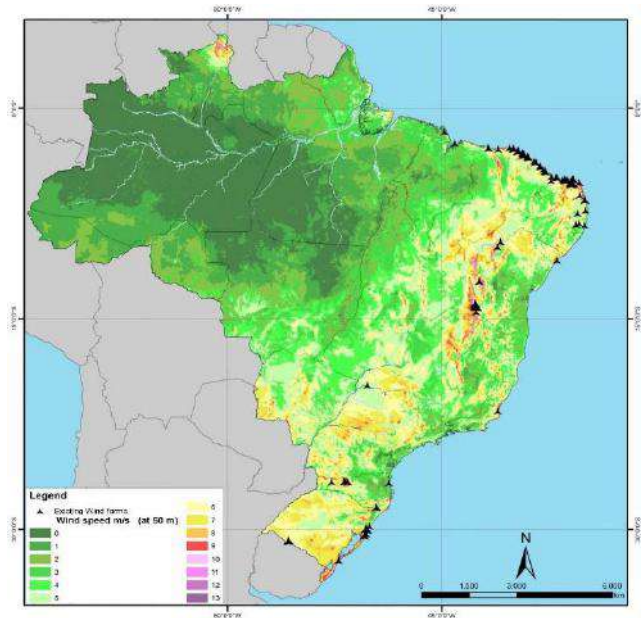


Fig.11: Wind speeds
(Adapted from EPE,2018)

Considering several premises and restrictions, Brazil's potential for onshore WPP is estimated at the order of 143 GW (able to produce 272 TWh/year), 50% of it in the Northeast region ([51], [59]).

Compared to other power sources, the wind is inconstant. Very fast variations of direction, intensity, and turbulence are unpredictable. Not dispatchable, wind power enters the grid once it is generated, those why other sources must complete demand. The hydro-wind-solar model considers wind power as a second layer; a variable layer just over the base of nuclear power.

- **Solar**

The average annual solar radiance is high and relatively close in intensity in the different climatic regions of Brazil as shown in Fig.12

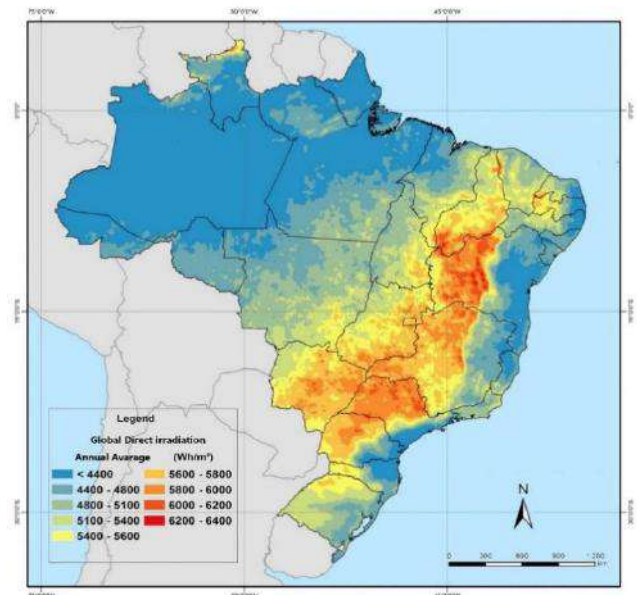


Fig.12: Solar radiation
(Adapted from EPE, 2018)

The 700 km width diagonal band, from Northeast Brazil to Paraguay, has excellent conditions to promote PVPP, including Midwest and Southeast regions where population and power demand is concentrated. A country of continental extension like Brazil has room for large solar power plants; however, urban agglomerations and fertile (arable) land should not host large PV plants.

The maximum daily average global radiance, around 6.5 kWh/m² occurs in the northern region of the state of Bahia. The minimum daily average global solar irradiation, about 4.3 kWh/m², occurs in the coastal region of the state of Santa Catarina [61].

Deforestation or the use of areas subject to reforestation to install large-scale PVPP is incongruous with any preservation program [30]. Excluding the Amazon and Pantanal biomes, the remaining area has regions not suitable for those installations. Fig.13 maps the suitable areas for this technology, considering other priority use of the land [51].

To achieve the COP21 goals of reducing GHG emissions, the Brazilian government will adopt policies in several sectors [62]. Brazil intends to ensure 45% of 2030 power generation from renewable sources, including hydroelectric, while the global average is only 13%. Concerning land use, the goal is to restore and reforest 12 million hectares of vegetation in addition to ending illegal deforestation.

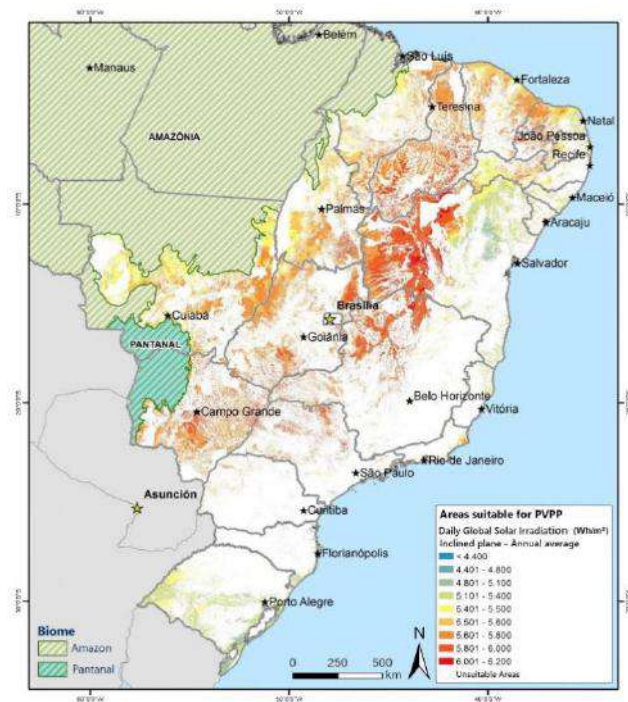


Fig.13: Areas suitable for large-scale PVPP

(Adapted from EPE, 2018)

Hybrid Wind-PV systems connected to the grid, using a common substation, already exist. Those systems using 2 variable sources are non-dispatchable and do not have electrical inertia. The produced power feeds directly into the grid. Fig.14 is an example of such installations.



Fig.14: Hybrid Wind-PV

Land occupancy of these power plants is an important issue since they compete with other land destinations such as agriculture or forest preservation.

The use of flooded surfaces, in particular the surfaces of the HPP reservoirs, is a solution that addresses this issue. Using the reservoir's water surface enables a full hybrid hydro-solar model, using one common substation to feed the transmission line. Floating PV outcomes as a technology that is widely used in the conservation of water resources [63]. PV-FPP integration with the existing infrastructure of HPP has vast potential and capability to meet the peak load demand without losing the electrical inertia [64].

- Water



Fig.15: Free water surface

(GIS output with IBGE and ANA water databases)

The Brazilian territory contains about 12% of fresh water on the planet. It is an enormous water potential, as shown in Fig.15, capable of providing a volume of water per person 19 times higher than the minimum established by the United Nations (UN) - of 1,700 m³ per inhabitant per year [65].

Water is considered public property and a limited natural resource, with economic value, and with multiple uses. Drought periods directly affect the availability of this resource.

Despite the abundance, Brazilian water resources are not inexhaustible. Access to water is not the same for everyone. The geographical characteristics of each region and the changes in river flow, which occur due to climatic variations throughout the year, affect the distribution.

The sum of the water surfaces in Brazil is 170,000 km² as illustrated in Fig. 16. HPP reservoirs are 22% of all free water surfaces. When the reservoirs are full, they total 38,000 km² [33]. These reservoirs can host floating PV systems. These large surfaces of water are wave-less, flat, and without shading. Hydroelectric dam's water surfaces are ideal for PV-FPP to work together with the HPP as a hybrid system.

VI. RESULTS

The following sections discuss the outputs of the hydro-solar model applied to the case of Brazil. First, the analysis of HPP behavior with the same size PVFP under coordinated hybrid operation is discussed. Followed by a study of a case of an existing HPP to demonstrate the feasibility of such a model. Finally, the country size power production environment is analyzed using the hydro-solar model and its potential is established. Then, compared to fossil fuels use by TPP in the current generation model.

• **Hydro-Solar generation model**

PV Floating Power Plants (PV-FPP) placed near HPP can share the substation e and the grid connection taking advantage of the hydro-solar synergy ([3], [66]). Operation through a shared control room makes managing the hybrid power generation system easier, more reliable and more efficient. Random fluctuations in the solar resource availability on the sub-hourly scale are not considered, as well as demand variability. The PV-FPP will be designed to meet rated HPP capacity at the highest local radiation condition. This design criterion respects the maximum rated capacities of the transmission line and the transformer.

The proposed hydro-solar model is represented in Fig.16. The graph shows the daily power production of the hybrid facility on an hourly scale. The coordinate's axis is in P.U.

Three representative conditions are illustrated.

(a) Base scenario.

Unrestricted condition in which the HPP can turbocharge water to its nominal capacity.

(b) Restrictions scenario allowing only 50% of the rated daily rated water flow.

In addition to the increase in total generation during sunny hours, the reduction in hydroelectric generation during the day and contributes to the formation of a "virtual battery" [37]. This concept refers to damming water upstream from 8 a.m. to 3 p.m. daily. Respecting the daily flow restrictions imposed by the regulatory agencies, dammed water must be used during the same day maintaining average river flow. The HPP will

manage the use of the "virtual battery" according to its technical and commercial conveniences.

(c) Restrictions scenario allowing only 50% of the rated daily rated water flow but using the virtual battery in the afternoon and evening time. This generation profile better attends load curves and can represent a significant increase in HPP's operating profit.

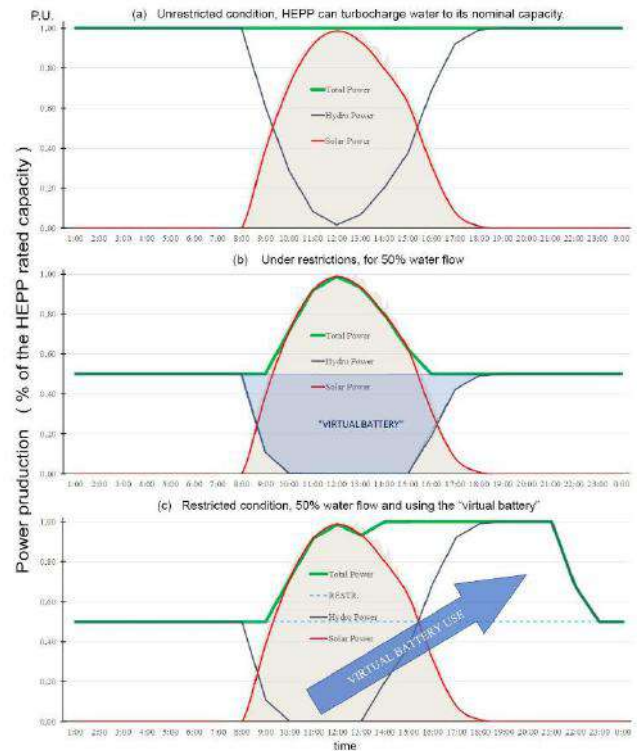


Fig.16: Hydro Solar Model

Item (c) of Fig.16 clearly shows the benefit of the hydro solar model when drought limits the water flow of the HPP. Power generation can increase very significantly without exceeding the daily allowed water flow.

• **Hydro-Solar model simulation**

A study of the case simulated a hypothetical PV-FPP paired with the existing Porto Primavera HPP in a full hybrid operation model during 2019 [67].

Despite being a run-of-the-river plant, this HPP has a 2,250 km² lake. For its formation, the flooded area increased the riverbed 9 times. Its 10.2 km length dam is the longest in Brazil. The 16 gates spillway has a flow capacity of 52,800 m³/s. The powerhouse has fourteen 110 MW turbines and can generate 1,540 MW. PV-FPP for the same peak capacity will occupy 15.5 km², which is 0.7% of the lake's surface. However, PV-FPP of this size does not yet exist in the world.

The maximum flow is conditioned to allow 24,000 m³/s in Porto São José heading downstream. The minimum flow rate is 4,600 m³/s to avoid the formation of marginal downstream lagoons that can trap fish and cause damage to ichthyofauna, and of approximately 5,500 m³/s between 5 a.m. and midnight, to provide conditions for transverse navigability (ferry crossing) in the port immediately downstream.

Without restrictions, at rated capacity (CF=100%), the HPP Porto Primavera would be able to generate 1,125 TWh/month. Recorded data for 2019 shows that the maximum effective generation occurred in January and totaled 0.81 TWh, therefore the maximum effective CF was 71%.

The seasonal profile for Porto Primavera’s dam location is in Fig.17: *Seasonal irradiation profile*. Using the average daily irradiation measured by 3 stations close to the center of the dam, month by month, PV power was calculated. The

yearly average of daily irradiation in this local is 5.0 kWh/m².

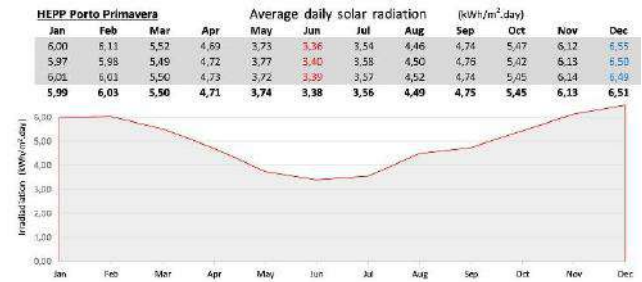


Fig.17: *Seasonal irradiation profile*
(Adapted from CRESESB)

Table 4 shows the HPP's real power and energy production and simulated energy production of the PV-FPP, demonstrating the hydro-solar model benefits. These results can be observed graphically in Fig.18.

Table 4: 2019 simulated H_S energy production

2019	month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Power	MW	1,093	990	1,001	962	865	840	837	864	1,051	985	915	1,067
H	TWh	0.81	0.67	0.74	0.69	0.64	0.60	0.62	0.64	0.76	0.73	0.66	0.79
PV	TWh	0.34	0.31	0.32	0.26	0.21	0.19	0.20	0.26	0.26	0.31	0.34	0.37
H_S	TWh	1.16	0.98	1.06	0.95	0.86	0.79	0.83	0.90	1.02	1.04	1.00	1.17

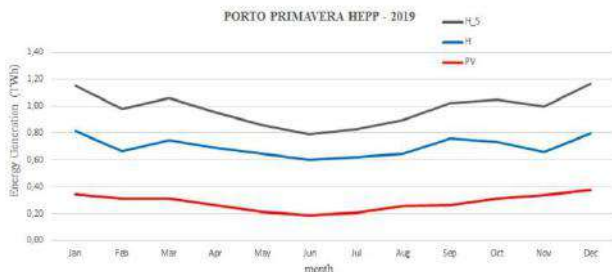


Fig.18: 2019 H_S energy production

When the PV generation is added, the CF (based on the nominal capacity of the HPP) will slightly exceed 100% in the summer (December and January) with a minimum of 73% in July. The annual power generation totaled 8.37 TWh with an average CF=62%. The hydro solar model could generate an additional 3.3 TWh, increasing the annual electric generation of the hydro + PV set to 11.75 TWh for the same water flow. With 40% additional annual generation the gain in the annual 2019 average CF could be 25%, by turbocharging the same volume of water.

• **The Hydro-Solar Potential**

The World Bank's Energy Sector Management Assistance Program (ESMAP) stated that grid-connected hybrid systems that combine hydroelectric power and floating photovoltaic technologies are still at an early stage of development. It also states that the combination of solar and hydroelectric power dispatch can soften the variability of solar production while making better use of existing transmission assets [68].

- **Itaipu Bi-national**

Itaipu HPP is a run-of-the-river HPP but has a large artificial lake. The flooded area is 1,350 km². It is the second world's largest HPP (only the Three Gorges HPP, in China, has a larger installed capacity) and holds the annual electricity production world record: 103.1 TWh generated in 2016 [69]. To match its capacity, a gigantic PV-FPP that would cover about 10.5% of the lake is needed (Table 5). This model is able to yearly generate additional 129 TWh.

Table 5: The hydro solar potential of Itaipu

Hydroelectric Power Plant (HPP)	Localization	Rated Capac. (MW)	Flooded Area (km ²)	Solar Area (km ²)	Coverage (%)	PV Annual Energy (TWh)
Itaipu binational	Parana river	14.000	1.350	140	10,4%	29,27

- Brazil

Table 6 summarizes Brazil's hydro solar potential by hydrographic basin, except for Itaipu. The implementation of the hydro solar model in all Brazil's HPP it may make additional annually 169 TWh available to the SIN.

The total TPP generation in 2019 was 135.2 TWh. Biomass, which is also a renewable (non-fossil) source of energy, and is used mainly as co-generation, was 52.5 TWh.

The balance: 84.7 TWh could be obtained from solar power. PV-FPP can produce the double without any GHG emission and not occupying the land.

Using this simulation for power demand data of 2019, January 30th, the highest load even recorded, resulted that all thermal generation could be replaced by a 91 GW hydro-wind-solar model as shown in Fig.19.

Table 6: Hydro solar potential – Brazil

Nr.	HYDROGRAPHIC BASIN	Rated Capac. (MW)	Flooded Area (km ²)	Solar Area (km ²)	Coverage (%)	PV Annual Energy (TWh)
1	AMAZON	23.619	4.687	240	5,12%	38,08
2	TOCANTINS-ARAGUAIA	12.935	6.185	130	2,10%	28,21
3	WESTERN ATLANTIC NE	0	0	-		0,00
4	EASTERN ATLANTIC NE	0	0	-		0,00
5	PARNAIBA	237	13	2	18,25%	0,57
6	SÃO FRANCISCO	10.579	6.219	110	1,77%	7,82
7	ATLANTIC EAST	1.072	234	11	4,58%	2,56
8	ATLANTIC SE	2.572	453	25	5,51%	1,08
9	PARANA	35.841	15.211	351	2,31%	77,37
10	PARAGUAY	663	489	70	14,33%	0,86
11	ATLANTIC SOUTH	1.779	411	20	4,87%	1,84
12	URUGUAY	5.755	560	60	10,71%	11,04
Total in Brazil, except of Itaipu		95.051	34.461	1.019	2,96%	169,43

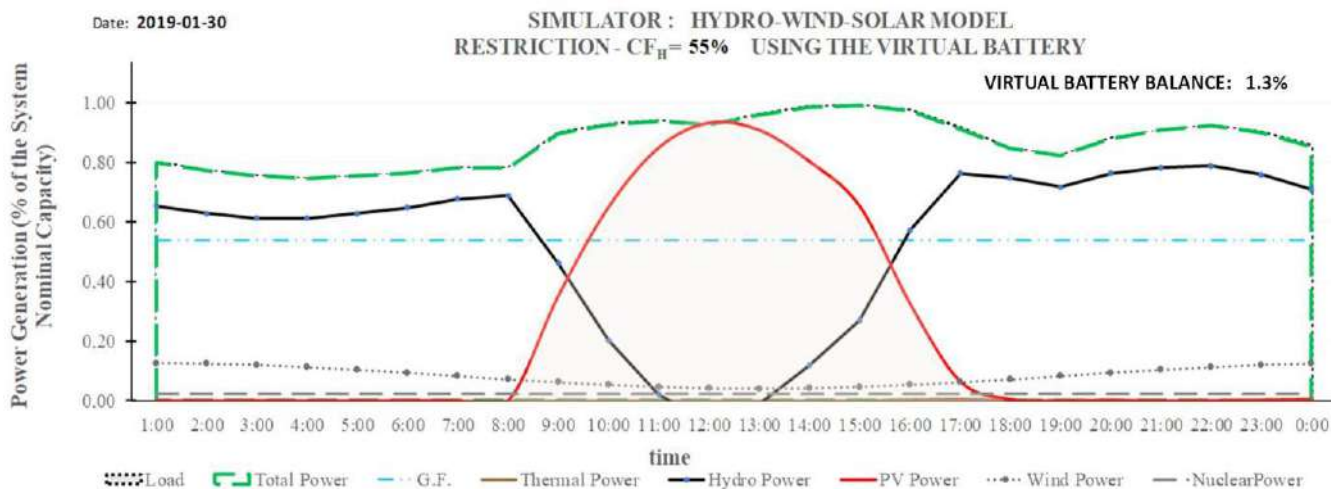


Fig.19: Model simulation for the highest load

This hydro-wind-solar model represents the sum of all the PV-FPP designed to peak power equivalent to the hydroelectric power plants' nominal rates and installed at HPP the dams.

Drought restrictions at that time allowed only 55% of nominal water flow. Real nuclear and wind generation were considered. HPP should be modulated using the water not turbocharged (the "virtual battery") from 8 a.m. to 6 p.m. This simulation resulted that 1.3% of the virtual battery will remain in the reservoir contributing to its storage capacity recovery.

- **Environmental risks of large scale PV**

Alongside the technical and economic aspects, social and environmental aspects must be considered when planning PV installations.

These aspects encompass visual impacts, facility safety, impacts on tourism and leisure, impacts on water quality, impacts on aquatic flora and animal life, impacts on bird habitats, etc. [3]. PV technology has important environmental risks in two phases:

(a) In the phase of the production of PV panels, which is an energy-intensive technology. The production of elemental silicon is chemical-intensive. More than 500 chemicals are used for imprinting electronic circuits on silicon wafers [70]. 50-80% of GHG emissions arise during the production of the PV panel [71]. Emission levels depend on the type of technology and the source of energy used in manufacturing. China leads silicon PV cells and panels fabrication ([28], [72]),

and,

(b) At the end of its useful life, after 25-30 years of power generation, at the decommissioning of the PVPP, when part is recycled and the remainder disposed of in some landfill [73]. Recycling PV panels at the end of their useful life to reclaim aluminum, glass, and silver, and minimize associated environmental impacts is only starting to gain attention [72].

As there are no evident GHG emissions during power generation. Emissions from solar energy are much lower than those from fossil-fueled generation. Nonetheless, environmental risks and impacts must always be an important consideration [74].

VII. CONCLUSION

Brazil's geographical location, mostly between the Equator Line and the Tropic of Capricorn, greatly favors the use of solar source, mainly PV technology. Brazil can replace its 2019 fossil thermo-electric generation by using 50% of the proposed hydro-solar model potential.

Full implementation of this model, all over the country's HPP, can aggregate new 84.7 *TWh/year* to the SEB. This model can be used by micro- and mini-mills of DG, as well as to SHPP, and even smaller installations. MMDG and self-power-production reduce the grid's load curve. Large-scale PVPP, on land or the water, will help mitigate the afternoon's new peak-time power demand. WPP will attend mainly the night demand.

HPP reservoirs can benefit from PV-FPP installed on their free water surface, supplementing the hydropower with the available PV potential, taking advantage of the existing infrastructure, reducing the need for TPP dispatch, and, without occupying the land.

The proposed hydro-solar model will occupy, on average, only 3% of Brazil's HPP reservoirs with PV-FPP as seen in

The potential to expand the floating PV generation exceeding the HPP capacities is much bigger despite the concerns related to aesthetics, navigation, intrusion on recreational water bodies, and environmental impacts.

In the environmental aspect, by reducing the current 84.7 *TWh* from TPP 50 million tons of Carbon Dioxide can be avoided yearly. The full implantation of the hydro-solar model in all Brazilian HPP will reduce the emission of 200 million *tons* of carbon dioxide into the atmosphere by not dispatching the TPP. By reducing the evaporation on circa 20,000 *m³/MWp.year* [75], full implementation of this model all over Brazil will save 1.58 billion cubic meters of water per year.

The suggested model in this article needs to be implemented, tested, and better evaluated, including social and environmental impacts, and other issues that might arise. In the hybrid generation model, Brazil's available HPP compensates for wind and solar inconsistencies and provides the required inertia and stability to the SIN.

This model will allow the operation of the electric system in face of the predicted climate change, mitigating the disadvantages of the current hydro-thermal model, replacing it with a Carbon-free, modern, and sustainable hydro-wind-solar model.

The hydro-solar hybrid generation model can be used to combat global warming all over the world, in places where there are HPP and the radiation conditions allow PV.

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Multicopper Oxidases Enzymes use and its Characteristics

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Keywords— *Multicopper oxidases, Microorganisms, Blue copper proteins, laccases.*

Abstract— *Multicopper oxidases are a large family of blue copper proteins which contain from one to six copper atoms per molecule. Their catalytic centre consists of three domains which involve type-1 Cu, type-2 Cu and a pair of type-3 Cu's. They include laccases, ferroxidases, ascorbate oxidase, bilirubin oxidase, laccase like multicopper oxidases. MCOs are capable of one electron oxidizing of aromatic as well as non-aromatic compounds with a concomitant four-electron reduction of molecular oxygen to water. These properties make them a valuable tool in various industries (food, textile, pharmaceutical) medicine or environment protection.*

I. INTRODUCTION

Multicopper Oxidases (benzenediol: oxygen oxidoreductase EC 1.10.3.2) are a family of enzymes that catalyse oxidation reactions of a substrate with simultaneous reduction of molecular oxygen to water. The universal catalytic centre is responsible for these reactions for all MCOs, composed of 4 or more copper atoms which form T1, T2 types and diatomic T3 types. Although the structure of the catalytic centre of most enzymes classified as MCO is similar, their biological functions and catalytic properties may be completely different. Various enzymes characterized by the presence of a catalytic centre typical of MCO and the ability to oxidize organic and inorganic compounds have been recognized. Many researchers have sought to analyse the characteristics on the basis of which it is possible to properly classify a newly identified enzyme which displays MCO properties. However, this problem still seems to be unresolved for most MCOs due to the highly similar properties of most substrates and considerable homology of amino acid sequences especially within the catalytic centre. The most commonly described MCOs include laccases especially from fungi belonging to the *Basidiomycota* division), and so called Laccase-like

Multicopper Oxidases (LMCO), ascorbate oxidase (mainly described in higher plants), bilirubin oxidase (e.g. *Myrothecium verrucaria*), some fungal pigments and ferroxidases (*Saccharomyces cerevisiae* yeasts) [1].

II. MULTICOPPER OXIDASES: CLASSIFICATION, STRUCTURE AND PROPERTIES

A common feature of all enzymes included in the MCO family is the presence of a catalytic centre composed of at least four copper atoms divided on account of their spectroscopic and magnetic properties into three types: T1 and T2 types containing one copper atom and the diatomic T3 type [2]. Type T1 gives the enzyme molecule a blue colouring and exhibits intense light absorption at a wavelength of 610 nm, resulting from a covalent copper-cysteine bond. In turn the T2 type is colourless and, similarly to the T1 type, detectable by means of electroparamagnetic resonance spectroscopy (EPR). The T3 type does not exhibit activity in EPR spectroscopy as a result of antiferromagnetic coupling of copper atoms. However, it is distinguished by a light absorption band at a wavelength of 330 nm [3] (Fig. 1).

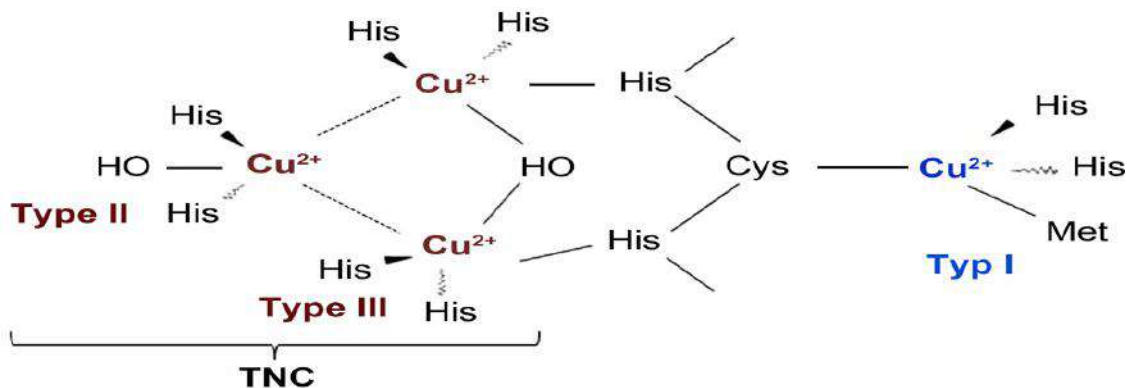


Fig: 1- Model of the catalytic cluster of MCO

In the T1 centre, where the substrate undergoes oxidation, the copper atom is bound to two histidine residues and one cysteine forming a distorted trigonal pyramid structure. The His-Cys-His sequence mentioned, which is characteristic of MCO, links T1 with T3. Sometimes the fourth amino acid residue, with weaker binding (most commonly methionine, leucine or phenylalanine), may occur in an axial position, which affects the oxidoreduction potential of the enzyme, stabilizes it and regulates its activity. The copper atom of T2 type and two atoms of T3 type, located in close proximity, are coordinated by the so called inter domain copper binding sites, composed of 2 and 6 histidine residues respectively,

and forming a triatomic copper cluster. It is a structure unique for the MCO family and is the place where binding and the four electron reduction of molecular oxygen into water occurs [4]. The majority of MCOs contains about 500 amino acid residues and adopts the β -sheet layout in its secondary structure, shaped into the characteristic motif of the Greek Key [5]. Typically, an MCO molecule consists of three domains formed in this manner. The T1 copper centre is located in domain 3 (blue copper-binding domain), and the T2/T3 triatomic copper cluster is located at the interface between domains 1 and 3, which is farther away from the protein surface compared to domain 3.

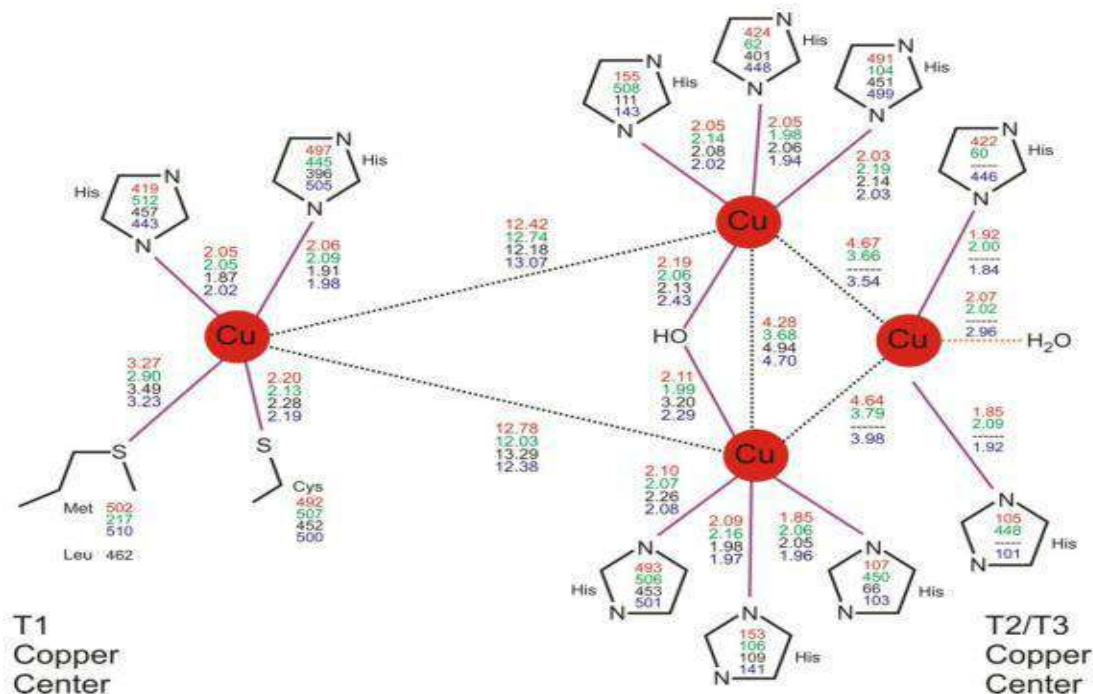


Fig. 2 : Overall arrangement of the reactive copper cluster in several representatives of the multicopper oxidase family. Residue number and distances between atoms are represented in colors: red, CotA laccase from *Bacillus subtilis* (PDB code: 1GSK); green, ascorbate oxidase from *Cucurbita pepo* (PDB code: 1AOZ); black, laccase from *C. cinereus* (PDB code: 1A65) and blue, CueO protein from *E. coli* (PDB code: 1KV7).

However, apart from the three-domain MCOs, proteins possessing two or six domains have also been characterized [6]. The MCO catalytic mechanism includes (1) the reduction of the T1 Cu site by capturing an electron

from the oxidized substrate, (2) transferring the electron from the T1 site to the TNC and (3) reduction of O₂ with formation of two water molecules (Fig. 3).

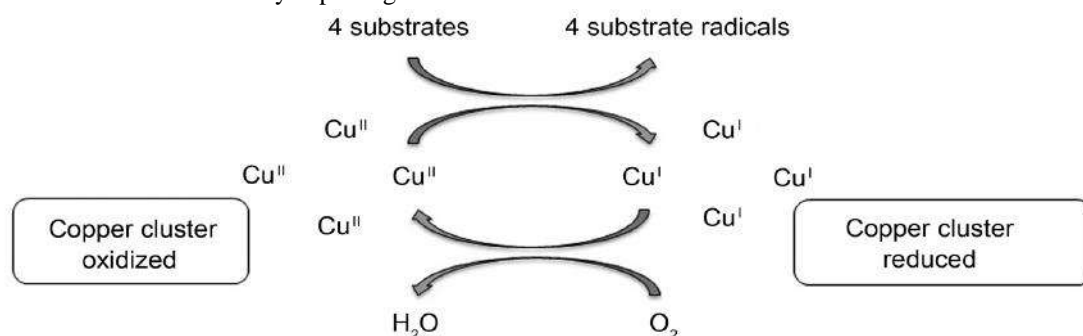


Fig: 3. Schematic of the catalytic mechanism of laccase.

MCOs oxidize a wide spectrum of substrates, such as phenol, methoxyphenol, aromatic amines, multi-aromatic compounds, metal ions [7]. MCO-catalysed reactions may occur directly (reactions of simple phenolic

compound oxidation) or in the presence of a compound called a mediator, which mediates the transfer of electrons from the substrate to the active enzyme centre (Fig. 4).

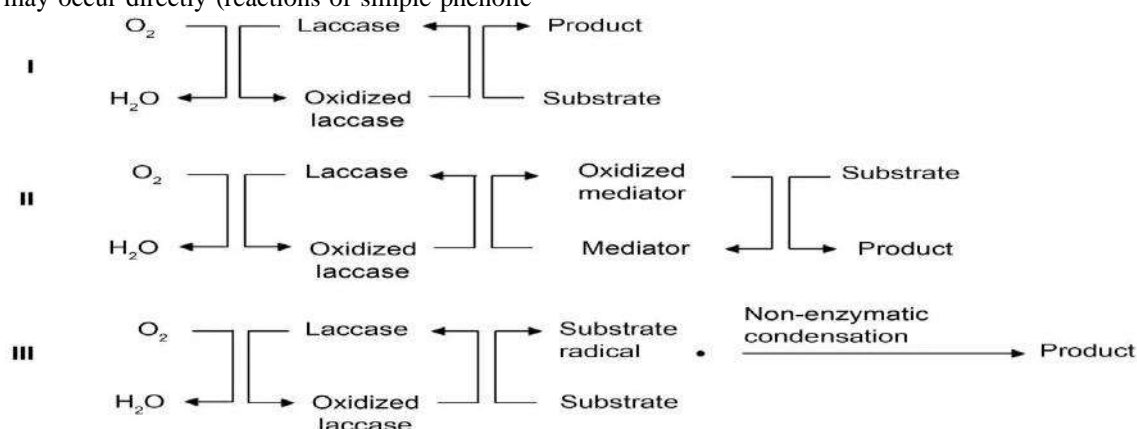


Fig 4. Mechanisms of reactions catalyzed by MCO.

If direct oxidation of the phenolic substrate leads to the formation of its reactive and unstable radicals, these may, in the process of non enzymatic, spontaneous coupling reactions combine to form dimers, oligomers or polymers [8]. MCOs are a very diverse group of enzymes produced by both prokaryotic organisms and *Eukaryota*, and are characterized by various, not yet fully understood, biological functions. Although all MCOs exhibit the capability for oxidizing aromatic compounds, two functional classes can be distinguished among them [86]. The first one is the enzymes that oxidize organic substrates more readily than metal ions. The group consists mainly of laccases and laccase-like enzymes. The latter, in turn, oxidize metal ions, such as Fe (II), Cu (I) and/or Mn (II), with higher efficiency, compared to organic substrates. The latter enzymes are referred to as metal oxidases, and the most common ones among them are human

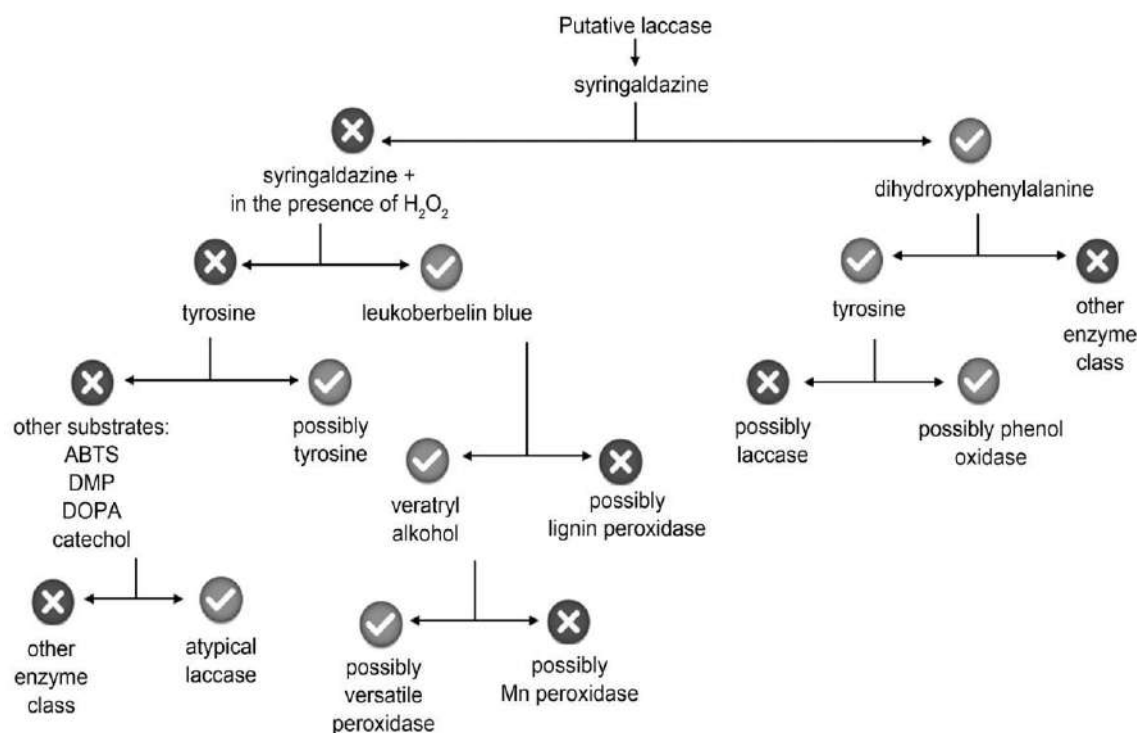
ceruloplasmin (Cp) and yeast ferroxidase [9]. The MCO division is not permanent and systematic, as there are no clear criteria for classification. For example, according to Hoegger *et al.* [10] multicopper oxidases form 10 enzyme groups: *Basidiomycota* laccases, *Ascomycota* laccases, insect laccases, MCO fungal pigments, fungal ferroxidases, plant and fungal ascorbate oxidases, plant-like enzymes like laccase, copper resistance proteins (CopA), bilirubin oxidases and copper efflux proteins. In turn, Sirim *et al.* [11] distinguished within the MCO family: laccases, ferroxidases, ascorbate oxidases (AO) and bilirubin oxidases (BOD).

III. IDENTIFICATION METHODS OF MCOS

Until recently, the identification of enzymes included in the MCO was based mainly on the characteri-

stics of their biochemical features and catalytic abilities. MCO interactions with substrates can be broadly divided into two categories and one can distinguish enzymes with low substrate specificity and enzymes with high specificity. The plant and fungal laccases belong to the first category and they can oxidize diphenols, aryl amines and aminophenols, and their K_m values are generally within the range of 1-10 mM. The remaining MCOs have a significant degree of substrate specificity ($K_m < 1$ mM) [12]. Some substances such as guaiacol, diammonium salt of 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS), 2,6-dimethoxyphenol (DMP) and catechol have long been termed model laccase substrates [13]. However, it turned out that many of them are also oxidized by other enzymes from the MCO group, e.g. LMCO or bilirubin oxidases. Syringaldazine used to be considered to be a specific laccase substrate [14]. Syringaldazine and ABTS

can be converted by MnP or LiP. However, the oxidation which depends on H_2O_2 allows for distinguishing these enzymes from MCO. Multi Copper Oxidase can also be distinguished from MnP using the leucoberbelin blue dye test. This compound reacts specifically with manganese ions released by MnP, resulting in the emergence of blue colour exhibiting the maximum absorption of light at the wavelength of 620 nm [15]. Figure-4 presents a scheme for the identification and differentiation of laccases from other ligninolytic enzymes proposed by Fernandes *et al.* While the ability to oxidize specific substrates allows one to quickly determine the activity of a given enzyme from the MCO group, in the era of the development of highly advanced molecular techniques, it should not be the only method of identification and characterization of the newly recognized protein.



Fig; 5. The proposed scheme for the differentiation of laccases from other ligninolytic enzymes.

The development of omics techniques, such as genomics, transcriptomics and proteomics has contributed to determining the genes responsible for encoding enzymes, studying their expression at the level of the transcriptome and quantitative and qualitative analysis of the MCO against the background of other proteins in the body. Perry *et al.* [16] was the first to identify two genes encoding laccases *Agaricus bisporus* and found that these enzymes may exist as isoforms and be encoded by multigene gene families. Hence, hundreds of genes encoding MCO have been identified in both fungi and

bacteria. The presence of many genes encoding enzyme isoforms in one strain may indicate the involvement of these enzymes in various physiological processes. The confirmation of this hypothesis may be the fact that individual enzyme isoforms often differ in substrate specificity and their activity may be different in different pH or temperature variants. Some of them have a constitutive character, and some may be induced, for example, by aromatic compounds or copper ions. Genomic and proteomic techniques have made it possible to identify consensus sequences for MCOs which distinguish them

from other enzymes. These sequences contain four (L1, L2, L3, L4) contiguous fragments of copper-binding amino acid residues, whose degree of similarity, depending on the organism from which the enzyme is derived, can range from 75 to 85%. The L2 and L4 regions allow the enzyme to be classified as MCO, whereas the L1 and L3 sequences indicate the subgroup of the enzyme [17].

IV. LACCASES VS. OTHERS MCOS

Among the microbial MCOs, laccases constitute the most studied and described group, being also the most numerous one. These are three domain MCOs which were isolated for the first time by *H. Yoshida* in 1883 from resin from the *Rhus vernicifera* tree. Plant laccases, owing to the dehydrogenation mechanisms, play an important role in the polymerization of lignin-forming phenolic compounds, regeneration of damaged tissues and iron oxidation by converting Fe (II) to Fe (III) [15]. Although according to some researchers, the term laccase should be reserved exclusively for enzymes obtained from plants, also other three domain MCOs, e.g. of microbial origin, are called laccase if only they exhibit the ability to oxidize aromatic compounds [18].

Laccases of fungal origin most often occur in the form of several monomers which oligomerize and then form multimeric complexes. The average molecular weight of the monomer ranges from about 50 to 110 kDa. An important feature of fungal laccases is a carbohydrate group with covalent binding, usually constituting 10 to 45% of the total enzyme molecule and consisting mainly of mannose, N-acetylglucosamine and galactose. All these features protect fungal laccases against proteolysis, high temperatures, extremely high or low pH values and other unfavourable factors [74]. Among the fungi capable of the biosynthesis of laccases, the most numerous groups are those from the *Basidiomycota* division, e.g. *Lentinus tigrinus*, *Agaricus bisporus*, *Trametes versicolor*. Amongst them, there occur quite often the so-called fungi of white wood rot, incl. strains of the species *Phlebia radiata*, *Pleurotus ostreatus*, *Phanerochaete chrysosporium*, *Cerrena unicolor*. The synthesis of these enzymes has also been described in the fungi belonging to the *Ascomycota* division, e.g. *Aspergillus niger*, *A. oryzae*, *Neurospora* sp., *Trichoderma atroviride* and *T. harzianum* [19]. In fungi, laccases are involved in the processes of morphogenesis, lignin degradation and defence reactions to stress. These enzymes produced by saprophytic and mycorrhizal fungi are involved in the circulation of organic matter in the soil by degrading plant litter polymers or the formation of humic compounds [20]. Bacterial laccases have been identified in the cultures of strains including *Azospirillum*

lipoferum, *Escherichia coli*, *Bacillus subtilis* and several species of *Streptomyces*. They were also described in *Anabaena azollae* cyanobacteria. Bacterial laccases are characterized by greater activity and stability than fungal enzymes at high temperatures, at alkaline pH and in the presence of high concentrations of chlorine and copper ions [15]. Both phenol and non-phenol substrates can under laccase mediated catalytic reactions. In the case of molecules with high redox potential and with large size particles, which are not able to independently penetrate into the active enzyme centre, the action of the so called mediators is indispensable. They are organic compounds of low molecular weight which, when oxidized by laccase, form highly active cationic radicals capable of oxidising non-phenolic compounds. The most commonly used synthetic mediators are ABTS, hydroxyanthranilic acid (HAA), hydroxybenzotriazole (HBT) and hydroxyphthalimide (NPI). Natural mediators such as vanillin and syringaldehyde also have a similar effect [21].

Laccase-like multicopper oxidases (LMCO), similar to laccases, catalyse the oxidation of various substrates combined with the reduction of the O₂ molecule to two molecules of H₂O. Their biological functions are similar to the role of laccases, but not all of them have yet been recognized. LMCO have been described in many bacteria and fungi. The average molecular weight of LMCO is in the range of 51-66 kDa, while the number of amino acid sequences of enzymes is 470-600. LMCO of *Streptomyces* bacterium have also been described, whose molecular mass is 32.6 kDa, and the amino acid sequence length is 297. The optimum pH value for LMCO activity is not the same because it depends on the substrate used for its measurement [22]. For example, three types of LMCO originating from *Aspergillus niger*: McoA, McoB and McoG were purified and characterized for their biocatalytic potential. All three enzymes were monomers with molecular weights in the range of 80 to 110 kDa. The highest McoA activity was observed in the pH 5.0 environments, while pH 6.0 was optimal for McoB and McoG. Additionally, McoA and McoB oxidized DMPPDA (N, N-dimethyl-p-phenylenediamine) in a wider pH range than McoG [89]. The LMCO isolated from *Myrothecium roridum* showed activity of both MCO and bilirubin oxidase.

Bilirubin oxidase is a thermostable enzyme containing a disulphide bond. BOD catalyses the oxidation of tetrapyrroles, e.g. bilirubin to biliverdin as well as diphenols or aryl diamines with simultaneous reduction of four oxygen atoms to water [23]. This enzyme was discovered in the non-ligninolytic fungus *Myrothecium verrucaria* MT-1 in 1981 by Noriaki Tanaka and Sawao Murao. Unlike laccases, BODs are characterized by higher

activity and stability at neutral pH and high temperature, however not higher than 60°C. They are also characterised by high tolerance to chloride anions and other chelators. For example, bilirubin oxidase isolated from *Myrothecium verrucaria* (MvBOD) exhibited the highest catalytic activity in the temperature range of 30-60°C and pH from 7 to 8.5. However, in solutions with pH above 9, a decrease in BOD catalytic activity by as much as 50% has been observed [24].

Another example of MCO is SLAC, a two-domain multicopper oxidase described in *Streptomyces coelicolor*, which exhibits the ability to oxidize aromatic and non-aromatic compounds containing amino and hydroxyl groups. Due to the similarity of the sequence to fungal laccases, but also smaller size, this enzyme has been defined as a small laccase. On the basis of the comparative analysis of protein sequences, the similarity of SLAC and other laccases in the position of metal ligands has been established. However, the occurrence of 24 histidine residues in the SLAC sequence has been established, which may indicate its role in binding the excess of intracellular copper ions in order to transfer them during export through the TAT secretory system [25]. SLAC is characterized by resistance to reducing compounds and thermal stability. In addition, this enzyme exhibits the highest activity in the environment with pH 9. Owing to these features, SLAC have found their application in the pulp and paper industry for dye decolorization.

V. APPLICATION OF MULTICOPPER OXIDASES

On account of the ability to oxidize many substrates, extracellular character and fairly high stability in a wide range of pH and temperatures, the MCO enzymes are characterized by a high application potential. So far enzymes from this group have found application in environmental protection, medicine, pharmaceutical industry, cosmetics and in the food industry. MCO enzymes have been applied in many areas of the food industry, like baking, vegetable and fruit processing, winemaking and brewing. The bakery industry commonly uses laccases to improve bread structure, as well as the flavour and durability of pastries [26]. However, it has been proven that other MCOs, such as bilirubin oxidase, can be used to cross-link biopolymers by improving the physicochemical properties of food products. The process increases the durability and stability of dough, at the same time reducing its viscosity. This effect was noted especially when using lower quality flour [27]. MCO is used, e.g., for cross-linking arabinoxylans so that the created network of transverse polymer bonds has a positive effect on crumb and crustiness of bread. Laccases can be used instead of physical adsorbents like SO₂ to eliminate undesirable phenol derivatives, causing darkening and clouding of fruit juices, beers and wines. New reports have appeared lately, indicating the possible use of MCOs isolated from cultures of lactic acid fermentation bacteria, among others for removing biogenic amines from wine and some oriental cuisine products.

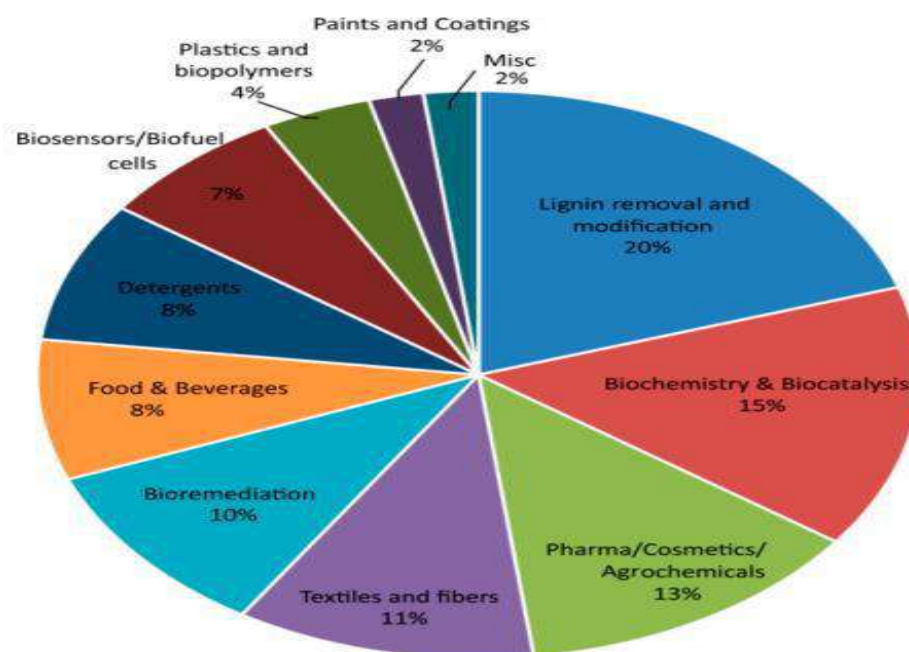


Fig.6: Applications of multicopper oxidases

The use of MCO in the food industry is quite common. Preparations available on the market, such as Falouvorstar, Suberose or LACCASE Y120, which are based on laccase activity, are successfully used in brewing, production of corks for the wine industry and improvement of the colour values of food products. Enzymes from the MCO group are used as biocatalysts in the reactions yielding many active substances which are components in the composition of household chemistry, body care products and medicines characterized by antimicrobial and antioxidant activity. Such activity is exhibited by molecular iodine (I₂), whose preparation through oxidising it has been described for MCOs isolated from the culture of *Alphaproteobacterium* sp. Q-1 and *Roseovarius* sp. A-2. Strong antifungal activity has also been proven for iodinated phenolic compounds obtained in the reaction catalysed by laccase. Laccases are also successfully used as biocatalysts in the synthesis of drugs, among others β -lactam antibiotics and anti-cancer agents, e.g. vinblastines or mitomycin. Since 2006, when antiproliferative activity of laccase was demonstrated for the first time, intensive research has been conducted on the use of this enzyme as an anti-cancer agent [28]. The ability to inhibit cell division of breast, liver, colon and prostate cancer has been proven for laccases from various species of basidiomycetes. The application of laccase manufactured by *Cerena unicolor* in the treatment of blood and cervical cancer has been demonstrated and covered by patent protection. This enzyme, added in the right concentration, had a strong cytotoxic effect on cervical cancer cells of the SiHa and CaSki line and did not affect adversely the fibroblast cells constituting the reference system.

VI. SUMMARY

Multi Copper Oxidase proteins are enzymes containing from one to six atoms of copper per molecule. Multicopper oxidases include laccases, ferroxidases, ascorbate oxidase, bilirubin oxidase, some fungal pigments with multicopper oxidase character and the so-called laccase-like enzymes. MCOs possess the ability to oxidize both organic and inorganic compounds. The reactions catalysed by MCO are accompanied by the reduction of molecular oxygen to water. These properties make them a valuable tool in bioremediation processes, medicine, pharmaceutical industry, cosmetics and food industry.

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Study of Water Discharge in Way Sikabiry Watershed, Liliboy Village, West Leihitu District, Central Maluku Regency

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Keywords— *Cross-sectional Area, Flow Rate, Water Discharge.*

Abstract— *The problem of flooding often hits Liliboy Village every rainy season, the problem of flooding is generally caused by poor drainage systems and a bigger impact is the result of damaged watersheds, watersheds that are supposed to be water conservation have undergone land use changes due to human intervention. The result of land use change that can be seen directly is that unpredictable discharge often occurs in the rivers where the watershed is damaged. For this reason, this study aims to determine the scouring pattern that occurs and the amount of water discharge in the Way Sikabiry watershed. This research was conducted in October 2019 in the Way Sikabiry watershed using the Profile (Cross Section) method, which is to place an unsinkable object on the surface of the river for a certain distance and record the time it takes for the floating object to move from one point of observation to another point of observation. have been done. The data used in this research include primary data such as river discharge data and secondary data in the form of watershed maps, measurements and drainage area. The results showed that the scouring pattern that occurred in the Way Sakabiry watershed resulted in a large downstream water flow but high flow rate while in the upstream it produced a small flow rate but a low flow rate and the amount of water discharge in the Way Sakabiry watershed upstream was 0.53095 m³ / second while in the downstream it is 0.73981 m³ / second.*

I. INTRODUCTION

A river is a natural way for water to flow into the ocean, lake, sea, or into another river. The river consists of several parts, starting from a spring that flows into a tributary. Several tributaries will join to form the main river. This water flow is usually bordered by a channel whose bottom and cliffs are on the left and right. The end of a river where the river meets the sea is known as the river mouth.

River is a part of the hydrological cycle. Water in rivers is generally collected from precipitation, such as

rain, dew, springs, underground runoff and in certain countries river water also comes from melting ice / snow. Apart from water, rivers also carry sediment and pollutants.

Hydrology is a branch of civil engineering that studies the movement, distribution and quality of water throughout the Earth, including the hydrological cycle and water resources. (www.wikipedia.com/air). In meteorology, precipitation (also known as a class in hydrometeors, which is an atmospheric phenomenon) is any product of the condensation of water vapor in the atmosphere. It

occurs when the atmosphere (which is a solution of giant gases) becomes saturated and water then condenses and leaves the solution (precipitates).

Sedimentary rock or sedimentary rock is one of the three main groups of rocks (along with igneous and metamorphic rocks) formed in three main ways: weathering of other rocks (clastic) deposition due to biogenic activity and precipitation from solution.

Pollutant or polluting materials are materials / objects that cause pollution, either directly or indirectly, such as to the extent that the largest of a river is for irrigation. as a drainage for rainwater and waste water, in fact, it has the potential to be used as a river tourism object, one of which is the Way watershed Sikabiry of Liliboy Village. This has an impact on the decreasing water discharge of the WaiSikabiryriver, high sedimentation rates and is prone to flooding.

Through the brief description above, then a periodic incentive study and handling of sedimentation and garbage as well as riverbed characteristics is needed by periodically backfilling the Way Sikabiry watershed area. Therefore, the analysis of sedimentation and garbage in the Way Sikabiry watershed is necessary to carry out special handling to overcome the water overflows that occur every rainy season in Liliboy Village. This study aims to determine how the scouring pattern that occurs in the Way Sikabiry watershed and the amount of water discharge in the Way Sikabiry watershed.

II. LITERATURE REVIEW

2.1. Definition of water discharge

Because the definition of discharge is very broad, in several studies several definitions are given so as not to get out of the predetermined topic, namely "water discharge", therefore only the discharge of river water is discussed.

In hydrology, it is stated that river water discharge is the height of river water as measured by river water level measuring instruments. Measurements are carried out every day, or in other terms, river discharge or flow is the rate of water flow (in the form of water volume) passing through a cross section of the river per unit time. In the SI system of units, the amount of discharge is expressed in units of cubic meters per second (m^3/dt). In technical reports, flow rates are usually shown in the form of flow hydrographs. Flow hydrograph is a discharge behavior in response to changes in biogeophysical characteristics that are direct in a watershed (due to watershed management) and / or changes (seasonal or annual fluctuations).

The ability to measure flow rate is needed to determine the potential of water resources in a watershed

area. Flow discharge can be used as a tool to monitor and evaluate an area's water balance through the approach of potential surface water resources.

2.2. Debit Formation Process

A river is formed by the flow of water from one or several water sources that are at an altitude, for example on a hilltop or high mountain, where a lot of rainwater falls in the area, then collects in a sunken part, over time it is too full, finally flows out through the lip of the basin that is most easily eroded by water, then the water will flow over the lowest ground surface, maybe at first evenly, but because there are parts on the surface of the ground that are not so hard, it is easily eroded, so that it becomes the channel created is getting longer and longer, along with the heavier and more frequent water flows in the channel, the longer and deeper the channel will bend, or branch. If the water flowing there is blocked by a rock as big as the channel, or a lot of stones, as well as a river below the surface of the ground, it occurs from water flowing from above, then it finds the parts that can be penetrated below the ground surface and flow into the direction of the lowlands over time the river will get wider.

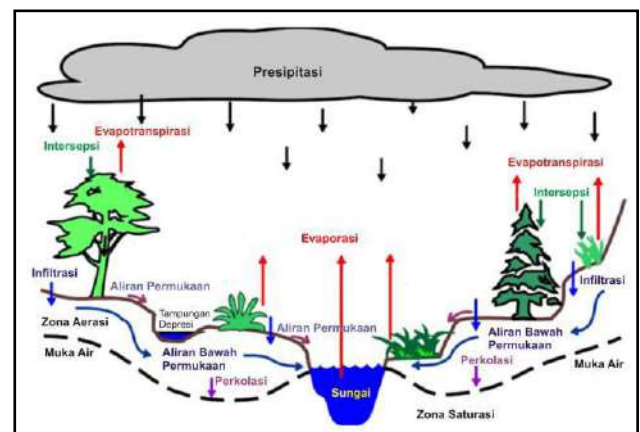


Fig.1: Hydrological cycle

2.3. Determinants of Water Discharge

1. Rain intensity

Because rainfall is one of the main factors that has a seasonal component that can quickly affect water discharge, and an annual cycle with the characteristics of a long rainy season (short dry) or long dry season (short rainy season). Which causes an increase in water discharge.

2. Deforestation

The main function of forests in relation to hydrology is to retain soil that has a high slope, so that the rainwater that falls in the area is retained and seeps into the ground to become groundwater. Groundwater in the upstream area

is a water reserve for river water sources. Therefore, a well-preserved forest will provide benefits in the form of availability of water sources during the dry season. It is better if the deforested forest will be disastrous for the people upstream and downstream. In the rainy season, rainwater that falls on barren land will erode the land with high slopes. Most of the rainwater will be runoff and very little infiltration. The result is landslides and / or flash floods that carry mud deposits.

3. Forest conversion into agricultural land

The risk of clearing forest for agricultural land is as great as deforestation. A decrease in river water discharge can occur due to erosion. In addition to increasing suspended solid content in river water as a result of sedimentation, increased water fertility will also be followed by increasing nutrient content in river water. Most of the forest areas that are converted into agricultural land have a slope of above 25%, so if you don't pay attention to soil conservation factors, such as cropping patterns, making terraces and others.

4. Interception

Is the process when rainwater falls on the surface of the aboveground vegetation, is held for a while, to be evaporated back into the atmosphere or absorbed by the vegetation concerned. The interception process occurs during rainfall and after the rain stops. Whenever rain falls in a vegetated area, there is some water that never reaches the ground surface and thus, although interception is considered not an important factor in determining the water discharge factor, watershed managers must still take into account the size of the interception because the amount of water lost as interception water can affect regional water balances. Changing from one type of vegetation to another, a different type of vegetation, for example, can affect water yield in the area.

5. Evaporation and Transpiration

Transpiration evaporation is also one of the components or groups that can determine the size of the water discharge in a watershed area, why is it said to be a determining component of water flow, because through these two processes it can create new water, because these two processes evaporate water from the water surface, soil and leaf surfaces, as well as plant branches so that they form moisture in the air. With the presence of water vapor in the air, rain will occur, with this rain, the water discharge in the watershed will also increase. Little by little.

2.4. Normalization of Streams and Embankments

River normalization is an attempt to increase the drainage capacity of the river itself. Flood handling in this

way can be done in almost all rivers downstream. The factors that are necessary in this method of handling are the use of a double section with a dominant discharge for the lower section, planning a stable channel against the process of riverbed erosion and sedimentation as well as cliff erosion and flood water level.

2.5. Flood Control Flow Making (Flood Way)

The creation of a Flood Way is intended to reduce flood discharge in the old river channel and flow it through the flood way. Making a flood way can be done if the local conditions are very supportive, for example the availability of a river channel that will be used for the flood way. The factors that need to be considered in planning a flood way include:

- a. Whether it is difficult to carry out normalization in accordance with the discharge design on the old channel that passes through the city.
- b. Whether land acquisition is difficult or not if the normalization or floodway is carried out.
- c. The condition of the old channel which turns too far to go out to sea is very unfavorable from a hydrological point of view.
- d. There is a path for a new, shorter channel to the sea using the existing small river.
- e. There is no disruption in the use of existing water resources.
- f. The size of the negative impact on the social and economy caused.

2.6. Retarding Basin Creation

In the making of the Retarding Basin, the depression area is needed to accommodate the volume of flood water that will come from the upstream, temporarily and then release it again when the flood recedes. Flood handling in this way is highly dependent on field conditions. Meanwhile, areas of basins or depressions that can be used for flood ponds must consider the following:

1. The basin area that will be used as a retention area must be an area that is not effectively utilized and has low productivity.
2. Utilization of the retarding basin must be beneficial and effective for the areas downstream.
3. The area must have the potential and be effective as a retention area.
4. The area must have a large storage area or volume, as for the buildings required to handle floods in this way, namely:
5. Reservoir embankment
6. Pool door

2.7. River Normalization

River normalization is mainly carried out in relation to flood control, which is an effort to increase river

drainage capacity. This is intended to accommodate the flood discharge that occurs and then be channeled into a larger river or directly to the estuary / sea, so that there is no runoff from the river. River flow normalization work basically includes activities consisting of:

1. Flood discharge calculation plan
2. Analysis of the initial capacity of the river (existing capacity analysis)
3. Calculation of the cross section and longitudinal design of the river
4. Doing a sudan on the meander river flow
5. Determine the height of the guard
6. Stabilizes the groove against erosion, landslides
7. Embankment Planning
8. Overview of the effect of back water due to tides

2.8. Calculation of Planned Flood Discharge

There are several methods for estimating the peak flow rate (flood discharge). The method used at a location is more determined by the availability of data. In practice, the flood discharge estimation is carried out by several methods and the planned flood discharge is determined based on technical considerations (engineering judgment). The calculated flood discharge plan results will later be used to dimension the river cross section to be normalized. The calculation of the flood discharge plan is divided into two, namely:

a. Planned Flood Discharge based on Rainfall

The amount of river flood discharge is determined by the amount of rainfall, the time of rain, the area of the river basin and the characteristics of the river basin. To calculate the planned flood discharge based on rainfall, the Java-Sumatra, Rational, Melchior, Weduwen, Haspers, and Gama I FSR methods can be used.

b. Planned Flood Discharge Based on Discharge Data

The amount of river flood discharge is determined by the amount of discharge, rain time, and the area of the river basin. To calculate the planned flood discharge based on the discharge, the Unit Hydrograph and Passing Capacity Method can be used. In the event that the discharge data is obtained which is long enough statistically and probabilistically, the frequency analysis method can be directly used without observing the rainfall event. However, if the discharge data is not available or is not long enough, it is necessary to collect rainfall data.

c. Distribution Parameters

In statistics, there are several parameters related to data analysis, including the average, standard deviation, coefficient of variation, and skewness coefficient (skewness). The Flood Discharge Distribution parameter is used to calculate the estimated flood discharge with a

certain return period from the existing annual maximum flood discharge data.

d. Frequency Distribution for Flood Discharge Data Analysis

In statistics there are several types of frequency distribution, four types of distribution that are widely used in the field of hydrology are:

- 1). Normal Distribution
- 2). Normal Log Distribution
- 3). Log-Person Distribution III
- 4). Gumbel distribution

1. Normal Distribution

The normal distribution or normal curve is also called the Gauss distribution. The best known probability density function (PDF) is the bell form and is known as the normal distribution.

2. Log-Person Distribution III

In certain situations, although the data estimated to follow the distribution has been converted into a logarithmic form, it turns out that the closeness between data and theory is not strong enough to justify the use of the Log Normal distribution. Person has developed a series of probability functions that can be used for almost any empirical probability distribution. Unlike the concept behind using the Log Normal distribution for peak floods, this probability distribution is hardly theory based. This distribution is still used because of its flexibility

2.9. River Initial Capacity Analysis (existig)

To analyze the initial capacity of a river, a program called HEC-RAS (Hydrologic Engineering Center - River Analysis System) is used. It is a program package from USCE (United State Corps of Engineer). This software can be used to perform Fixed Flow and Unstable Flow calculations (SteadyFlow and Unsteady Flow).

The Tuntang River is a natural river with a cross section of the river that is irregular (non uniform) and meandering river. In connection with the flow that occurs is in the form of non-uniform flow, and to speed up the calculation process the HEC-RAS program is used. Whereas for artificial rivers or channels with uniform cross-sections, the flow that occurs is in the form of uniform flow and can be solved using the Continuity Equation and the Manning formula.

The main components covered in this HEC-RAS analysis are:

- Calculation of the steady flow water surface profiles computations
- Unsteady flow simulation and water level profile calculation These components calculate the water level profile by an iterative process from input data that has been processed according to the criteria and standards required by this program package. While the output of this program can be in the form of graphs or tables. Among them are plots of river flow schemes, cross sections, profiles, rating curves, hydrographs (stage and flow hydrograph), as well as other hydraulic variables. Besides that, it can also display a combination of cross sections that form a three-dimensional river flow complete with its flow.

2.10. Planning River Cross Section Plan

River cross sections need to be planned to obtain ideal and efficient cross sections in land use. The ideal cross section which is meant to be a section that is stable to changes due to the influence of erosion and the influence of the flow pattern that occurs. While efficient land use is intended to pay attention to available land, so as not to cause problems with land acquisition.

Factors that must be considered in designing river normalization cross-sectional shapes are:

- River sediment transport
- Comparison of dominant discharge and flood discharge

In general, the downstream river channel has a very low ratio of water level to river width (h / B), double cross-section shape, very gentle riverbed slope and low drainage capacity. So that to increase the drainage capacity during a flood, a double section is made, by increasing the wet cross-sectional area of the riverbank utilization. The cross-sectional shape of the river is strongly influenced by the cross-sectional shape factor based on the flow capacity, namely the cross-sectional capacity will remain even though the shape changes.

It should be noted that the cross-sectional shape of the river is the most stable. The cross-sectional plan of the TuntangHilir River is planned to be in the form of a trapezoid with a bank. The sectional plan with the following considerations:

- The river channel is able to pass the planned flood discharge
- Riverbeds also need to be considered against scouring hazards

2.11. Making Short Cut

Shading is only carried out on very critical winding river channels and is intended so that floods can reach the downstream or sea quickly by considering a stable river flow. The thing that really needs to be considered in

making a sudetan is that the result of the sudetan does not cause a problem of flooding in the downstream part because there will be an increase in the amount of the flowrate and when the flood arrives because there will be an increase in the flow rate and when the flood arrives is shorter, so that it will lower the water level. flooding upstream and adding to flooding in the downstream. Based on the aforementioned considerations, the work of the sudetan is carried out in the river channel downstream of the protected area and must be balanced with river normalization in the downstream side of the sudetan.

1. The purpose of doing this is sudetan
2. The direction of the groove
3. Cross section of the Sudetan river
4. Attempts to maintain the sudan function
5. The effect of lowering the water level in the upstream corner of the environment
6. Effect of reduced flood retention function
7. An overview of the socio-economic aspects

2.12. Effect of Back Water Due to Tides

In flood control, it is necessary to pay attention to the water level during floods along the river and the flood water level due to back water. This is based on the consideration that the presence of runoff on some of the embankments will result in the collapse of the embankment, which is a failure of the flood control system. The method commonly used in calculating the effect of back water is the steady non-uniform flow hydraulic analysis method, especially for rivers that have irregular cross-sectional shapes and varying riverbed slopes.

III. METHODOLOGY

3.1. Time and Location

1. Research time
The research was carried out in October 2019.
2. Research sites

This research was conducted in Lilioboy Village, West Leihitu District, Central Maluku Regency

3.2. TechniqueData analysis

Analysis of the development of the availability of water sources in Lilioboy Village using the following analysis techniques:

Various data were collected, then processed and grouped towards the development of the availability of water sources in order to determine alternative solutions to problems related to the topic being carried out

3.3. Tools and Materials

The tools and materials used in this study are as follows: Current meter, meter, stop watch, writing instruments, buoys and measuring tubs



Fig.2: Map of the Research Location

3.4. Research Methods

The method used in this research is the profile method (cross section) by placing an unsinkable object on the surface of the river flow for a certain distance and recording the time required for the floating object to move from one point of observation to another observation point that has been carried out.

3.5. Data Retrieval Technique

a. Preparation phase

Literature study to find preliminary information related to the focus to be studied

b. Implementation Stage

- secondary data collection from related agencies in the form of land change development, social life, public service facilities, instructors and various government policies in the form of documents related to research problems.
- Primary data collection is obtained from direct observation or observation in research

3.6. Research Flowchart

Schematically the methodology is presented visually in the form of a flow chart as follows:

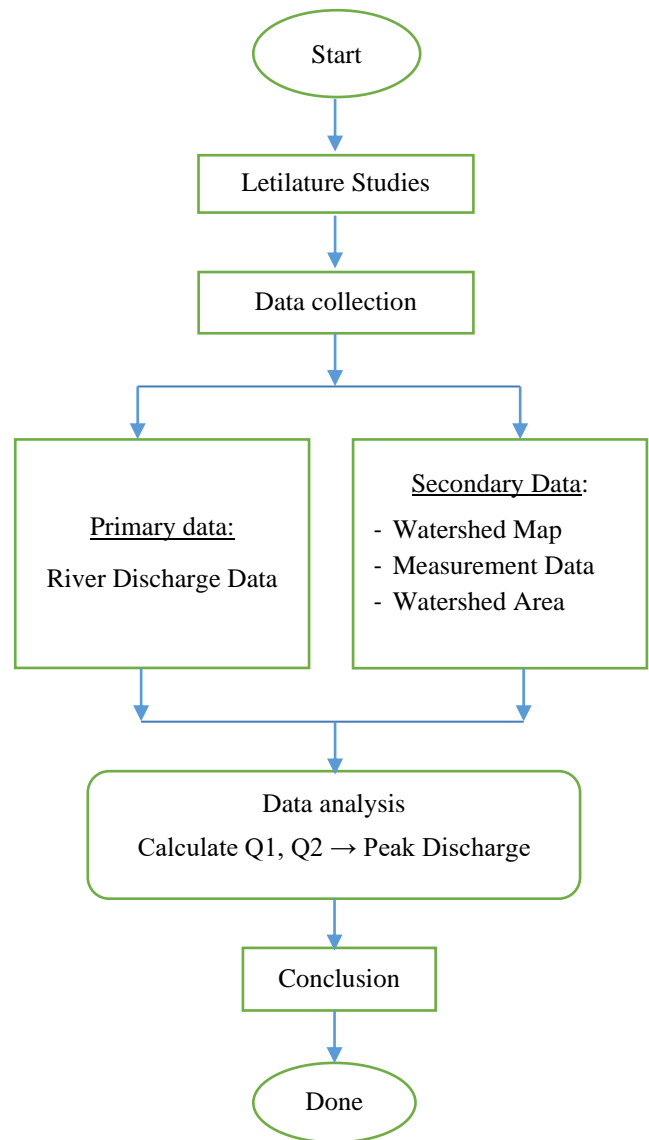


Fig. 3: Research Flowchart

IV. ANALYSIS AND DISCUSSION

4.1. Measurement of Flow Speed with Current Meter

Flow velocity measurement with Current meter can produce an adequate flow velocity estimate. The principle with measurement with this method is to measure the flow velocity of each depth at a certain interval point with the following measurement steps:

1. Choose a measurement location on a part of the river that is relatively straight and not much eddy.
2. Divide the cross-section of the same river by certain intervals.
3. Measure the flow rate at a certain depth according to the river depth at each point of the interval.
4. Calculate the average flow velocity.

4.2. River Flow Discharge Calculation Analysis

In this study, 2 (two) sample segments of the location representing a typical river channel with varying widths

and depths of the river represent their respective characters, as for the flow rates in each river flow segment, namely:

$$Q = A \cdot V$$

Where: Q = Flow Discharge (m³ / s)

A = Cross-sectional Area (m²)

V = Flow Velocity (m / s)

4.3. Water discharge measurement data in the Way Sikabiry watershed

Upstream:

- River width 73.00 meters
- Cross-sectional area 1.75 meter²

Downstream:

- River width 87.00 meters
- Cross-sectional area of 1.89 meters²

Table.1: Upstream Discharge Measurement Data

Rai (m)	Width (m)	In (m)	In Wheel (m)	Number of Turns	Time (seconds)	Speed On Point
0.00	MA. LEFT	0				
1.00	1.00	0.22	0.6	88	40	0.563
2.00	1.00	0.28	0.6	89	40	0.568
3.00	1.00	0.25	0.6	81	40	0.518
4.00	1.00	0.18	0.6	22	40	0.152
5.00	1.00	0.06	0.6	0	40	0
6.00	1.00	0.02	0.6	0	40	0
7.00	1.00	0.1	0.6	0	40	0
8.00	1.00	0.1	0.6	33	40	0.216
9.00	1.00	0.1	0.6	6	40	0.055
10.00	1.00	0.08	0.6	57	40	0.369
11.00	1.00	0.1	0.6	45	40	0.289
12.00	1.00	0.09	0.6	11	40	0.084
12.50	MA. RIGHT	0.00				

(Source: Analysis Results)

Table.2: Downstream Discharge Measurement Data

Rai (m)	Width (m)	In (m)	In Wheel (m)	Number of Turns	Time (seconds)	Speed On Point
0.00	MA. LEFT					
1.00	1.00	0.17	0.6	13	40	0.095
2.00	1.00	0.24	0.6	62	40	0.397
3.00	1.00	0.26	0.6	86	40	0.549
4.00	1.00	0.26	0.6	40	40	0.516
5.00	1.00	0.24	0.6	80	40	0.51
6.00	1.00	0.2	0.6	61	40	0.394
7.00	1.00	0.15	0.6	50	40	0.321

8.00	1.00	0.1	0.6	48	40	0.308
9.00	1.00	0.14	0.6	62	40	0.401
10.00	1.00	0.07	0.6	33	40	0.217
11.00	0.75	0.02	0.6	0	40	0
11.50	MA. RIGHT	0.00				

(Source: Analysis Results)

4.4. Results of Water Discharge Analysis in the Way Sikabiry Watershed

Table 3: Analysis Results of Upstream Discharge Measurement

Average Speed (m)	Area (m ²)	Discharge (m ³ / s)
0.563	0.22	0.12386
0.568	0.28	0.15904
0.518	0.25	0.12950
0.152	0.18	0.02736
0	0.06	0.00000
0	0.02	0.00000
0	0.1	0.00000
0.216	0.1	0.02160
0.055	0.1	0.00550
0.369	0.08	0.02952
0.289	0.1	0.02890
0.084	0.0675	0.00567
Total 2,295	1.56	0.53095

(Source: Analysis Results)

Table 4: Analysis Results of Downstream Discharge Measurement

SpeedAverage (m)	Area (m ²)	Discharge (m ³ / s)
0.095	0.17	0.01616
0.397	0.24	0.09428
0.549	0.26	0.14274
0.516	0.26	0.13416
0.51	0.24	0.12240

0.394	0.2	0.07880
0.321	0.15	0.04815
0.308	0.1	0.03080
0.401	0.14	0.05614
0.217	0.07	0.01519
0	0.015	0.00000
Total	1.85	0.73981

(Source: Analysis Results)

Note :

If the measurement is made at 1 point (0.5 or 0.6 d) sample (vertical 2) then V - average = V at that point.

Current meter register number: 348235 (C31) & 339968 (C2)

Current meter formula:

$$n < 1.01 \quad V = 0.2397. n + 0.018$$

$$1.01 n < 8.06 \quad V = 0.2556. n + 0.002$$

$$8.06 \leq n < 9.82 \quad V = 0.2494. n + 0.052$$

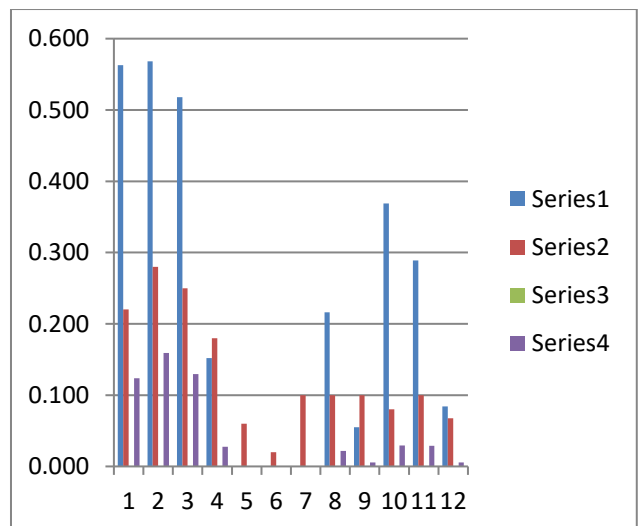


Fig.4: Depth Measurement Data Graph Upstream

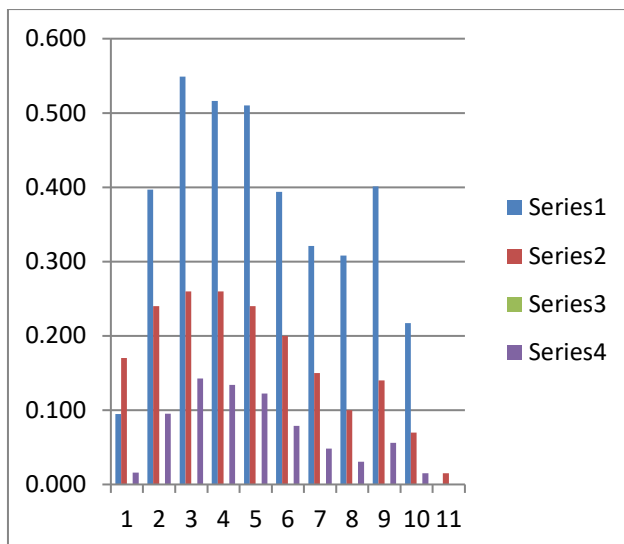


Figure 5: Depth Measurement Data Graphdownstream

Table 5: Comparison of Analysis Results for Flow Velocity, Upstream and Downstream Water Discharge.

Flow Typical	Depth (m)		Tilt (degree)	Cross-sectional Area (m ²)	Kec. Flow (m / s)	Discharge (m ³ / s)
	Minimum	Maximum				
Upstream	0.10	0.28	15 s / d 20	1.75	0.34090	0.53095
Downstream	0.10	0.26	30 to 35	1.89	0.40098	0.73981

(Source: Analysis Results)

V. CONCLUSION AND SUGGESTION

5.1. Conclusion

Based on the results of the analysis of water discharge calculations based on the cross-sectional area and flow velocity of the two typical / character watersheds upstream and downstream as follows:

1. The scouring pattern that occurs in the Way Sakabiry watershed results in large downstream water flows but high flow rates while in the upstream it produces small flow rates but low flow rates.
2. The amount of water discharge in the Way Sakabiry watershed upstream = 0.53095 m³ / second while in the downstream = 0.73981 m³ / second.

5.2. Suggestion

In planning the water structure (river talud) it is necessary to take into account the potential for scouring, especially in the watershed, to the next researcher.

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State and Society in the Process of Formulating Public Policy of Education: Contributions of Stephen Ball

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Keywords— Educational Policies. Stephen Ball, Formulation of Educational Policies, Popular participation.

Abstract— This article addresses the concepts and definitions in the process of formulating and implementing public policies, approaching the cycles of public policies, as well as strategies for better management in the elaboration of a policy, especially in education. The problem to be answered in this article is "what is the process of formulating public education policies regarding the contributions of Stephen Ball and others?". As a hypothesis, we point out that popular participation is the result of most of the definitions of education policy. The contributions of sociologist Stephen Ball are essential, in a perspective of stimulating and understanding education policies, as he is considered one of the sociologists with the most relevant publications on education policy studies in the United Kingdom and in other countries.

I. INTRODUCTION

This article presents concepts and definitions of the process of formulating and implementing public policies. It essentially aims to know the entire process, from the birth of the public problem to its evaluation, it is crucial for the understanding of public policies, as well as the knowledge of all public policy cycles.

The problem to be answered in this article revolves around the understanding of the process of formulating education public policies, built on the contributions of Stephen Ball and others. In addition, this article also seeks to answer the following questions: What are public policies? What are the phases or cycles of a public policy? Is popular participation important in the elaboration of education policies, with foundation on school problems identified by local society?

As a hypothesis, we list that popular participation is very important and necessary in the definition of education policy. Pontual (1995), Freire (1991), Silva (1998) and Paro (2005) showed that popular participation is fundamental in school life, as they show local problems and needs. With this, the problem is specified, defined, then, a coherence in the implementation and in the financial investments, providing an opportunity for a more adequate education policy.

The contributions of the sociologist Stephen Ball are essential, from a perspective of stimulation and understanding of education policies, as he is considered today one of the sociologists with the most relevant publications on education policy studies in the United Kingdom and in other countries. However, we critically identified that the models raised by Ball that separate the phases of formulation and implementation ignore the

disputes and clashes over policy and reinforce the rationality of the management process (LASWELL, 1958).

According to Brazilian researchers Mainardes and Gandin, "Ball's ideas are, in fact, broad and sophisticated and can be used not only by those who are more inquisitive about educational coverage and the sociology of education, but by researchers from several different areas and fields." (MAINARDES; GANDIN, 2013, p. 256).

Based on these authors, we can infer that this perspective is not restricted to the educational scope, but rather interesting for scientific research aimed at fostering theories of political action, with the intention of unraveling what Ball calls the "neoliberal imaginary".

Stephen Ball's theory helps us to recognize that, from the theoretical/epistemological position, the research objects are relevant to the researcher. In his research, he presented robust arguments that support the shortcomings perceived in the studies of a positivist matrix, whose expectation is to drive "improvements" in the political-administrative processes through the management of implementing activities variables (ROSA, 2019, p.14).

The bibliographic research was carried out through a survey of the state of knowledge and the creation of a theoretical framework focused on an empirical overview of the main topics, involving writers who research the following themes: Educational Policies; Public policy; Popular Participation and Stephen Ball's Concepts. Methodology is perceived as the critical knowledge of the scientific process paths, inquiring, and questioning regarding its limits and possibilities (Demo, 1989). This article, with a bibliographic research policy, would follow the assumptions of qualitative methodology, unfolding from bibliographic research, which implies an orderly set of procedures to search for solutions, observing the research subject.

Regarding the search criteria, the chosen articles have authors with at least a master's or PhD degree and with Qualis/Capes seal of certification. The research base in the search for scientific articles was directed to the SciELO index (CrossRef). Author-specific articles that specifically address public policy and mention Stephen Ball. In this sense, all texts found for the development of this research were searched using the following keywords: Public Policies and Stephen Ball.

II. METHODS QUALITATIVE RESEARCH

The bibliographic research served as a guide to the methodological path taken in this article. The assumptions of the qualitative methodology imply orderly procedures to

search for solutions to a set of questions, having the object of study in mind. The data obtained in the bibliographic research is presented and qualitatively compared to the findings in the literature survey, through data triangulation.

In this perspective, as the research is conducted to, even if indirectly through literary review, a certain population, this work can also be characterized as a social research, based on social involvement in public policies.

Neves (1996, p. 01) states that:

Social research has been strongly marked by studies that value the use of quantitative methods to describe and explain phenomena. Today, however, we can identify another form of approach that has been showing to be a promising possibility of investigation: it is the research identified as "qualitative". It initially appeared in the fields of Anthropology and Sociology. In the last 30 years this type of research has gained space in areas such as Psychology, Education and Business Administration.

The key components of a qualitative study, as defined by Strauss and Corbin (2008), are: first, the data source, which can come from various places, such as technical literature, non-technical literature, and interviews; and second, coding, which helps the researcher to use data analysis and organization tools.

A research experiment using the qualitative method does not fit into a fixed proposal. It encourages researchers to propose works that test new techniques using creativity and innovation. Qualitative research, in this regard, is a kind of investigation that tries to understand phenomena in their subjective nature (GODOY, 1995, p. 23).

Theoretical bibliographic research

The theoretical research method consisted of two construction types: the state of knowledge, which was called a survey of academic and scientific production; and the literature review, which led the authors to substantiate the contextualization of public policies.

State of Knowledge - Survey of Academic and Scientific Production

The state of knowledge is the recognition, registration and categorization that lead to a reflection and a synthesis on the scientific production of a certain area, in a certain period of time, covering articles, theses, dissertations and books on a subject or specific theme (Santos & Morosini, 2021). The search for the descriptors "Public Policies" and

“Stephen Ball” was conducted in the state of knowledge, which in this work is being called a survey of academic and scientific production. This research made an

investigation of academic production focusing on the selection of articles published in journals indexed in SciELO (CrossRef) with a time frame from 2010 to 2020.

Publications mentioning Stephen Ball and Public Policy (2010-2020)

DESCRIPTORS	2010		2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
PUBLIC POLICY AND STEPHEN BALL	0	1	0	0	0	12	0	18	0	28	0	39	0	40	0	22	0	9	0	19	0	37

Label: A = Articles. B = Books.

Source: self-made

Based on the research of published scientific productions that mention Stephen Ball and Public Policies (2010-2020), three were selected that emphatically address Stephen Ball's approaches to Public Policies.

intertwined power relations in the elaboration of a document of a national nature, as well as presenting the context of the production of texts, from which the context of influence is not removed, on the contrary, once again the power relations are put. It is clear, at the end of the text, which groups were hegemonic, and which interests they served.

Descriptor Year	Title	Author	Year
Article 01:	Stephen Ball's Policy Cycle and the analysis of curricular policies: contextualizing the geography	Narayana Fernandes de Sousa	2014
Article 02:	An introduction to Stephen J. Ball's ideas and contributions to the topic of educational policy implementation	Sanny Silva da Rosa	2019
Article 03:	Stephen Ball's contributions to the field of educational policy	Regina Célia Linhares Hostins; Olívia Rochadel	2019

The article published on the online Journal of Policy and Educational Management by Regina Célia Linhares Hostins and Olívia Rochadel mentions that in view of the survey carried out and the main concepts identified in Stephen Ball's work, it may be considered how fruitful and consistent his theory is to support the analysis of educational policies in the current context. The collected and organized data certainly allows for further development and discussions which were not brought up for discussion due to the limits for writing scientific articles. Notwithstanding, they constitute a productive source of data that will subsidize the production of other scientific articles about the subject (HOSTINS; ROCHADEL, 2019).

In her article published in 2019 in the Journal of Theoretical and Epistemological Studies in Educational Policy author Sanny Silva da Rosa tries to present and explore some of the views and contributions of Stephen J. Ball for novice education policy experts. Ball is an English sociologist and researcher on the issue of implementing public education policies. The article is divided into three sections: the first argues Ball's contributions to the issue of implementation from the perspective of political action through a synopsis of his main works; the second discusses Ball's contributions to the issue of implementation from the perspective of political action and the third discusses Ball's contributions to the issue of implementation from the perspective of political action. The last section of the essay examines Stephen Ball's theoretical-methodological "toolbox" and the consequences of his epistemological perspective for research on the implementation of

Sousa (2014) emphasizes in his article that from the discussions of Ball's policy cycle (1994) the understanding of the PNLD and the PCN's as representations, and as such, they present the context of influence, articulating all

educational policy guided by his main intellectual influencers (ROSA, 2019).

Based on these three published productions, we highlight that all three publications contributed to the development of this article. Nevertheless, none of the productions stresses the State and the society in the process of formulating education policies with Stephen Ball's input.

Theoretical Framework and Literature Review

Another methodological procedure was the literature review of the framework of authors cited and discussed in the theoretical framework as well as the bibliographic analysis of the state of the art. The review of literature provided the development of a theoretical context and a theoretical background, including writers or researchers who studied the following topics: teacher training; teaching performance and teacher-researcher.

Stephen Ball: Educational Policy Theory and Research

Stephen Ball is a scholar and professor at the Institute of Education at the University of London - United Kingdom. He has significant publications in the area of educational policies that have become quite important in other countries, but especially in the United Kingdom. Stephen Ball's ideas on educational policies were considered relevant in several countries such as the United Kingdom, Brazil, Africa, and India. Its main objective is to stimulate and understand how policies are created aiming to infer what lies behind a policy based on the consequences of market interests on education (BALL, 1990).

A criticism to be laid emphasis on is that Stephen Ball's knowledge comes from a poorly elucidated reality because the English model that he has formulated works a lot with agencies. There is a huge difference in applying Stephen Ball in a country that has these characteristics and was permeated by Thatcherism which practically privatized all education and works a lot with indicators and results, and to a continent-sized country like Brazil. Still, Ball, unlike this cycle of public policies, brought up a proposal with a variety of approaches that can actually be put to good use in Brazil. Ball defines as a cycle the context of influence, the context of text production and the context of practice (BOWE et al., 1992).

The elements of the presented context are interrelated and not only are they not defined as linear steps, but also do not have a temporal or sequential aspect. The contexts mentioned above present places, arenas, and interest groups. All involved in clashes and disputes (BOWE et al., 1992).

Stephen Ball has a relevant study on public policies in which he approaches the English model. We can critically show that these models that separate the phases of formulation and implementation ignore the disputes and clashes over policy and reinforce the rationality of the management process. (CORBITT, 1997; VIDOVIĆ, 1999; WALFORD, 2000; LOONEY, 2001; KIRTON, 2002; VIDOVIĆ; O'DONOGHUE, 2003; LOPES, 2004; LOPES; MACEDO, 2011).

One of Ball's important works, *Politics and policy making in Education*, written in 1990 addresses educational changes and the processes that shaped policy from the 1970s (the post-war consensus period) to the late 1980s – a period dominated by the neoliberal tendency of Thatcherism (ROSA, 2019, p. 4). The introduction of that book was based on the National Curriculum that was instituted in the 1988 Reform in England brought about by Margareth Thatcher. It aimed at standardizing teaching content in schools in three countries in the United Kingdom: Wales, England, and Northern Ireland.

In order to investigate different aspects of the reform, Ball built an ethnographic classification using various qualitative techniques such as documentary sources and interviews with actors in the political process. Regarding the analytical approach, the author classified it as "critical and deconstructive". This allowed him to carry out a kind of "disassembly" of things, to assess the distributive impact of existing policies and proposals. (BALL, 1990)

Another aspect addressed by Ball is the sociology of education that has made several contributions in recent years in terms of criticizing the management of schools and teachers at many forms of inspection and measurement (BALL, 2003). On the other hand, through conditions and possibilities, the sociology of education has developed an analytical view of power that has defined that schools and families have become the stage for experiments in the implementation of technology policies, as well as a field of research and knowledge.

Public Policies: a literature review

Public policies were presented and consolidated in the second half of the 20th century, with political science playing an important role in valuing the field of study. The knowledge of political analysis emerged in 1950, in the United States, and has changed and spread over the years, having public policies as an object of study. Its greater dissemination occurred through the publication of the book *The policy sciences* (1951), by Daniel Lerner and Harold D. Lasswell.

Considering its emergence and origin, the purpose and meaning of public policy will be briefly introduced using some definitions as a starting point. Public policies are

always linked to an action determined by the State, although these actions arise from the needs of a society, not from the State. Therefore, it can be said that public policies are designed with a social context as a basis (SOUZA, 2006, p.05).

Public policies have several actions that cause significant social impacts for a society, such as minimizing difference, as an example. These actions are decisive for countries with great social inequality like Brazil (GONÇALVES, 2017, p. 23).

For that matter, what is in evidence is the evaluation of policies, as they directly or indirectly address elements such as the relevance of a culture for democracy, the relationship between the quality offered and the financing conditions, the valorization of the expansion of access to school institutions, the meaning of qualified management and the results of student performance, configuring an approach focused on the materialization or effectiveness of public policies for basic education (KUNZ; ARAÚJO; CASTRATIONI, 2017, p. 38).

For better understanding of what a public policy is, Dye (1984) offers a brief definition. He emphasizes that it is what “the government chooses to do or not to do”. Mead (1995) defines it as a study addressed within politics that analyzes government through public issues. For Lynn (1980), it is a series of government actions that will generate specific effects. Peters (1986) follows an equivalent line: public policy is the sum of state activities, which act directly or through delegation. The best-known definition is that of Lasswell, who says that public policy decisions and analysis imply answering the subsequent questions: who wins what, why and what difference does it make.

In summary, public policies are created by actions triggered by the State. In Brazil, this takes place between the three levels of the Brazilian federation, that is, at the municipal, state, and federal levels, aiming to meet the demands of civil society. Regarding the creation process, it can be carried out with institutions that are not linked to the government, such as the private initiative. It stands out as keywords of what is a public policy elaborated in four traditional elements: totally dependent on government involvement; the identification of a problem; goal design; alignment of a method of action (DEUBEL, 2006).

It is important to highlight that public policies therefore arise from a social need that requires that the State meet the demands of this specific population. Thus, they are not aimed at the entire population of a country, for example, because they focus on solving a problem that emerges from a specific group, whose need for State action is central and essential.

Public Policy Cycles

Public policies are organized in cycles or phases that will be unfolded below. They are presented in sequence so that they are understood as a natural chain from one phase to another.

The first cycle takes place with the emergence of the public problem and its identification, which is when an individual or a group of people observe a circumstance in society and identify a problem. For instance: Brazil has a few professionals with higher education and many Brazilians do not even enter a bachelor’s degree. Most of those who do not access higher education claim lack of financial conditions. To face this problem, public policies such as FIES and PROUNI arise in order to facilitate funding for access to higher education (BRASIL, 2019).

The second cycle is to establish an agenda which is a set of problems that a government body or an authority decides to tackle. There are three kinds of agendas, the formal agenda, the political agenda, and the media agenda. The formal agenda consists of problems that the government decided to solve, the political agenda refers to problems that the political community considers relevant and the media agenda that concerns communication and influences the previous two. The process of establishing a government policy agenda (agenda-setting) comprises a set of problems considered to be a priority for a public agency and bring to light how specific issues, at a given moment, become important focusing the government's attention and becoming part of its agenda.

For example, at an earlier time, bullying in schools was not identified and characterized as nowadays. As it was not acknowledged, it did not pass through the first cycle of creating a public policy, which is the detection of a problem. Based on this, bullying was not part of the government agenda. Although, as soon as it was perceived in a systematic way, as it occurs today, bullying started to be countered. Identified as a socially systematized problem, it could now be implemented on the government agenda (ALVES; AZEVEDO; LOPES, 2016, p. 69).

The third phase is the formulation of the public policy in question, which constitutes alternatives that are elaborated to face a problem or situation. It occurs after its entry into the governmental agenda where possible solutions to the policy objectives are defined. These are the

lines of action and programs to be developed, the strategies used to achieve the established goals. This phase will be approached in greater depth later, including the role of the State and the society in the process of formulating education policies (RAEDER, 2014, p. 127).

The fourth cycle of public policy formulation is the decision. It consists of the decision-making process that involves the entire legislative framework of the country. In that regard, this phase goes from the enactment of legislation by the Legislative Power to the sanction or veto of the Executive Power. Adverse decisions by the Judiciary are also applicable in all its instances, within the scope of jurisprudence, judgments, precedents, etc.

The fifth stage of this process is the implementation of public policies. Implementation is nothing more than putting into practice everything that was thought, elaborated, reformulated, and planned. Generally speaking, implementation implies actions that are intended to achieve the goals set out in previous decisions. It is when the planned actions reach the beneficiary defined by the public policy.

The sixth phase is the evaluation of public policy. This step is the result of the entire public policy development. The main role of this phase is analyzing the proposal made and diagnosing the positive and negative effects it caused. The evaluation is a set of what has been elaborated and reformulated. It comprises all public policy cycles and assesses the changes and social results initiated by them (RAEDER, 2014, p. 127).

As the seventh and final cycle foreseen in this entire process, there is the possibility of extinction of public policy, which can occur due to several reasons and under various processes of dissolution or replacement. The decision to dissolve a public policy comes from an evaluation that points out the non-achievement of the pre-established goals either for not having solved the problem or for not being able to solve the demand of a specific population. When a public policy reaches this point, the policy cycle is expected to be interrupted (HOWLETT et al., 2013). When the evaluation of a public policy is carried out it diagnoses the value of the public policy. If the implemented actions are proved ineffective, the process for the discontinuation or replacement of the public policy begins.

Education Policies and Popular Participation

Popular participation is defined as the direct participation of the population in government actions, as well as in the implementation or formulation of public policies. Popular participation imposes room for citizenship that provides an improvement to the existing representative system and direct democracy. We list a

theoretical and political critique of the functioning of the democratic system in the world and in Brazil (ENAP, 2018, p. 7).

Educational initiatives are government policy plans guided by principles and ideas that address school populations and are implemented by education management professionals (MENDONÇA et al., 2020, p. 169).

There have been good experiences in Brazil with popular participation in the processes of policy definition. As an example of two recent popular participation experiences there are the "Ten Year Education Plan" and the "World Social Forum". The Decennial Education Plan was a proposal of Brazilian society. It was a pioneer and historically marked movement in the late 1990s. On the other hand, The World Social Forum was based on popular mobilization against neoliberal policies, which points to an "inclusive" discourse, however it leaves the poor population aside and reduces their possibilities of participating in the process of socialization of goods produced worldwide (ARELARO, 2007, p. 903).

In recent decades, the instruments of popular participation in governments and in the formulation and management of public policies have been very relevant in the transformation of how to manage the Brazilian State (ENAP, 2018, p. 6).

The principle of democratic management of education included in Brazil's Federal Constitution of 1988 was a very controversial issue because it limited the democratic management of education to the public sphere. According to article 206, item VI of the National Constitution, democratic management is restricted to "public education, in accordance with the law" (BRASIL, 1988).

According to Horta (1998):

The great leap in the 1988 Constitution is the fact that "[...] the right to education is no longer respected not only when compulsory education is not offered by the government, but also when this offer is made irregular." (HORTA, 1998, p. 26-27).

In Arelaro's view (2007, p. 901), this "distraction", which in fact is understood as a "limitation" to the democratic character of the Constitution, had the broad and transparent popular participation as an incentive, which really portrayed a political struggle within which conservative and privatist pedagogical thinking was the winner at that moment. This situation was resolved with

the implementation of democratic management in schools, which will be dealt with in more detail below. Democratic management and popular participation are based on “participatory pedagogies” that have a positive impact on learning and are developed from a pedagogical act that involves participation and autonomy, both assumptions of learning itself. So, training a citizen to participate is training him to participate in the destiny of his country with responsibility.

Educational policies, within the scope of the three instances of educational management of teaching, which are totally different at the municipal, state, and federal levels, are defined as a more solidary action among the public spheres. The federative scope is responsible for the distribution and collaboration, making the system more equitable among them, sharing tasks and responsibilities (ARELARO, 2007, p. 901).

In 1990, the Child and Adolescent Statute (ECA), Law n.8.069/90, established the right of parents, which foresaw the importance of parents' rights in participating in the pedagogical work of schools. It is good to emphasize that the participation and collaboration of parents in schools is of great value, as well as the monitoring of the entire educational process. Research shows that students, schools, and parents benefit from this act. One of the most important factors for this process is the alignment of family and school. Both are great influencers in children's development (BRASIL, 1990).

Comer (1984) emphasizes the importance of parents in school and emphasizes the gain of formal learning for students. This results in a better school environment and reduces family conflicts with the school. The ECA approved in the early 1990s enshrined this right. However, this right was never implemented and was therefore little respected in schools. According to the ECA, parents could monitor their children's development and their assessments, in addition to being able to attend and participate in the pedagogical proposals developed at the school (BRASIL, 1990, Art. 53, Single Paragraph). Notwithstanding, it is important to point out that the participation of parents in school had a significant increase.

For that matter, in 1996, the Law of Directives and Bases of National Education (LDB), Law n. 9,394/96, following the process of parents' participation in schools, encouraged each school to propose greater collective participation of the local and school community, involving both in pedagogical projects and in school councils (BRASIL, 1996, Art. 14).

III. FINAL CONSIDERATIONS

This article discussed the concepts and definitions of the process of formulating and implementing public policies. The main purpose was to comprehend the entire process, from the birth of the public problem to its evaluation. This is crucial for the understanding of public policies, as well as all public policy cycles.

The problem answered in this article was “Based on the contributions of Stephen Ball, how is the process of formulating public education policies with popular participation? In addition, the research questions were as follows: What are public policies? What are the phases or cycles of public policy? Is popular participation important in the elaboration of education policies, based on school problems identified by local society?”

As a basic hypothesis, popular participation is considered to have a significant role in defining educational policies. Pontual (1995), Freire (1991), Silva (1998) e Paro (2005) demonstrate that popular participation is essential in school life because it brings out the local problems and needs. Henceforth, the problem is defined and specified giving coherence in the implementation and in the financial investments, providing a more adequate education policy.

The contributions of the sociologist Stephen Ball were essential to the discussion proposed, due to his fostering of the understanding of education policy. Nowadays, Ball is one of the sociologists to have the most relevant publications on the studies of educational policies in the United Kingdom besides other countries.

Stephen Ball's theory helps us to recognize that the theoretical and epistemological position changes the relevance of the object to the researcher. In his research, he presented robust arguments that support the shortcomings perceived in the studies of a positivist matrix, whose expectation is to drive “improvements” in the political-administrative processes through the management of implementing activities variables (ROSA, 2019, p.14).

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Profile of hospitalizations of women with heart failure in public hospitals in the municipality of Macapá, Amapá, 2016 to 2021

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Keywords— Sociodemographic profile, Internment, Cardiac insufficiency, Women.

Abstract— *Objective: describe the sociodemographic profile of hospitalizations of women with heart failure in public hospitals in the city of Macapá, Amapá. Method: Retrospective study, with a quantitative approach, analyzing the profile of 704 women hospitalized with heart failure in four public hospitals in the city of Macapá-AP, between July 2016 and July 2021. The Hospital Information System of the Health, through DATASUS and the Brazilian Institute of Geography. Results: The results indicate that females represented 42.25% of hospitalizations, 75.55% occurred in the Emergency Hospital, 63.3% of hospitalized women were over 60 years old; 33.78% were brown; and 73.25% were hospitalized as an emergency. Conclusion: It is concluded that although women represent a large audience in the city of Macapá, the demand for hospitalization is still low in relation to heart failure, but it has been growing in the age group from 60 years old, which demonstrates the need to implement policies public services in Primary Health Care for disease prevention.*

I. INTRODUCTION

Cardiovascular diseases (CVD) are one of the main causes of death for men and women in Brazil, accounting for about 20% of all deaths in individuals over 30 years of age, and 27.4% of hospitalizations in people over 60 years of age years, with congestive heart failure (CHF) being the main cause of hospitalization. [1] The entry of women into the labor market in the 1960s and social changes contributed to increased stress in the routine of this group, in addition to the adoption of habits such as smoking and poor diet, accompanied by a rapid rise in the female mortality rate, in which During this period, the mortality rate for women increased from 10% to 25%. [2]

Defined as a complex syndrome in which the heart loses the

ability to pump blood to the body to meet physiological metabolic needs, it causes twice as many deaths as all types of cancer, 2.5 times as many accidents and deaths from violence. [3]

Heart failure accounts for 8% of all deaths from CVD and in the period between 2001 and 2012, 3.96% of hospital admissions due to this heart disease in the country were found. Of these hospitalizations, the number of men and women were equivalent. Regarding age, 53% of hospitalized men were between 70-79 years old, while women were older from 80 years old and a slight increase in the third decade of life. [4]

This scenario demonstrates that the costs of hospitalizations for cardiovascular diseases are the highest among the main

causes of hospitalizations in Brazil, this is due to the increase in life expectancy and growth in the proportion of elderly people in the country, which tends to favor the incidence of CVD and increase of health costs in the elderly. [5]

The risk factors for CVD for both sexes are diverse, such as: sex, age, genetics, smoking, alcoholism, sedentary lifestyle and unhealthy foods. In addition to habits that aggravate the development of dyslipidemia, such as: overweight, insulin resistance, peripheral vascular disease and systemic arterial hypertension. [6] In addition, there are studies that point to the prevalence of hypercholesterolemia, hypertension and obesity in women. [7] Preventive measures aimed at reducing these factors directly impact a smaller number of cases of the disease. In this way, there is a significant reduction in the number of hospitalizations and deaths due to this pathology. [8]

Given the relevance of the topic for public health, it is essential to carry out a study on hospitalizations associated with heart disease, in order to direct health promotion policies for this gender. Thus, this study aimed to analyze the profile of women hospitalized with heart failure in public hospitals in the municipality of Macapá, in the State of Amapá, from 2016 to 2021.

II. METHOD

Retrospective study, with a quantitative approach, analyzing the profile of women hospitalized with heart failure in public hospitals in the city of Macapá-AP, between July 2016 and July 2021. The participating public health institutions were: Emergency Hospital, Children and Adolescents Hospital, Women's Hospital and Dr. Alberto Lima Clinics Hospital. The SUS Hospital Information System (SIH/SUS) was used as a data source, through DATASUS, available through the electronic address:

<http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sih/cnv/nipi.def> and the Brazilian Institute of Geography (IBGE).

To obtain the epidemiological profile of these hospitalizations, the following variables were analyzed: total hospitalizations, hospitalizations per year, incidence of hospitalizations, deaths, sex (female, male), age group and color/race (white, brown and black).

To analyze the statistical data, Word and Excel programs were used, the information was arranged in tables and for the discussion of the results, the available literature on the subject was used, based on the LILACS data network (Latin American and Caribbean Literature in Sciences), SciELO (Scientific Electronic Library Online), Ministry of Health and Brazilian Society of Cardiology.

There was no need for submission to the Research Ethics Committee as the data were made available by the Unified Health System and collected from a public domain database.

III. RESULTS

According to the projection of the Brazilian Institute of Geography (IBGE) the resident population in the capital Macapá in 2015 was 456,175, there was a larger female population compared to males with 230,076 and 226,099 people, respectively.

In that period, 704 admissions for heart failure were recorded in public hospitals in the city of Macapá, corresponding to 0.89% of the total of 78,841 admissions in the four hospitals in the city. Males stood out with approximately 57.55% and females with 42.45% of hospitalizations for HF. Regarding hospitalizations for HF in health facilities, the Emergency Hospital presented 75.55%, followed by the Hospital de Clínicas Dr. Alberto Lima with 21.45%. However, Hospital de Clínicas admitted more women than men, as shown in table 1.

Table 1: Hospitalizations for Heart Failure in Public Hospitals in the city of Macapá, according to sex, Amapá, July 2016 to July 2021.

Hospital Institutions	Male		Female		Total
	f (x)	f (%)	f (x)	f (%)	
Children and Adolescents' Hospital	01	0,14	02	0,28	0,42
Women's Hospital	03	0,44	01	0,14	0,58
Clinic's Dr. Alberto Lima Hospital	73	10,37	78	11,08	21,45
Emergency's Hospital	328	46,60	218	30,95	77,55
Total	405	57,55	299	42,45	100%

Source: Ministry of Health - SUS Hospital Information System (SIH/SUS) /DATASUS, 2021.

According to table 2, when the scenario of the municipality is observed, only in females, it was found that women over 60 years of age were responsible for 63.3% of

hospitalizations for heart failure in females in the period under study, with a more significant value in the age group from 60 to 69 years of approximately 26.10% of the total.

Table 2: Age group of women hospitalized for heart failure in Hospital Establishments in the city of Macapá - AP, July 2016 to July 2021.

Age Group	Admissions	
	f (x)	f (%)
Under 1 year	04	1,30
15 ----- 19	02	0,65
20 ----- 29	06	2,00
30 ----- 39	16	5,35
40 ----- 49	32	10,70
50 ----- 59	50	16,70
60 ----- 69	78	26,10
70 ----- 79	47	15,70
80 years and over	64	21,50
Total	299	100,00%

Source: Ministry of Health - SUS Hospital Information System (SIH/SUS) /DATASUS, 2021.

Among the color characteristic, it was noticed in table 3 that hospitalizations for heart failure in brown women predominated with 33.78% of the cases. Another relevant data is the lack of information regarding this characteristic

representing 61.50%, it is important to fill in this field given the prevalence of some diseases whose color variable is relevant.

Table 3: Color of women hospitalized for heart failure in public hospitals in the city of Macapá-AP, July 2016 to July 2021.

Women's color	F (x)	F (%)
White	05	1,67
Black	05	1,67
Brown	101	33,78
Yellow	04	1,38
No information	184	61,50
Total	299	100,00

Source: Ministry of Health - SUS Hospital Information System (SIH/SUS) /DATASUS, 2021.

Analyzing table 4 by the nature of care, it was found that 73.25% of the women hospitalized were through the Emergency Department and 26.75% in an elective way,

mainly at the Emergency Hospital and Dr. Alberto Lima Clinics, respectively, verified in the table 1.

Table 4: Hospitalizations of women due to heart failure, according to the nature of care, in public hospitals in the city of Macapá-AP, July 2016 to July 2021.

Service Character	F (X)	F (%)
Elective	80	26,75
Urgency	219	73,25
Total	299	100,00%

Source: Ministry of Health - SUS Hospital Information System (SIH/SUS) /DATASUS, 2021.

According to the data below, in table 5, the mortality rate due to heart failure in these health institutions varied from 10.55% in the Emergency Hospital to 21.79% in the

Hospital de Clínicas Dr. Alberto Lima. In the other institutions there were no records and in the municipality this average rate was 13.38%.

Table 5: Mortality rate of women due to heart failure, according to Hospitals in the city of Macapá-AP, July 2016 to July 2021.

Hospital institutions	Mortality rate
Clinic's Dr. Alberto Lima Hospital	21,79
Emergency Hospital	10,55
Total	13,38

Source: Ministry of Health - SUS Hospital Information System (SIH/SUS) /DATASUS, 2021.

IV. DISCUSSION

CVDs are the main causes of death among men and women in Brazil, with the Southeast and South regions having the highest mortality rates compared to the North, Northeast and Midwest.

Between 2008 and 2016, there were 2,171,286 hospitalizations for HF in Brazil for the same standardization. In the Northeast, the lowest average was identified in Sergipe, with 4.68, and the highest in Piauí, with 15.82. The Midwest region was the most homogeneous, with the highest rate in Goiás, 13.99, and the lowest in Mato Grosso do Sul, with 11.28. In the Southeast region, there are rates around 10 hospitalizations per 10,000 inhabitants, except for the state of Minas Gerais, which presented an average of 17.9 cases. In the South region, Santa Catarina had the lowest rate, 16.70, and Paraná, the highest, with 21.10 [9]

The total of 704 admissions for heart failure in public hospitals in the city of Macapá corresponded to 0.89% of the total admissions. HF was responsible for 2.54% and 2.25% of all causes of hospital admissions in Paraíba and Brazil, respectively. In Paraíba, the total number of hospital admissions for HF between 2008 and 2017 was 51,172, representing the main cause of hospitalizations for cardiovascular diseases (29.4%), followed by other ischemic heart diseases (13%), stroke (11%), primary hypertension (10%) and acute myocardial infarction (5%). [10]

In this study, there was a predominance of males, although females had a high percentage. In Brazil, in the last five

decades there was a higher prevalence among men, and later women have been more affected, worsening with advancing age. [1] A similar proportion was found between men and women, differing from the information found in the Breathe study, carried out in 2015, in 51 Brazilian hospitals, both public and private, in which 60% of the patients were female. This difference may have occurred because the period analyzed in this study was longer, in addition to covering all hospitals that provide information to DATASUS. [12]

In the city of Macapá, women over 60 years old were responsible for 63.3% of hospitalizations for HF, being more significant in the age group from 60 to 69 years old, with approximately 26.1% of the total.

In the general public in Brazil, in the period from 2010 to 2019, there was a predominance of 25.9% among individuals aged between 70 and 79 years, 23.1% between 60 and 69 years and 21.3% in those over 80 years [12].

It is relevant to analyze that CVD accompany population aging, especially in women. Although cancer is still the biggest concern in this public, the highest incidence of death in women is in cardiovascular diseases (53%) compared to breast cancer (4%). According to the Ministry of Health, acute myocardial infarction and stroke are the main causes of death in Brazilian women over 50 years of age, the most vulnerable being in the postmenopausal period. [13] In addition, the presence of several modifiable risk factors deserves attention in prevention, such as smoking, dyslipidemia, obesity, metabolic syndrome, sedentary lifestyle, arterial hypertension and diabetes mellitus. [14]

In this study, there was a high rate of lack of information, followed by a predominance of brown color. A study carried out in Piauí found the absence of records of this information in 72.6% of hospitalizations, 25.2% were brown, 0.52% were white and 1.0% were black. [15]

Regarding the reproductive period of women, several authors consider that although female hormones have protective activity in the pre-menopausal period, it has now been found that vascular impairment can start in the female population even in youth, when associated with some factors, such as contraceptives oral diseases, polycystic ovary syndrome, obesity and smoking, contribute to health weaknesses in this population and increase the risk for CVD. [7]

This high prevalence of risk factors for CVD in the female population may be related to the insertion of women in the labor market, exposing them to a sedentary lifestyle, smoking and inadequate eating habits. In addition to the overload of responsibilities in family care and domestic activities. [6; 16]

There is an evident need to invest in health promotion and prevention actions, which provide more information to individuals about risk factors, in order to raise awareness of behavioral changes and favor aging with quality of life. [16] Physical inactivity is directly associated with the risk of increased cardiovascular diseases, and it is essential to maintain the ability to move efficiently through physical exercise, which favors the reduction of sedentary lifestyle and the progress of chronic degenerative pathologies. [17]

V. CONCLUSION

Knowing the profile of women who are being hospitalized in hospital units is of great relevance for health planning, seeking to direct care assistance to the existing demand for this demographic group. The percentage of hospitalizations for heart failure in the city was more expressive in the male population, but it is observed that elderly women aged 60 years represent an important number of hospitalizations, mainly due to the risk of complications.

Such hospitalizations and complications generate a burden on the health system and quality of life of these elderly women, so it is necessary to act on changing habits and eliminating risk factors highly prevalent in the female population, such as a sedentary lifestyle, smoking and decompensated blood pressure. For this, the performance of primary health care is essential, in order to prevent the progression of underlying diseases and intervene in the different levels of health prevention, in order to reduce mortality from cardiovascular diseases in the female public.

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Impact of Coronavirus Disease (COVID-19) towards Hotel Tourism Industry

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Keywords—*Coronavirus Disease, COVID-19,
Hotel Industry, Tourism Industry, Supply
and Demand.*

Abstract— *The coronavirus disease (COVID-19) that spreading over worldwide in year 2019, give significant impact towards global economics. In addition, there movement control gives negative impact towards global economic development. Therefore, this study evaluated the impact of COVID-19 towards hotel tourism industry as the most effected sector due to restriction of movement. This study collected data about two companies that involve in hotel tourism industry, both of the companies show negative movement of share price that indicates the declining profit. In the same time, this study developed supply and demand curve simulation regarding the effect of COVID-19 towards hotel tourism industry. The simulation indicates, the decrement of demands creates decrement of price of hotel according to market equilibrium. When the price is reduced, many hotels shrinking their operation that creates lower supply to balance the changes of price. Therefore, at the market equilibrium during COVID-19 outbreak, the hotel tourism industry suffering lower demand and facing lower price for hotel services. This situation creates the hotel industry is dealing with an unprecedented crisis due to the disruption caused by the global COVID-19 pandemic. This study contributes the advancement of literature of COVID-a9 effect towards global economy. In addition, the findings of this study will help government to provide suitable policy in helping hotel tourism industry to survive in current economic situation. This study also helping hotel industry in planning their financial management to make sure hotel industry can be survive until the post COVID-19 situation.*

I. INTRODUCTION

The current scenario of COVID-19 outbreak give impact on the growth of hotel tourism industry worldwide. For instance, a hotel industry in Malaysia was experienced in facing a high loss of income during COVID-19 outbreak. The high loss happened in hotel tourism industry was due to the implementation of Movement Control Order (MCO) by Government of Malaysia since 18 March 2020. From January until March 2020, the tourists withdrew 170,084 rooms booking, that give impact on the significant fall of revenue of RM 68,190,364 (Waisul

Karim, 2020). While, in Kuala Lumpur city that is the hub of hotel industry and famous for tourism also face with the significant loss of RM 23,021,301 by cancelling rooms of 55,050 rooms (Zubair and Shamsudin, 2021). Therefore, management team need to plan a good strategy to overcome the loss happened in hotel tourism industry during COVID-19 outbreak. As suggested by Cabral and Marques (2022), innovation in the hotel tourism industry can improve customer satisfaction. In addition, innovation also can improve customer service and loyalty, increase productivity, reduce costs and create opportunities

in the face of challenge (Brooker and Joppe, 2014; Wikhamn, 2019).

Hotel tourism industry have a good potential to develop in Malaysia due to the demand from tourists to visit the natural place in Malaysia (Abu Bakar, et al., 2020a). Tourism industry is the third-largest contributor to Malaysia's Gross Domestic Product (GDP). In year 2019, tourism industry contributed 15.9 per cent to the total GDP in Malaysia (Malaysian Investment Development Authority, 2021). However, the COVID-19 outbreak gives huge impact to the Malaysian tourism industry, which led to the cancellation of the "Visit Truly Asia Malaysia 2020" campaign that planned by government to be launched on year 2020. Various strategy was planned by government to encourage tourists to visit Malaysia. Therefore, government of Malaysia was launched the National Tourism Policy (NTP) 2020-2030 on 23 December 2020, to ensure the continuity of the country's tourism industry and make Malaysia a preferred tourist destination globally. Therefore, this study was developed to investigate the impact of COVID-19 outbreak towards hotel tourism industry as the most effected industry in Malaysia.

II. LITERATURE REVIEW

Various studies were established to investigate the impact of COVID-19 outbreak toward the economic development (Abu Bakar and Rosbi, 2021a; Nguyen, et al., 2021; Abu Bakar and Rosbi, 2020a). Most of researchers found that COVID-19 outbreak give an impact on the growth of economic development worldwide (Zaheer, et al., 2022; Khan Jaffur, et al., 2022). Researchers also suggested that government need to provide a suitable policy to overcome the impact happened during COVID-19 outbreak (Saif-Alyousfi, 2022; Abu Bakar and Rosbi, 2021b; Abu Bakar and Rosbi, 2020b).

According to Le and Nguyen (2022), COVID-19 outbreak gives negative impact on the business continuity, where the industry is unable to maintain during or after COVID-19 outbreak. Furthermore, COVID-19 outbreak also led to the impacts on the socio-economic (Nicola, et al., 2020). Le and Nguyen (2022) also mention that, socio-economic life has been disrupted and businesses are struggling with the risk of closing down or discontinuing their operations. The performance of stock market also important in determine a growth of economic. Therefore, study that investigate the impact of COVID-19 outbreak on the performance of stock market also revealed that COVID-19 outbreak has significant negative impact on stock returns (Ofori-Boateng, et al., 2021). Besides that, study from Mushafiq (2021) regarding Pakistan Stock Exchange found that commercial banks, insurance

industry, real estate industry and textile industry were also badly affected by the COVID-19 outbreak. While, Rakshit and Neog (2021) study the impact of COVID-19 on the exchange rate volatility in Brazil, Chile, India, Mexico and Russia. They found that negative and significant effect of COVID-19 on the market return with parallel with others study.

Currently, most of the tourism literature focuses on the influencing factors of tourism industry (Khan Jaffu, et al., 2022; Abu Bakar, et al., 2020b) and discusses the impact of COVID-19 outbreak (Seker, 2022; Abu Bakar and Rosbi, 2020c). Studies that are focusing on the tourism industry found that COVID-19 outbreak has a bad impact on the socio-economic (Abdel Maksoud, et al., 2022; Aduhene and Osei-Assibey, 2021; Ozili, 2020). This is due to the MCO implement by most of country worldwide. As a result, countries all around the world established stringent travel restrictions and closed their borders, effectively halting international travel (Jafari, et al., 2021; Mao et al., 2021; Peterson et al., 2021). Parvin, et al., (2021) found that COVID-19 outbreak has a huge negative impact on the tourism industries in terms of earnings reduction.

Tourism industry is the most effected industry due to the spread of COVID-19 virus. Compared to other industries, lockdown and social distancing policies implemented by most of country worldwide directly caused steep declines in tourism industry (He, et al., 2021). Study by Skare, et al., (2021) regarding the impact of the COVID-19 outbreak on the tourism industry worldwide. They suggested that private and public policy support must be coordinated to assure capacity building and operational sustainability of the travel tourism. Moreover, tourism managers must carefully assess the effects of epidemics on business and develop new risk management methods to deal with the COVID-19 crisis. Peterson et al., (2021) reveal that among the health pandemic and economic effect due to COVID-19 outbreak, tourism and hospitality industries are one of the hardest struck due to several interrelated factors, including travel restrictions, national lockdowns, business closures and the subsequent impact on lives and livelihoods. Therefore, Wen, et al., (2021) suggested the new forms of tourism such as slow tourism and smart tourism may also drive future tourism activities. Tourism industry need to reconsider their service designs and distribution channels in order to attract tourism to visit their country.

III. IMPACT OF COVID-19 TOWARDS SHARE PRICE FOR HOTEL TOURISM INDUSTRY

The COVID-19 has affected every sector across the globe, and the hotel tourism industry is among the hardest hit. This study evaluated the effect of COVID-19 outbreak towards movement of share price among company of hotel tourism in Malaysia. Two companies selected from Kuala Lumpur Stock Exchange in detecting the impact of COVID-19 towards stock market especially in hotel tourism industry.

Company A operates hotels and resorts that focusing on tourism industry. Figure 1 shows the dynamic behavior of share price starting from January 2020 until October 2021. These monthly observation periods are selected because in this period Movement Control Order (MCO) are declared by government in preventing the spreading of Coronavirus disease.

The number of observations is 22 months. The first observation in January 2020, shows the value of share price is MYR 4.908. This value is the average share price value for particular month.

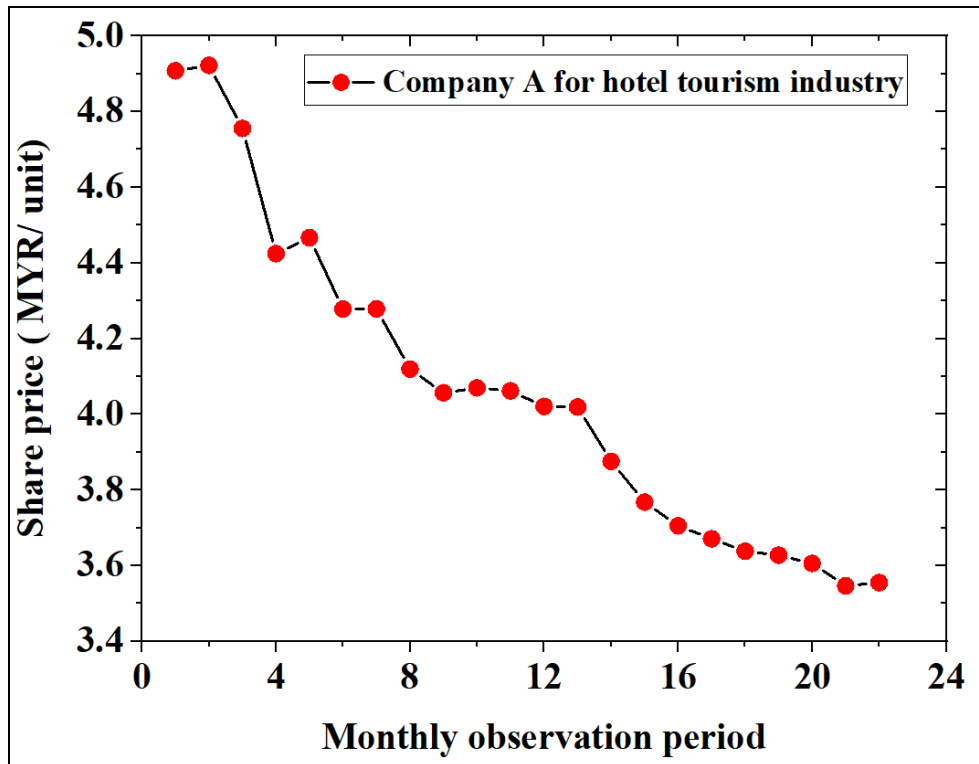


Fig. 1: Share price for company A of hotel tourism industry

The last observation is on the October 2021 with the value of share price is MYR 3.555. The percentage of changes calculated using Equation (1).

$$\begin{aligned}
 \% \text{ Changes} &= \frac{P_{last} - P_{first}}{P_{first}} \times 100\% \dots\dots\dots (1) \\
 &= \frac{3.555 - 4.908}{4.908} \times 100\% \\
 &= -27.76\%
 \end{aligned}$$

The decrement of share price indicating the financial asset is suffering loss. In this situation, -27.76% occurs for share price that indicating hotel tourism company was suffering financially during COVID-19 outbreak.

From the financial perspective, this company need some remedy in adjusting their financial management to make sure this company can survive until the economy situation is stable. This company can employ linear programming model in managing their operation that focusing re-checking the staff allocation and fund optimization.

Next, this study performed share price analysis for another company to evaluate the effect of COVID-19 outbreak towards hotel tourism industry. The company B is listed on Kuala Lumpur Stock Exchange in Malaysia. This company B is providing the leading award-winning business class hotel with 5-star services in Kuala Lumpur, Malaysia.

The analysis involving 22 monthly observations starting from January 2020 until October 2021. Figure 2 shows the movement of share price for company B that involved in hotel tourism industry. The first observation in January 2020 shows the value of share price is MYR 0.228. This value declined until reaching the minimum value of MYR 0.052 at 19th observation which is on July

2021. The last observation indicates the value of share price is MYR 0.081 on October 2021.

Figure 2 shows the movement of data of share price for company B that involved in hotel tourism industry. The trend of the movement shows significant decrement trend during COVID-19 outbreak.

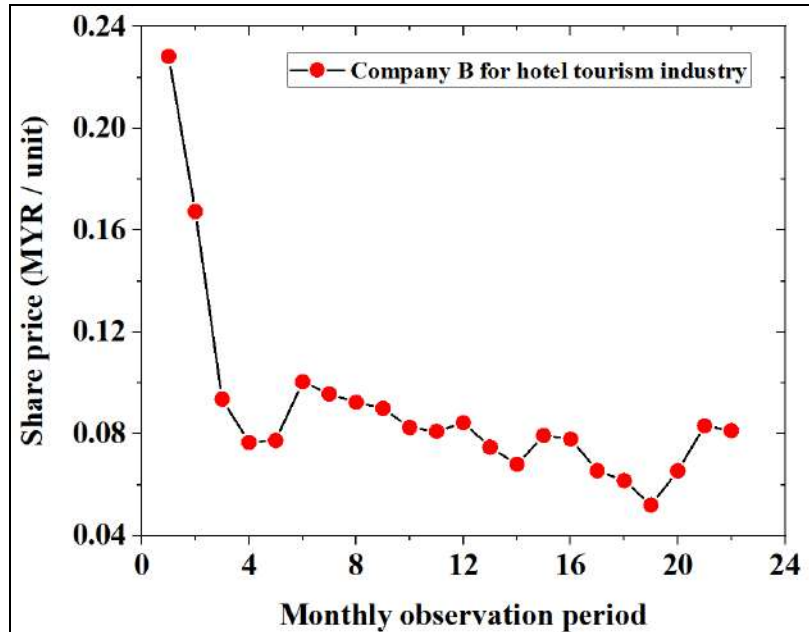


Fig. 2: Share price for company B of hotel tourism industry

The calculation of percentage of changes indicates in Equation (2).

$$\begin{aligned}
 \% \text{Changes} &= \frac{P_{last} - P_{start}}{P_{start}} \times 100\% \dots\dots\dots (2) \\
 &= \frac{0.082 - 0.228}{0.228} \times 100\% \\
 &= -64.04\%
 \end{aligned}$$

In Equation (2), the variables are described as follows:

P_{last} : Value of share price for last monthly observation.

P_{start} : Value of share price for first monthly observation.

Figure 1 shows the percentage of changes is -64.04 percentages. This value indicates there is significant drop in share price for company B. Therefore, company B need to perform some remedy in improving financial status including marketing. The company B needs to develop new business strategy to survive in current situation.

IV. IMPACT OF COVID -19 TOWARDS DEMAND AND SUPPLY IN HOTEL TOURISM INDUSTRY

The theory of supply and demand is a relationship that explains the interaction between the sellers of a product or service, and the buyers for that product or service. The theory of demand says that at higher prices, buyers will demand less of a product or service. In addition, the theory of supply explains that at higher prices, sellers will supply more of a product or service.

In microeconomics, the supply-demand law is an economic model of price determination in a market for a product or service. It explains that, holding all else equal, in a competitive market, the unit price for a particular good, or assets, will vary until it settles at a point where the quantity demanded (at the current price) will equal the quantity supplied (at the current price), resulting in an economic equilibrium for price and quantity transacted. It forms the theoretical basis of modern economics. This theory is applicable in analyzing the relationship between supply and demand for hotel tourism industry.

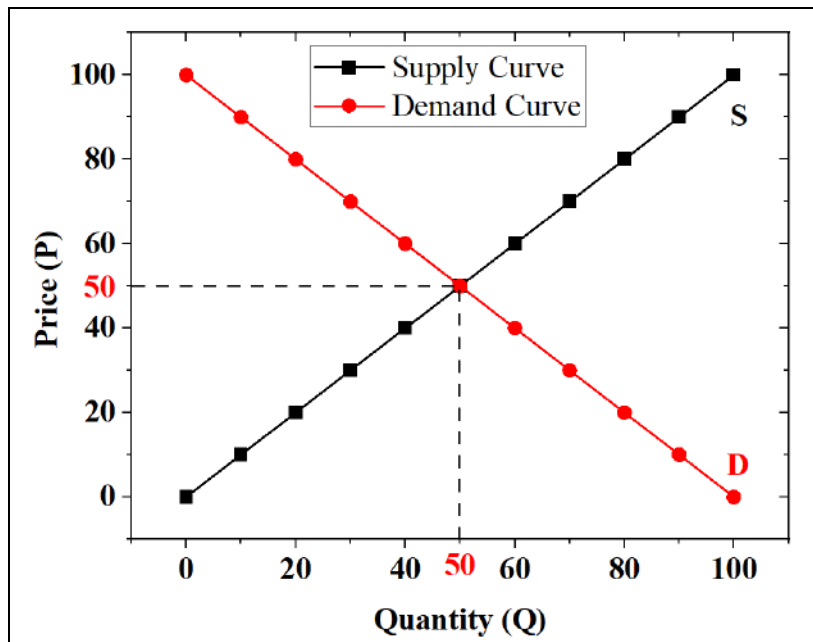


Fig .3: Supply and demand curve for hotel tourism industry

Figure 3 shows the demand and supply curve for hotel tourism industry. The market equilibrium achieved at when the Price (P) at 50% and the Quantity (Q) at 50%. The tendency to move toward the equilibrium price is known as the market mechanism, and the resulting balance between supply and demand is called a market equilibrium.

Figure 3 indicates the slope of Supply (S) is assumed at value of 1 which is unitary elastic. In the same time, the slope of Demand (D) is assumed at -1 that indicates negative slope.

The equation for price elasticity is shown in Equation (3) and (4).

$$elasticity_{demand} = \frac{\% \Delta Q_{demand}}{\% \Delta P} \dots\dots\dots (3)$$

$$elasticity_{supply} = \frac{\% \Delta Q_{supply}}{\% \Delta P} \dots\dots\dots (4)$$

In Equation (3) and (4), the parameter of Q is quantity and P is price.

Next, this study evaluated the movement of market equilibrium because of COVID-19 outbreak. In this calculation, this study considered Price (P) is in percentage. In addition, the Quantity (Q) also is considered in percentage.

Figure 4 shows the supply and demand curve for hotel tourism industry during COVID-19 outbreak. Figure 4 show the function of demand shift to new location and labelled as D2. This condition occurs because the

decrement of demand during COVID-19 outbreak including restriction of movement. The movement control order contributed to decrement of sales for hotel tourism industry because visitors were not allowed to travel further away from their residential areas. Therefore, lower quantity was demanded by customers during the COVID-19 outbreak. This situation contributes lower demand that shifted the demand function to lower value.

Market equilibrium drop to value of 30 percentage of Price (p) and 30 percentage of Quantity (Q). Next, this study calculated the changes in price using Equation (5).

$$\begin{aligned} \Delta P &= \frac{P_{t+1} - P_t}{P_t} \times 100\% \dots\dots\dots(5) \\ &= \frac{30 - 50}{50} \times 100\% = \frac{-20}{50} \times 100\% = -40\% \end{aligned}$$

The drop of price is 40% from the initial market equilibrium.

A market is in equilibrium if at the market price the quantity demanded is equal to the quantity supplied. Equilibrium is the state in which market supply and demand balance each other, and as a result prices become stable.

In this situation, the company need to introduce marketing strategies including digital marketing approach using social media. The government also need to support the hotel tourism industry with incentive and policy to encourage visitors to travel and using hotel services.

Therefore, the collaboration between industry and government is crucial to achieve good economic situation.

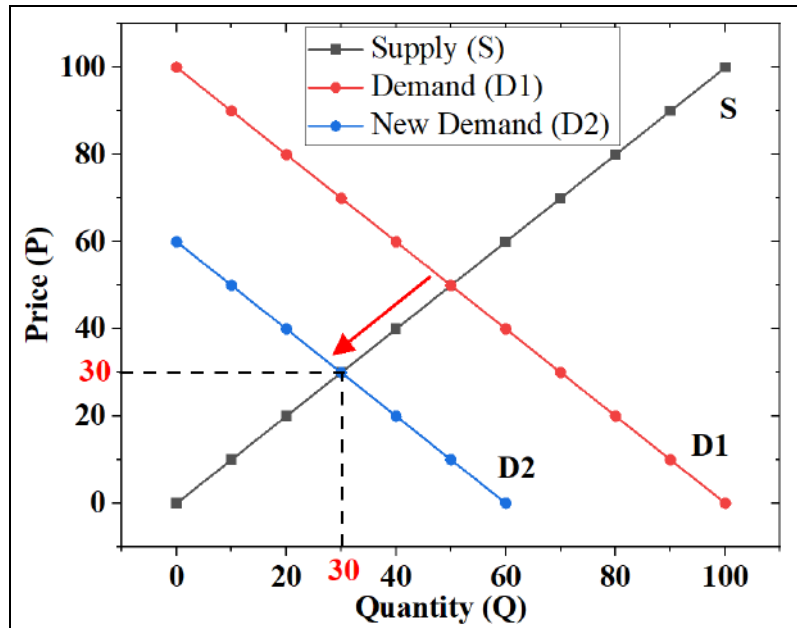


Fig .4: Supply and demand curve for hotel tourism industry during COVID-19 outbreak

V. CONCLUSION

The objective of this research is to evaluate the impact of COVID-19 outbreak towards hotel tourism industry. This study evaluated the share price movement during COVID-19 outbreak. In addition, this study analyzed the impact of COVID-19 outbreak towards hotel tourism industry using demand and supply curve.

The main findings of this study are described as follows:

- (1) There is significant drop of share price for two companies that involved in hotel tourism industry. The company A experienced -28 % and company B shows -64 % of share price decrement. Both of this company is mainly focus on hotel business.
- (2) The decrements of share price were contributed by movement control order that limit the tourist to stay in the hotel. In addition, the COVID-19 spreading creates uncomfortable feeling for tourists to travel during the COVID-19 outbreak situation.
- (3) Next, this study performed simulation of supply and demand curve for hotel tourism industry. In normal situation, the market equilibrium achieved when the value of Price (P) is at 50 % and value of Quantity (Q) is 50%). Equilibrium is the state in which market supply and demand balance each other, and as a result prices become stable.
- (4) However, the COVID-19 outbreak had changed the landscape of economic worldwide. The

demand curve for hotel tourism industry dropped significantly. This is contributed by the tourists were unable to moving far away from their locality and residential. The simulation of calculation shows the price change to negative 40 percentages. This value gives negative impact towards hotel tourism industry during COVID-19 outbreak. Both of companies were struggled in surviving financially during the COVID-19 outbreak.

As the solution to this situation, a few recommendations are suggested to industry players and government body. The companies should increase their promotion and marketing using digital social platforms. In the same time, the companies should look at their operational cost to optimize financial management. In the same time, government could provide incentives and policy that encourages the tourists to travel and using hotel tourism facilities and services.

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Chlorpyrifos Toxicity in Sheep and Effect of *Corchorus Olitorius*

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Keywords— *Chlorpyrifos, Acetylcholine
esterase, Toxicity, Corchorus olitorius,
Sheep.*

Abstract— *The organophosphorus compound chlorpyrifos is widely used in southern Libya for pest control. Chlorpyrifos poisoning in sheep is very rare, however accidental poisoning could happen. The parent compound chlorpyrifos is not very toxic until metabolized to the toxic form which known as chlorpyrifos oxon. The delayed clinical signs of chlorpyrifos toxicity increase mortality rate due to the delayed treatment regime. Exposure of sheep to chlorpyrifos mainly develops nervous system toxicity accompanied with other systems toxicity including respiratory, cardiovascular and digestive system. Bowel evacuation by using blend of corchorus olitorius reduces chlorpyrifos toxicity and improves the animal health*

I. INTRODUCTION

Organophosphorus pesticides are widely used in agriculture as an alternate for organochlorine and other insecticides due to its high efficiency and lower persistence in the environment (Rao et al 2003). Chlorpyrifos is also used to control house pest through applying it around the buildings and the indiscriminate uses lead to potential adverse effects on human and animal health by and over the time (Kammon et al 2011). Chlorpyrifos is an organophosphorus pesticide, undergoes to metabolic activation inside the body producing toxic substance called chlorpyrifos oxon (Abo-donia et al 1996). Chlorpyrifos oxon is 10-100 times more toxic than chlorpyrifos and acts on acetylcholine esterase with high affinity compared to other organophosphorus compounds (Sparling and Feller 2007) and depresses its activity (Banaee et al 2013), and thereby affecting neuromuscular function of the organism, the toxic effect of acetylcholine inhibitor is caused by disruption of nervous system function due to accumulation of an excessive amount of acetylcholine in the synapse leading to muscle twisting and paralysis, low-level exposure to chlorpyrifos is linked

with numerous physiological and behavioral changes (perez et al 2013). The oxon form of chlorpyrifos has also a negative effect on other body systems including the respiratory and digestive system (Banaee et al 2013). Nausea, vomiting, salivation, diarrhea and muscular tremor were observed in animal exposed to chlorpyrifos whereas in the chronic form animals show weight loss and decreased productivity (Akhtar et al 2009). Chlorpyrifos toxicity increase lipid peroxidation and decrease antioxidant enzymes activity, intramuscular injection of vit C, vit E and melatonin reduce toxic effect of chlorpyrifos (Karaoz et al 2002). Several antioxidants including phenolics were detected in *corchorus olitorius* and suggested to have potential effect in scavenging of free radical and health improving (Adedosu et al 2015). Atropine and pralidoxime have classified as effective antidotes for acute toxicity of chlorpyrifos and distinctively improve cardiorespiratory components impairments induced by acute chlorpyrifos poisoning (Felippe et al 2020).

II. CASE REPORT

A total of 6 rams have accidentally accessed an emulsion of chlorpyrifos (100 ml of dorsban 48% EC in 20 L of water) prepared for pests control in an alfalfa farm located in southern Libya. Eurolax which acts as laxative, appetizer, anti-acid and detoxicant was given orally at dose of 2g/kg twice daily for 2 days. Animals were also injected with multivitamin (oligovit) from KELA and dexamethasone 200 mg (dexavet) from ANVET PHARMA JSC at dose of 1ml/20kg and 1ml/10kg respectively. Among the six rams, 2 rams were treated with multivitamins. Fluid therapy was given to one of the severely affected rams, all animals were kept under supervision for three days and the animals were also kept under the similar environmental condition. A blend of corchorus olitorius was given to the severely affected animals. Temperature, respiration and heart rates were also measured. The mildly affected animal which shows less clinical sign has only received multivitamin without eurolax and dexamethasone due to the owner request. No atropine or pralidoxime were administered to the intoxicated rams as veterinary service was limited in that area.

Following 24 hours of exposure to chlorpyrifos, toxicity was developed. 5/6 (83%) of the rams showed signs of toxicity presented by dullness, loss of appetite and tremor at the early stage which estimated from 24-36 hours. One ram was fastened and did not show any toxicity signs, among the 5 intoxicated rams; 4 rams showed signs of acute toxicity, and one ram showed signs of mild to moderate toxicity. Decreased bowel movement was observed in the poisoned animals. At the advanced stage which estimated from 36 hours and over, the intoxicated rams showed bloat, irregular rapid respiration with interrupted heart beats terminated with death. Temperatures of the affected animals were normal with average of 39.1 degree centigrade, respiration rate was about 85 per minute and heart rate was 76 beats per minutes. Irregular heart beat and disturbed respiration were characteristic. Faeces of the poisoned rams were sticky and covered with white grey material. Bowel movement with passing of smooth watery faeces was observed in the animal which received corchorus olitorius. Miosis was also observed in the poisoned rams. Nervous manifestations such as digging in ground and water containers accompanied with restlessness were seen in the moderately affected ram. Mortality rate was high as 80% of the animals have died even receiving intensive care. The animals have died in a time period ranged from 40-72 hours of toxicity; the severely intoxicated rams died after 40 hours, while the mildly intoxicated ram which did not received neither Eurolax nor Corchorus olitorius has died after 68 hours. The severely poisoned ram which showed

bowel movement after receiving blend of Corchorus olitorius remained alive.

III. DISCUSSION

The parent compound of chlorpyrifos oxon is not very toxic (Sparling and Feller 2007) as clinical signs of intoxication appeared after 24 hours of exposure to chlorpyrifos. Metabolic activation of chlorpyrifos by cytochrome P450 leads to formation of chlorpyrifos oxon (Heikal et al 2013) which is 10 times and over more toxic than the parent compound (Sparling and Feller 2007). Exposure of animals to chlorpyrifos produces signs of acetylcholine toxicity due to inhibition of acetylcholine esterase activity at the synapses (Palanikumar et al 2004). Toxicity signs of acetylcholine in the intoxicated rams were presented by dullness, loss of appetite, frequent urination, miosis and tremor at the early stage which estimated from 24-36 hours. Neurotoxicity is characteristic for chlorpyrifos toxicity (Karaoz et al 2002) and this study has completely agreed with Karaoz and colleagues as clear nervous manifestations such as digging in ground and water containers accompanied with restlessness were seen in the intoxicated ram. Severity of organophosphorus compound toxicity is a dose dependent (Eskenazi et al 1999); among the intoxicated animals 4 rams showed signs of acute toxicity, and the heaviest ram showed signs of mild to moderate toxicity. At the advanced stage which estimated from 36 hours and over the intoxicated animals show several symptoms such bloat, irregular rapid respiration with interrupted heart beats terminated with death, these symptoms were also stated by Mohamed 1990. Mohamed 1990 and Yadav et al 2018 have demonstrated occurrence of catarrhal and necrotic enteritis in chlorpyrifos intoxicated animals respectively, in this study we observed that faeces of the poisoned rams were sticky and covered with white greyish material which is an indicator of catarrhal necrotic enteritis. Despite several studies found that diarrhea is a main sign of acetylcholine toxicity, no any of the intoxicated rams showed diarrhea and decreased bowel movement was observed in the all poisoned rams. Following administration of corchorus olitorius, bowel movement was stimulated and the intoxicated-ram passed dark green smooth watery feces followed by health improvement unlike the other rams which died even receiving several medications without blend of corchorus olitorius. Previous study has also demonstrated benefit of corchorus olitorius for bowel movement (Nagahara et al 2020). Based on these observations, corchorus olitorius can be used as a powerful agent for reducing chlorpyrifos toxicity and

decreasing mortality rates particularly in regions with poor veterinary services.

IV. CONCLUSION

Accessing of animals to Chlorpyrifos develops cholinergic toxicity. Treatment with Eurolax was not successful; the all Eurolax-treated animals have died, however the Corchorus Olitorious treated animal remained alive. Accordingly, corchorus olitorious can be considered as an important agent for Chlorpyrifos toxicity control particularly in areas with limited veterinary services.

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Challenges and Perspectives of Entrepreneurship in Nursing

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Abstract— The study aimed to investigate in the scientific literature the challenges and perspectives of nurses' performance in nursing entrepreneurship. This is a bibliographic, descriptive research with a qualitative approach. The search in the scientific literature was carried out from May to July 2021 in two databases: SCIELO (Scientific Electronic Library Online) and LILLACS (Latin American and Caribbean

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Keywords—Challenges, Entrepreneurship, Nursing.

Literature in Health Sciences). The descriptors in Health Sciences (DeCS) used in the search for data consisted of: challenges, entrepreneurship and nursing. Nine publications were analyzed in full, which suited the purpose of the study. The study made it possible to identify that the entrepreneurial nurse is a reality on the rise. There are numerous advances, challenges and entrepreneurial practices in nursing, an extensive field that allows nurses to work promoting health to the population. Offices, home care, consulting and audits are some of the examples that enable the professional nurse to act independently, innovatively and entrepreneurially.

I. INTRODUCTION

In recent decades, the field of entrepreneurship has advanced considerably, mainly due to economic changes, technological innovations and globalization [1, 2]. This scenario points out ways to be explored by different professionals, in particular, nursing professionals.

In this context, it is understood that Entrepreneurship is related to the creation or improvement of something, providing benefits to the individual and society [2]. For some authors, entrepreneurship consists of a set of practices adopted in order to guarantee the generation of wealth and the best performance of societies [3]. For others, entrepreneurship is the process of creating something new with value, innovating, daring, dedicating the necessary time and effort [4, 5].

In Brazil, entrepreneurship began to receive more attention in the 1990s, a period in which there was an increase in national and international market demand associated with technological advances [6].

It is observed in the national and international market that, currently, the entrepreneur is related to the exploration of new opportunities, to social and institutional responsibility, enabling the progress of new technologies and management procedures and social inclusion [3, 7].

To accompany this new scenario, nurses must know how to identify opportunities, and seek the necessary resources to transform them into business, that is, they increasingly need to dare and visualize new spaces, leading new fields and practices of professional activity.

The nurse is recognized as a liberal professional, through a ministerial opinion established in 1946, in which it was decided to release it also for autonomous practice [8].

The operation of nursing offices and clinics, which provide nursing services and consultations, is regulated by the resolution of the Federal Nursing Council (COFEN) No. 568 of 2018 [9]. These establishments must be registered as companies with the regional nursing councils, being exempt from annuity payments. Configuring in

possibilities of action of nursing professionals in the job market.

Currently, it is known that the labor market in Brazil is in an economic and political crisis, perceived by the increase in unemployment. According to a survey carried out in Brazil in 2016, out of a total of 414,712 nursing professionals, 12.4% of nurses reported unemployment in the last 12 months, and 78.9% reported difficulty finding a job [10]. There is concern about the saturation and stagnation in the area, becoming a reality to be faced. In addition, there is an intensive commodification in the health area and the transfer of public investment to the private environment [11], which leads to new paths to the nurses' job market, which must be taken into account by future professionals.

In this perspective, realizing the importance of knowing the job opportunities in the nursing area and considering that it is from the knowledge of a science that it can be understood and delimited new directions, the following guiding question was delimited: What are the challenges and perspectives of entrepreneurship in nursing?

The study aimed to investigate in the scientific literature the challenges and perspectives of nurses' performance in nursing entrepreneurship.

II. METHODOLOGY

It is a bibliographical, descriptive research, with a qualitative approach, defined in a research alternative that proposes to seek and analyze published knowledge regarding a specific topic.

The search in the scientific literature was carried out from May to July 2021 in two databases: SCIELO (Scientific Electronic Library Online) and LILLACS (Latin American and Caribbean Literature in Health Sciences). The descriptors in Health Sciences (DeCS) used in the search for data consisted of: challenges, entrepreneurship and nursing.

The inclusion criteria defined for the selection of articles were: full texts published in a journal indexed in the Portuguese language, in the last 12 years. Subsequently, an initial analysis of all the articles found was performed, by reading the titles and abstracts and articles unrelated to the theme were excluded.

The review of selected databases resulted in thirty-five publications. Considering the inclusion and exclusion criteria, twenty-six articles were excluded from the study. Dissertations and theses were excluded. Thus, nine publications were analyzed in their entirety, which suited the purpose of this bibliographic research. The

presentation of the results and discussion of the data obtained were presented in tables and later analyzed in the light of the relevant literature on the subject.

III. RESULTS AND DISCUSSION

Nine studies that met the previously established inclusion criteria were analyzed. Next, Table 1 will be presented, which contains a synthesis of the productions.

Table 1: Synthesis of included studies according to author, year of publication, title, objectives and conclusions.

Authors	Year	Title	Objectives	Conclusions
Patriota; Santos; Rosa [4]	2018	The importance of entrepreneurship for the professional nurse	To analyze the importance of entrepreneurship for the professional nurse.	It is inferred that there is a lack of literature on entrepreneurship in its broad concept and also in nursing.
Andrade; Bem; Sanna [2]	2015	Entrepreneurship in Nursing: panorama of companies in the State of São Paulo	To identify and characterize the nursing companies managed by business nurses, registered with the Board of Trade of the State of São Paulo until 2011.	The study made it possible to identify that the entrepreneurial nurse is a reality on the rise from the identification of 196 companies opened by this professional, later analyzing the time of existence, the main economic activity of the company, capital value, percentage of nursing partners and the distribution of companies by region of the State of São Paulo.
Fonseca; Araújo; Olivindo [12]	2020	Entrepreneurship in Nursing: motivations and possibilities for nurses to undertake	To analyze in the literature the field of action of nurses in entrepreneurship in Nursing	Entrepreneurial entrepreneurship emerges as an innovative area of work for nurses in the labor market, enabling independence and professional autonomy, in addition to development of concepts that stimulate students and professionals in the field of nursing to enhance, improve, and strengthen entrepreneurial actions as an alternative of professional growth.
Colichi; Lima; Bonini; Lima [13]	2019	Business entrepreneurship and Nursing: integrative review	Identify the knowledge produced on business entrepreneurship in Nursing.	There is a need to prepare nurses with adequate skills to increase their ability to integrate into the labor market and improve their own well-being and that of society.
Colichi; Lima [14]	2018	Entrepreneurship in nursing: comparison with other health professions	To characterize nursing companies and other health professions, comparing indicators	The indicators reinforce the need to include entrepreneurship content in undergraduate nursing courses, with a view to preparing for new job markets.

			related to entrepreneurship among these professional categories.	
Chagas; Milagres; Silva; Cavalcante; Oliveira; Santos [15]	2018	Business entrepreneurship among nurses	To characterize business entrepreneurship among nurses.	Business entrepreneurship among the nurses studied was a professional opportunity seen from the need for profitability and personal satisfaction, which forced them to move away from traditional work niches.
Bolina [16]	2019	Nursing in the contemporary socio-political and economic context: stimulating private entrepreneurship and/or strengthening social entrepreneurship?	Provoke some questions in order to reflect on which path(s) we want to tread for the edification of Brazilian nursing.	It is necessary that nursing guide its political-legal project, in order to critically reflect on the relationship of public and collective interest to the detriment of economic and corporate interests.
Erdmann; Stein Backes; Alves; Albino; Farias; Guerini; Abe; Cordeiro; Pudell [17]	2009	Training entrepreneurs in nursing: promoting socio-political competences and skills	Analyze and discuss concepts and characteristics related to entrepreneurship.	The exercise of teaching focused on active methodologies can be an important way to foster new entrepreneurial possibilities for the area of nursing/health.
Santos; Bolina [18]	2020	Entrepreneurship in nursing: a need for innovations in health care and professional visibility	Contextualize and discuss entrepreneurship in nursing.	Entrepreneurship is not only an important competence for the search for an autonomous practice, but also a characteristic that enhances the practice of nursing professionals in caring for people and communities.

Source: Own authorship.

Currently, it is perceived that the labor market and the economy are in potential transformations, due to the global culture established, and the consequences for the economy due to the pandemic caused by the new coronavirus (SARS-COV-2) [19, 20]. The entrepreneurial concept emerges as a need to meet the demand, where technological innovation and changes in society's way of life are present.

The National Curriculum Guidelines of the undergraduate course in Nursing establish administration and management as one of the nurses' competences, demanding that these professionals are able to be entrepreneurs, managers, employers, among other actions [21]. Thus, the nursing course should sensitize the student to the desire to undertake, through the inclusion of entrepreneurship content in the training of professionals [7, 22].

In this context, it is understood that entrepreneurship must seek innovations and business opportunities, configuring itself in a promising performance of nursing, enabling the opening of new spaces in the job market.

Among the various activities of the entrepreneurial nurse, we can mention consulting and auditing, teaching, promoting events, providing specialized services on vaccination, breastfeeding, sterilization of hospital material, supply and rental of hospital equipment, sale of products, transport and accommodation of patients, among others that allow the nurse an autonomous and entrepreneurial action [4].

Nursing has auditing as one of the important areas of entrepreneurship [23]. Institutions are always looking for strategies to solve or avoid financial crises and competitiveness, thus the audit emerges as one of the most effective options [24].

In December 2019, numerous cases of pneumonia began in the city of Wuhan, China, caused by a new coronavirus not yet identified in humans, causing an epidemic that soon spread across Europe and the Americas [25]. In this scenario, the World Health Organization (WHO) declared on January 30, 2020 that the outbreak of the novel coronavirus (2019-nCoV) constituted a Public Health Emergency of International Concern and on March 11, 2020, it was declared the pandemic of COVID-19, disease caused by the new coronavirus (Sars-Cov-2) [20].

In this context, there was an increase in the visibility of the work of the professional nurse, at the same time that it boosted even more the necessary transformations and innovations in the profession. Thus, it is understood that nurses need to transform themselves in the face of new challenges to be faced, not limiting themselves to the old concept of exercising only care [4].

In this perspective, the study by Andrade, Bem and Sanna [2] points to the need to dare, aiming to discover new opportunities in unknown spaces, since being an entrepreneur requires motivation to explore and act in new areas, requiring changes and transformations in the way of exercising the profession.

In addition, considering the numerous actions of the entrepreneurial nurse, the nurse's role in the home care service or "Home Care" has been highlighted in studies. There are many patients who prefer this form of care, as it frees the patient from the hospital environment while performing the necessary health care [26].

The nursing professional's search for other actions outside the hospital context, offering quality and diversified care in clinics, offices, schools, Home Care, consultancies, audits, are presented as examples in which entrepreneurship in nursing has been strengthened. In addition, other factors also contribute to the opening of new fields of work for nurses, such as the expansion of women's performance in the job market, different lifestyles, intense technological advances, new family arrangements, among others [27].

In this context, there are also complementary health practices, among them acupuncture, which consists of a Chinese technique, performed through the stimulation of points by needles, laser and other approaches [28].

Although universities are considered important institutions in the training of future entrepreneurs, the study by Chagas [15] showed that most nurses did not recognize them as encouraging entrepreneurship, identifying a gap in nursing training when it comes to encouraging entrepreneurship.

In addition, the research by Chagas [15] pointed out that enterprising nurses with registered ventures have high profitability compared to those who work in the traditional job market. These results demonstrate the innovative possibilities of nursing action.

In this way, it is understood that investment in skills and entrepreneurship takes advantage of current and future trends and enables opportunities for social, political and economic transformation [14].

IV. CONCLUSION

The study allowed us to identify that the entrepreneurial nurse is a reality on the rise. Through entrepreneurship, nurses can contribute to innovations in health care and, therefore, increase the visibility of the profession.

There are numerous advances, challenges and entrepreneurial practices in nursing, an extensive field that allows nurses to act promoting health to the population. Offices, home care, consulting and audits are some of the examples that enable the professional nurse to act independently, innovatively and entrepreneurially.

Entrepreneurship, as an innovative area of action in nursing, works by promoting health in society, being significant for the movement and renewal of the economy, in order to provide improvements in society, generation of jobs and expands options for consumers, thereby reducing inconsistencies resulting from the economic crisis.

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Mediation, ecology of knowledge and literature: A dialogue on the margins¹

Mediação, ecologia de saberes e literatura: um diálogo nas margens¹

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Palavras chave— *mediação, literatura, direito
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Palabras clave— *mediación, literatura,
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conocimiento, Derrida.*

Abstract— *This essay intends to offer reflections about a possible path
between private mediation and literature, having as an argument, both a
derridian reading of alterity, and the theory of ecology of knowledges by
Boaventura de Sousa Santos.*

Resumo— *Este ensaio pretende oferecer reflexões acerca de um possível
percurso entre a mediação privada e a literatura, tendo como argumento,
tanto uma leitura derridiana da alteridade, como a teoria da ecologia de
saberes de Boaventura de Sousa Santos.*

Resumen— *Este ensayo pretende ofrecer reflexiones sobre un posible
camino entre la mediación privada y la literatura, teniendo como
argumento tanto una lectura derridiana de la alteridad como la teoría de
la ecología del conocimiento de Boaventura de Sousa Santos.*

“A mediação é um trabalho sobre afetos em conflito,
não um acordo entre as partes, exclusivamente patrimonial,
sem marcas afetivas” (WARAT)

“O que é a literatura? A literatura como instituição
histórica, com suas convenções, suas regras etc., mas
também essa instituição da ficção que dá, *em princípio*, o
poder de dizer tudo, de se liberar das regras, deslocando-
as, e, desse mundo, instituindo, inventando (...) a lei da
literatura tende, em princípio, a desafiar os suspender a lei.
Desse modo, ela permite pensar a essência da lei na

experiência do “**tudo poder dizer**”. É uma instituição que
tende a extrapolar [*déborder*] a instituição.” (DERRIDA)

“A literatura não é o fato de uma linguagem se transformar
em obra, tampouco é o fato de uma obra ser fabricada com
linguagem; a literatura é um terceiro ponto, diferente da
linguagem e diferente da obra, um **terceiro ponto que é
exterior à reta que vai de uma à outra e que por isso
mesmo desenha um espaço vazio**, uma brancura essencial
onde nasce a pergunta “*O que é a literatura?*”
(FOUCAULT)

“A literatura trabalha nos interstícios da ciência: está sempre atrasada ou adiantada com relação a esta, semelhante à pedra de Bolonha, que irradia de noite o que provisionou durante o dia, e, por esse fulgor **indireto**, ilumina o novo dia que chega. **A ciência é grosseira, a vida é sutil, e é para corrigir essa distância que a literatura nos importa.**” (BARTHES)

“Todo ser humano é livre para se abrir, através de seu próprio caminho e de sua autotransformação liberadora, para o autoconhecimento de seu destino espiritual. O direito neste Sentido deveria estar inscrito entre os direitos do homem (...) *Transgressão* queria dizer originalmente *passar para outro lado, atravessar*. Com o tempo, a palavra veio a significar, para os tradutores da Bíblia: “violação da lei divina”; e, para os juristas: “violação de uma lei”. A passagem de um nível de Realidade para outro ou de um nível de percepção para outro significa uma infração `as leis divinas ou humanas? **A transdisciplinaridade é uma transgressão generalizada que abre um espaço ilimitado de liberdade, de conhecimento, de tolerância e de amor.**” (NICOLESCU)

Meus caros amigos, hoje iremos prostrar um pouco sobre uma tríade que me vem consumindo há tempos. E peço permissão para acessá-los, porém, como nos ensina Nussbaum, pensadora estadunidense, não gostaria de tocá-los simplesmente pela via racional, essa nossa velha categoria, que, desde Kant, mas, mais ainda, desde Sócrates, vem governando as relações humanas – por certo, sabidamente falha, não dizer, frágil – assim, pela via da fragilidade que bem mais do que a razão nos compõe como humanos, é que gostaria de lhes falar. Sobretudo, pois, pela fresta da fragilidade do humano, entraria talvez uma dimensão mais interessante, não que isso nos componha em nossa totalidade, entretanto, admitamos, por mais que nossa *sociedade espetacularizada* não queira admitir, por mais que nosso ego não nos permita pedir ajuda, solicitar o Outro, de fato, a fragilidade nos compõe. Desde sempre destinados à incompletude, desde o nascimento até o termo da existência, carecemos – somos, portanto, mais do que o *zoon politikon* aristotélico, seres que carecem.

E, por isso que nos une, por essa abertura que nos compõe, convido-os à reflexão sobre literatura, mediação e filosofia. Não procurarei aprofundar as diversas matizes conceituais de cada um de nossos convivas. O que a filosofia é, o que a literatura é e o que a mediação é, importaria muito mais a um exercício intelectual acadêmico quase sem gosto e Barthes já nos ensinou que o saber tem mais a ver com sabor do que qualquer outra coisa – não há saber sem sabor, ou seja, não sabemos apenas para uma dimensão intelectual da vida, pois, saborear o conhecimento é um exercício que se

consome apenas pela e na mediação do Outro, não há o *eu*, como diz Lévinas, antes do Outro, portanto, o Outro chega **antes do saber, da razão, antes de nos darmos conta**; assim, meus caros, iniciamos nossa jornada. O termo mediação, que está no meio, que intercala, que une, que ata, que é ponte, que está entre a ação, só existe porque o Outro a permite.

Aquele frágil humano que está sempre a se doar, a permitir nossa forma de existir, para o bem ou para o mal. A mediação do mundo se dá pelo intermédio do Outro. Insisto: ele, ela, chegam antes do *eu*, assim, a mediação é uma tarefa que é possível a partir dessa face que se nos mostra a cada momento; arriscaria dizer que o mundo, só é mundo, quando e por que o Outro nos empresta essa chance, logo, ele é quem media nossa relação com o mundo: Ele, o Outro, que apesar de constituir nossa ponte para o mundo, é também ele, ela, uma categoria absolutamente segredosa – ai como eu queria falar para vocês sobre o segredo!!! rsrs -, então, vamos a uma questão objetiva para o entendimento do que pretendo dizer a você: O Outro, a Outra, são, em sua totalidade, ininteligíveis pela categoria racional - ao mesmo tempo em que apontamos e dizemos: isso é isso; nesse momento, o mundo, nossas pré-compreensões, o Outro, já tomaram conta, e assim, vivemos a procurar uma fotografia de um pássaro que está sempre a voar. O Outro e a Outra, paradoxalmente nos permitem ao mundo, e ao mesmo tempo, furtam-no. Mirem: nos permitem uma vez que sem eles não haveria mundo e nem sequer sentido, de outro lado, quando entendemos que alcançamos o mundo, se torna necessário perceber que aquilo que compusemos enquanto mundo, não passa de um olhar nosso, portanto, incompleto, inacabado – essa visão de mundo pode ser melhorada...

A LITERATURA E O OUTRO

Se estivermos atentos ao que nos ensinam, tanto Derrida quando Foucault, percebermos que a literatura para eles possui algo comum: não há para ela a possibilidade de um dizer final, ou seja, a própria questão do que seja a literatura, é já uma resposta que quando dada, alarga, torna além, um branco essencial, que nos impede sufoca-la com nossa sanha de apreender tudo. Vejamos que a palavra apreender é já um sinal do problema que se anuncia: olhar o Outro e a Outra sob a nossa perspectiva é torná-los, quando muito, um efeito de nossas próprias dimensões de observação, portanto, a literatura aparece como esse local privilegiado de talho com o humano; ora, vez que ela não se dá a concessões, não está limitada por uma regra universal, senão aquela que ela própria inventa a cada ato de si; relembrei aqui uma pergunta que eu mesmo me fiz em um texto escrito há anos: *É o humano literatura?* Bom, por certo, a resposta é positiva, pois, se observarmos com cuidado e carinho esta

pergunta, veremos que ao fazê-la estamos a projetar o humano para além de si, de nós mesmos, e, portanto, entregando-o à sua dimensão mais primordial, a da relação com o Outro, que o constitui, que o mostra frágil, carente, e, ao mesmo tempo, não permite marcá-lo com o açoitado do conceito científico. Estamos sempre em um *por vir* que é anunciado pelo encontro.

Logo, gostaríamos de dizer que se de um lado perguntar pelo *quê* da literatura é reconhecer que ela se anuncia sempre escorregadia e para além de nossos olhos, o humano, em nossa concepção, também apresentar-se-ia nessa mesma dimensão. Por isso, nossa proposta de trabalhar a mediação junto da literatura, pois, parece-nos, que apenas por essa via, não interdita pela nossa questão racional e aprisionadora, poderíamos de uma só vez: reconhecer a nossa fragilidade ante o Outro, e assim não projetarmos nele nossas próprias formas de perceber o mundo, e, ao mesmo tempo, ao sabermos que ele é um infinito, carente, suscitaria um trabalho ético de não furto da alteridade, que nos tornaria seres mais empáticos, o que nos conduz a uma dimensão clara da mediação: a escuta ativa.

A literatura é o infinito do Outro e da Outra, pois, o *é*, conectivo verbal mormente requerido pelo pensamento racional não daria conta desta frase. Veja, o *é* indica o que algo seria, dimensionando sua forma de existir, entanto, quando opomos o termo infinito ao lado do *é*, parece, e espero que sim, vocês, junto comigo, entendem que quero evidenciar um paradoxo. Não há o *é* para dizer da literatura, senão aquilo que ela torna enquanto arranca do mundo aquilo que ele tem e oferece a ele uma morada outra. Da mesma forma, o Outro, se atentarmos ao mínimo ético requerido por Lévinas, fica claro que não pode ser definido, pois, ele só *é* na medida do *eu*, e, já sabemos, o *eu*, não existe sem o Outro; incorreríamos em uma contradição performativa se acaso disséssemos que o *eu* tem condições de dizer do Outro, da Outra – para a relação/mediação com eles e deles, a razão não basta, e como nos diz Warat, o afeto entra em questão.

Lembram-se que ao início do texto convidei para uma reflexão a tocar mais do que a razão, pois, aqui chegamos a esse ponto: o saber, só com sabor; o sabor, quem nos permite é o Outro; O Outro é impossível captar com a razão; já é tempo de percebermos a necessidade de desenvolvimento de nossa dimensão afetiva, sob o risco de nos relacionarmos apenas como nosso próprio espelho, milimétrica e racionalmente esculpido pelo nosso ego.

A literatura como horizonte.

Por isso trouxemos a literatura, pois, ela, como o Outro, são maneiras de existir que por mais que cataloguemos, nunca daremos conta de dizer totalmente o *que é* e o *que não é*.

Vejam que pela via da literatura podemos alcançar várias questões importantes para a mediação:

- a) a literatura pode causar no leitor uma espécie de transcendência ética, na qual ela ou ele podem acessar existências que estariam ou estão para além das suas próprias capacidades especulativas;
- b) a literatura não possui um encerramento de si, pois, miremos: ela é órfã do escritor quando está em posse do leitor, e além, é também órfã do leitor quando ainda não foi publicada, por isso, ela sempre será aquilo que não se pode dizer: a literatura rompe assim com um paternalismo que castra a invenção, pois, nunca saberemos o que o autor quis dizer ao certo; de outro lado, ela sempre requer uma acolhida do leitor, que por sua vez, carecendo do autor, necessita inserir ali também um pedaço a mais de literatura, de si: somos seres carentes, não por causa de uma falta inventada pela *indústria cultural*, mas por um condição ontológica que nos impinge a ir além, e além, tem o Outro, tem literatura;
- c) perceber o infinito da literatura é perceber que ela sempre espera: quando está a ser escrita, o autor espera o leitor; o leitor, por sua vez, espera o texto e nele se perde, tornando-se outro; não há literatura sem o Outro, seja ele leitor ou o próprio texto transformado pelo leitor que vem; conseguimos perceber a arapuca que é querer dizer algo sobre o que *é* a literatura?
- d) ainda, ao alargar o mundo, a literatura também o inventa. Narrar é uma tarefa a que sempre estamos lançados enquanto seres de linguagem, portanto, as narrativas da literatura fundam novos mundos, novas formas de viver, logo, ao abrir-se a elas, abrimos também nossas condições de percepção do Outro, que até então estava preso em nossas parcas pré-compreensões;
- e) gostaria de dizer uma frase inspirado no livro de Frédéric Gros *Desobedecer*: as principais tragédias humanas não teriam sido cometidas por atos de desobediência, mas sim de obediência *cega*, logo, a relação do pensamento com a literatura é imprescindível para reconhecermos a nossa chance de desobediência das normas que impedem o acesso ao Outro de maneira ética – a literatura, como algo mais interessante que o próprio mundo, permite com que nos desvencilhemos do peso dos dogmas, e esse é um primeiro passo para estar junto do Outro;
- f) se pensarmos em uma dimensão mais abrangente, o real, em tese, não existe, há sim mediações pelas quais tentamos acessá-lo, logo, a literatura se

- portaria como uma espécie de mediadora do real, ou seja, pense em uma pessoa antes e depois do contato com uma obra como *O grande sertão veredas* ou *Sobrevivendo no inferno* dos Racionais. Não nos parece que o mundo será o mesmo, logo, a literatura nos abre os poros dos sentidos para uma sorte de linguagem que por sua vez nos mostram forma de existir para além do que podíamos supor;
- g) a literatura não é, ela sempre está a caminho de si, existindo nos interstícios; é ela mesma composta por várias camadas. O texto é sempre outro quando voltamos a ele; e se nos arriscássemos a pensar que os seres humanos também são textos com camadas a serem desvendadas? E se assim como a forma do texto, suas entonações, pontos, exclamações, perguntas, cada suspiro da gramática, o humano também carece desse cuidado ao ser tocado/lido: a literatura nos ensina as profundezas do humano;
- h) se observarmos a incompletude da literatura, percebemos que ela não impõe uma forma correta de existência, vejamos Saramago e sua forma peculiar de literatura; não cumpre as regras e funda a literatura; o humano, assim como a literatura, é singular, e talvez, deixar ir, como nos ensina Caetano, seja a forma mais adequada de olharmos esse Outro; não postular medidas gerais e abstratas e/ou modelos, mas sim, deixar com que o Outro aconteça, em toda sua singularidade;
- i) a literatura, como a mediação, não requer pontos finais, vejamos que a obra não se encerra em suas páginas; a mediação e o Outro, na mesma feita, nunca podem ser dados como findos pelo mediador; ele aprende, assim, que o Outro e suas circunstâncias, não podem ser emparedados pelas nossas apreensões, o fim da mediação é o nascimento do Outro, daí que, a literatura não é obra do seu autor, tampouco, do leitor, ela é o trânsito entre um e outro com o mundo, da mesma maneira, o mediador ou mediadora não são autores da narrativa do Outro, apenas são vias pelas quais haverá uma construção da narrativa, sem que haja determinação *a priori*;
- j) a informalidade da literatura é também requerida pela mediação; ela permite que o Outro se mostre sem vestes; e assim, lembramos Derrida, a *literatura tudo pode dizer*, como quiser, sem que haja determinações formais: veja que grande encontro! E ensinamento maior ainda, pois, a literatura, singular que é, quando feita, faz também outras regras, inventa-as, transgride-as; a narrativa, sempre singular, necessariamente irá transbordar nossas pré-compreensões...

Transgressão e ecologia de saberes

Não poderia deixar de convocar rapidamente duas questões que entretecem nossa prosa. A primeira delas é a questão da *transdisciplinaridade* que envolve esse assunto. Não se tratará de nos mantermos presos à disciplina, pois mesmo a interdisciplinaridade ainda está armadilhada pelas arapucas das disciplinas. O Outro é indisciplinado, e desde Foucault já sabemos o problema histórico pelo qual construímos narrativas castrantes. É necessário deixar viver para viver. Assim, a mediação necessita descer à ordens que necessariamente não irão se mostrar pela aparência conflituosa, local em que atua o direito ortodoxo. Portanto, ir aonde não se pode ir é transgredir a disciplinar e deixar o Outro e a Outra livres, tanto para composição da narrativa, como para construção da resolução ou não do conflito.

Logo, transgredir é inverter os polos, deixar falar antes de dizer. O ouvido antes da fala. E quando estamos com a literatura, ouvimos, e esse ouvir nos permite sair de nós mesmo. O outro é sim literatura. Como o é o humano, frágil ser de narrativas. Quando Nicolescu nos convida a transgredir para além da disciplina, está de alguma forma e eticamente, supondo que o Outro não cabe em nós, para o bem e para o mal ele precisa ser liberto do cativo do *eu*... Transgredir é assunto da mediação, que apenas como um ato de doação se consuma, doar-se à narrativa do Outro, sem querer dar a ele a melhor ou a correta direção.

A *ecologia dos saberes* é teoria criada por Boaventura de Sousa Santos e nos ajuda aqui pois nela não temos as hierarquias da ciência convencional. Saberes se mostram de forma dinâmica e complementar, porém, nunca superiores ou inferiores, nos parece que perceber isso é entender que naquilo que de nós se distancia mora a chance da novidade, do Outro, da atitude ética perante o mundo.

Convido-os para irmos além da disciplina, deixando para trás uma *egologia* e propondo uma *ecologia* da mediação na qual além de seus princípios norteadores, suas regras, tenhamos nas mãos e nos olhos a hipótese sempre aberta de que o Outro vai nos decepcionar em nossas intenções de aprisiona-lo, de dizer o que fazer, pois, entendemos que apenas assim, nessa abertura para a fragilidade de si e do Outro, podemos ver nascer a cor azul que distingue a vida em sua dimensão de mais poesia, de mais autonomia; que reconhece o conflito como forma de composição do humano, que não quer prender, que liberta e deixa viver. O medo, que é uma forma de criar cativo, é irmão da imposição, com ele, o humano não inventa, se não inventa, não exerce sua existência em totalidade. Entreguemo-nos à transgressão que o Outro traz consigo, para o bem dele, para o nosso bem, para que não caiamos no erro moderno de querer encerrar a existência em uma narrativa racional. Do mediador, requeremos mais literatura, para que não se limite

e, por sua vez, não imprima ao mediando aquilo que ele não consegue experienciar...Isso que é a singularidade de cada um e que só vem no contato com um ouvido atento e ético, que transgride a razão e faz sempre aquilo que é impossível fazer.

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Classification of hazardous areas - natural gas installations

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Keywords—*Hazardous areas, natural
gas networks, IGEN code, IEC code.*

Abstract—*An explosive atmosphere can be created by a gas or vapor, dust or even fibers. Methane-based risks dominate the gas generation and distribution sector. The probability that any hazard exists in fuel concentration is determined by the specifics of the system under consideration. For example, a natural gas vent line is much more likely to contain this hazard than a lube oil line - unless, of course, the oil line flange joint is leaking. In this work we present the global assessment of the risks of explosion that inevitably involves the definition and classification of hazardous areas with natural gas due to the presence of explosive atmospheres.*

I. INTRODUCTION

The ignition of an explosive atmosphere is related to three events necessary for the flame condition to occur: a) existence of oxygen, b) the source of ignition and c) the fuel. A flammable atmosphere thus corresponds to a mixture of oxygen and a combustible gas in a concentration such that it is flammable.

For large industrial installations, oxygen is, of course, the most complicated element to isolate, given the costs involved, so it is not usual to protect the installation in this way. In practice, preventing the formation of a flammable atmosphere is a complicated task. In aerial natural gas infrastructures, exposed to the weather, with many flanged and threaded connections, the probability of small leaks is high. In this way, the biggest control to avoid the flame is the control of the ignition source, being that the main ignition sources correspond to the electric arcs and the heated surfaces. As these sources of ignition are present in any industrial installation, it is also practically impossible to

eliminate them, installing sources of ignition or installing appropriate equipment to operate in these locations.

The equipment area classification service must be performed by experienced teams, since a wrong work in this sense can make projects unfeasible, promote unnecessary changes in existing installations and even bring operational, maintenance and personnel training concerns. .

The present work seeks to exemplify the size and characteristics of classified areas, as well as the costs involved, comparing the results obtained in the area classification in natural gas stations when using a specific standard and a more general standard.

II. CLASSIFICATION OF HAZARDOUS AREAS IN BRAZIL - STANDARDS CONSIDERED

The standard used in Brazil for classifying hazardous areas that operate with combustible gases is ABNT-NBR-IEC-60079-10 - Electrical equipment for explosive atmospheres - Part 10: Area classification. According to this

standard, areas are classified according to the frequency and duration of the presence of a flammable atmosphere, with Zone 0 being an area with continuous presence or for long periods of a flammable atmosphere; Zone 1 an area where a flammable atmosphere may occasionally occur under normal operating conditions; and Zone 2 an area where the presence of a flammable atmosphere is not expected under normal operating conditions, and if it occurs, it will be for short periods. Thus, equipment certified to operate in Zone 0 is more demanding in terms of electrical requirements, limiting circuit power, as is the case with Ex-i (intrinsically safe) or limiting exposure of the electrical circuit, such as Ex-ma (two resin encapsulations). In general, all equipment certified for explosive atmospheres is more expensive than a similar one for industrial use.

But it is not only the cost of acquiring the “Ex” equipment that must be taken into account, those responsible must be aware that the presence of a classified area in the plant involved impacts the cost in other spheres, as follows:

Design: the design of electrical installations in classified areas is normally carried out by specialized companies, thus involving higher costs. Qualified personnel with adequate technical capacity are also needed to analyze and approve the same;

Installation: demand inspection of qualified work to evaluate the materials used and to monitor the assembly and disposal of the equipment, as foreseen in the project;

Operation: hazardous area requires operating personnel to be trained to operate in these locations. In addition, it is necessary to use equipment suitable for that area, making access to them difficult or even limited;

Maintenance: depending on the concept adopted, there may be complications in the context of equipment maintenance itself.

III. IEC 60079 CODE AND IGEM/SR/25 CODE

Within the oil and gas industry, the IEC standard is the reference used. The same, however, was conceived to meet the specific demands of the oil industry, thus presenting a vision totally focused on its own equipment, such as LPG spheres, hydrocarbon storage tanks, vessels, among others. In an attempt to apply the methodology of the IEC standard to classify areas of equipment that operate in the transport and distribution of natural gas, significant distortions occur regarding the size and classification of the region around these equipment.


To facilitate and standardize the process of classifying the area of natural gas installations, the standard IGEM/SR/25 - Hazardous area classification of natural gas

installations is suggested, which should be used to complement the IEC standard. The IGEM/SR/25 standard is based on an objective methodology to dimension the size of the classified area, making the classification of the area less subjective, and thus, bringing more confidence to those responsible for these classifications. For dimensioning the size of hazardous areas, the IGEM/SR/25 - Edition 2 standard used the RR630 research report from the HSE (Health and Safety Executive), which is based on the same mathematical modeling used by the IEC standard.

In many aspects, the IGEM/SR/25 and IEC 60079 standard bring equivalent concepts, such as:

3.1 – Differentiation between normal operating releases (fugitive leaks in connections, releases in relief valves, etc.) and catastrophic leaks (breakage in equipment or piping, etc.). For area classification purposes, only normal operating leaks are considered, considering concepts of probability, duration and conditions surrounding the facilities. On the contrary, catastrophic spills are emergencies and part of a contingency approach. This difference is important in order not to overestimate the size or type of the classified area.

3.2 - Are based on the same mathematical models for computational simulation of leaks and on the explosive cloud dispersion behavior.

3.3  They present a distinction between primary and secondary releases: the standards distinguish the type of release according to the equipment installed in the field. An equipment has a primary release if releases are expected to occur during its normal operation. An example of equipment classified in this category is a relief valve. Otherwise, an equipment is classified as being of the secondary type.

In natural gas distribution companies, the topic of area classification was normally discussed in a superficial way. However, in recent years, with the expansion of natural gas distribution networks and service to regions increasingly distant from the operational bases, there was a need for these companies to install field automation to monitor the network and enable more efficient management. As a result, for example, the difficulties of moving personnel to carry out consumption readings and regular on-site inspections to verify the operation of the equipment installed on the network were avoided.

Automation brings many gains in several spheres, having presented a great leap in the operational management of natural gas distribution companies; however, automation brought with it an unavoidable problem, electricity.

From then on, the topic of area classification became a concern and an obstacle to projects of this type, due to the

initial lack of knowledge on the topic and, in part, because the IEC 60079-10 standard is not clear for applications in distribution companies. To reduce these problems, many of these companies have switched to contracting outsourced services in the area classification of their equipment. The biggest problem is that such specialized companies use the IEC 60079-10 standard as a reference to carry out their studies, resulting in dangerous areas of great extension, thus causing all the problems mentioned above.

IV. PRESSURE REDUCTION STATION – NATURAL GAS

Among the equipment used by natural gas distribution companies, the most common and which deserve special attention are the non-buried gas stations.

These stations, when not buried, can be of the ERP type (Pressure Reduction Station) or of the EMRP type (Measuring and Pressure Reduction Station). The main difference between these devices is that the EMRP is installed at the end customers, having a consumption meter, while the ERP only reduces the operating pressure of a certain line.

Before starting a station's area classification, two assumptions need to be considered:

- the stations discussed in the present work do not operate in adverse situations. The IGEM/SR/25 standard considers as an adverse situation: a) gas with a lot of particulates or wet gas; b) operation with excessive vibration; and c) corrosive atmosphere, such as the marine atmosphere.
- secondary releases are caused by fugitive leaks, with maximum dimensions of 0.25 mm².

The process of classifying the area of non-buried stations according to the IGEM/SR/25 standard begins with the identification of 3 points basic:

- kind of equipment
- work pressure.
- availability of ventilation

For each piece of equipment in a gas station, the IGEM standard classifies the type of release, which can be primary or secondary. As a rule, all equipment in a gas station is of the secondary release type, with the exception of the relief valve. The equipment of a station that has secondary release type are: pair of flanges, threaded unions, threaded fittings and block valves.

The equipment with secondary release promotes a classified area of the zone 2 type. The equipment with

primary release, on the other hand, generates a classified area of the zone 1 type, with an associated zone 2 classified area. Figure 1 illustrates the equipment with secondary release and the dimension of the Zone 2 classified area generated by them.

The size of the hazardous area of equipment that falls into the secondary release type depends on the operating pressure and degree of ventilation. Tables 1 and 2 present the size of the hazardous area of equipment with secondary release, and must be used in conjunction with figure 1. Table 1 establishes the dimensions of a freely ventilated station and Table 2 of one with ventilation restriction.

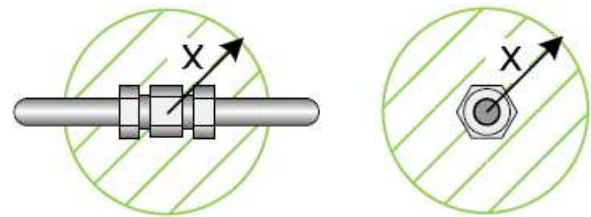


Fig. 1(a): Accessories or threaded unions

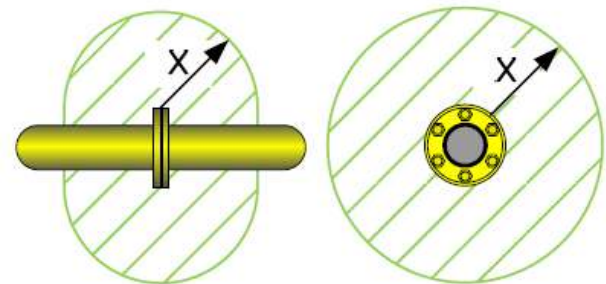


Fig. 1(b): Pair of flanges

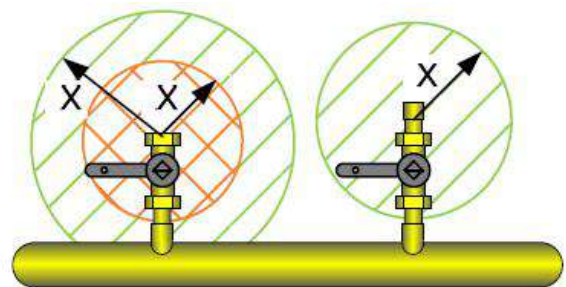


Fig. 1(c): Threaded stop valve, without and with plug

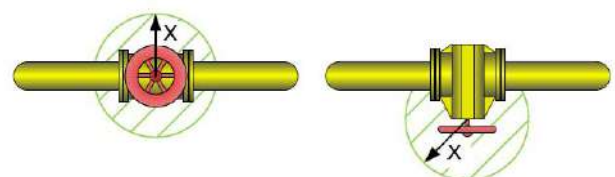


Fig. 1(d): Flanged block valve

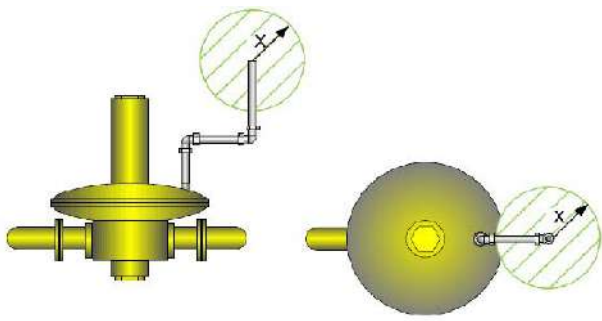


Fig. 1(e): Pressure regulator

Fig. 1: Identification of the location of the classified area in equipment with secondary release (adapted from the IGEM/SR/25 Edition2 standard)

Table.1: Dimension of the classified area of Stations Unrestricted Ventilated (IGEM/SR/25 Edition2)

Operating pressure (bar)	Dimension (X) of Zone 2 under normal operating conditions (m)
> 75 < 100	1.5
> 50 < 75	1.5
> 30 < 50	1.0
> 20 < 30	1.0
> 10 < 20	0.75
> 7 < 10	negligible
> 5 < 7	negligible
> 2 < 5	negligible
> 0.1 < 2	negligible
< 0.1	negligible

Table.2: Dimension of the classified area of Stations hundred ventilation restrictions (IGEM/SR/25 Edition2)

Operating pressure (bar)	Dimension (X) of Zone 2 under normal operating conditions (m)
> 75 < 100	2.0
> 50 < 75	2.0
> 30 < 50	1.5
> 20 < 30	1.5
> 10 < 20	1.0
> 7 < 10	0.75

> 5 < 7	0.75
> 2 < 5	0.50
> 0.1 < 2	0.50
< 0.1	0.50

4.1 – Area Classification around Relief Valve type equipment

Relief valve type equipment is present in the vast majority of pressure reducing gas stations. This device discharges any rises in the pressure of the gas network to the environment, causing this equipment to have the primary release type. The standard suggests the area classification as shown in Figure 2.

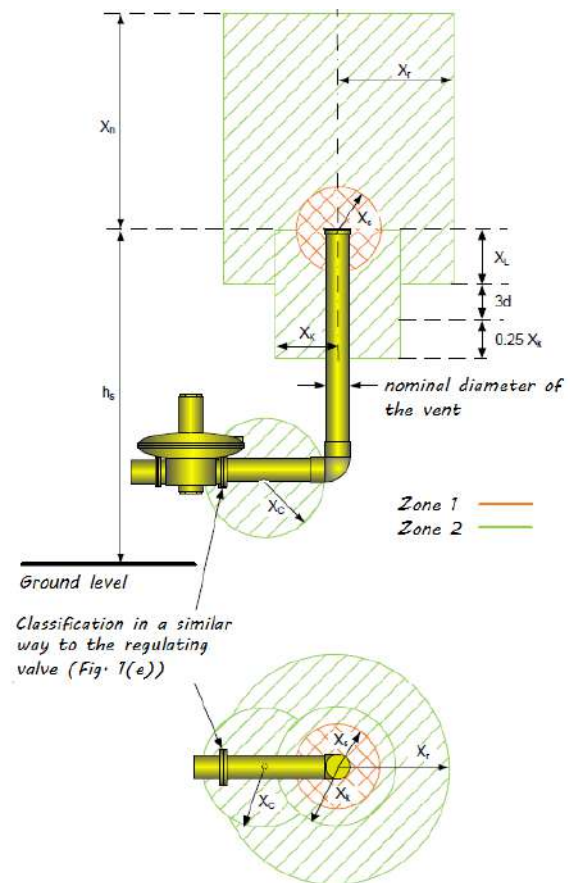


Fig. 2: Relief valve hazardous area (primary release). IGEM/SR/25 Edition2

The IGEM standard uses tables to obtain the values of X_r , X_h and X_k , and the input variables to obtain these values are: the vent diameter and the maximum flow of the relief valve (given in kg/s) .

The value of the maximum flow rate of the relief valve can be obtained from the manufacturer's technical data. If

this value is not available, the standard suggests equations to obtain the flow, as follows:

For operating pressure ≥ 0.85 bar:

$$g = 675 (C_d)A(M^{0.5})T^{-0.5}(P + 1.013)^{1.05} \quad (1)$$

For operating pressure < 0.85 bar:

$$g = 1500 (C_d)A(M^{0.5})T^{-0.5}(P)^{0.5} \quad (2)$$

given: g = mass released [$\text{kg}\cdot\text{s}^{-1}$];

M = molecular weight [$\text{kg}\cdot\text{kmol}^{-1}$]. Consider $\text{GN} = 17.367 \text{ kg}\cdot\text{kmol}^{-1}$;

p = gas pressure [bar]. Assuming 110% of the opening pressure of the relief valve;

T = gas temperature at the discharge [K];

C_d = orifice discharge coefficient (according to manufacturer's data or adopt = 1;

A = cross-sectional area of the vent [m^2].

Table.3: X_r , X_h and X_k values for vent diameter 25.4 mm. (IGEM/SR/25 Edition2)

Maximum flow from the relief valve (kg/s)	X_r (m)	X_h (m)	X_k (m)
> 0.01 <			
0.01 0.02	3.0	3.0	3.0
0.02 0.05	3.0	5.0	3.0
0.05 0.10	3.0	7.0	3.0

V. CASE STUDY - TYPICAL PRESSURE REDUCTION STATION AREA - NATURAL GAS

Considering a large station (Figure 3), with a regulating valve capable of regulating a flow of $20.000 \text{ m}^3/\text{h}$, inlet pressure = 35 bar, outlet pressure = 7 bar, maximum flow of the relief valve regulated with 1.2% of the maximum flow of the regulating valve (resulting in $240 \text{ m}^3/\text{h}$ or 0.0433 kg/s).

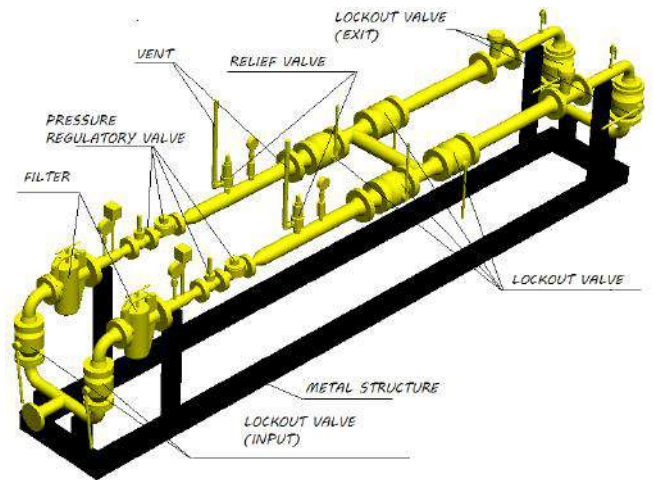


Fig. 3: Typical pressure reduction station

Figure 4 shows the size of the classified area (in a side view) around equipment of a $20.000 \text{ m}^3/\text{h}$ gas station, considering two types of ventilation: (a) free ventilation and; (b) obstructed ventilation.

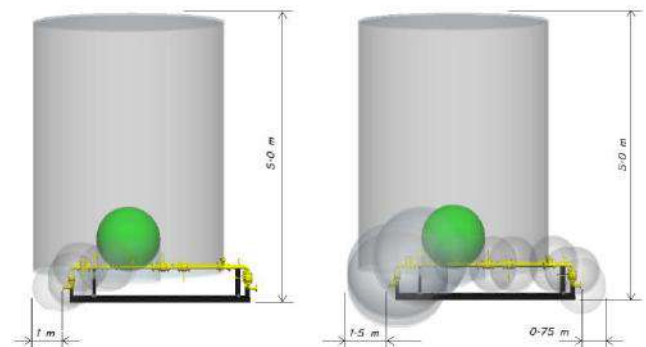


Fig. 4: Area classification considering: (a) free ventilation and; (b) obstructed ventilation.

Through Figure 4, it is noted that the free ventilation condition is more convenient, as it generates a smaller Zone 2 classified area, in addition, after the pressure adjustment to 7 bar, the size of the Zone 2 classified area is null, or according to the designation of Standard IGEM/SR/25, Zone 2 NE.

Next, Figure 5 presents the result of the classification of the fully ventilated station area, according to the IGEM (a) and IEC (b) standards. It can be clearly seen that the condition presented by the IGEM standard is more favorable in every way, since the Zone 1 classified area is relatively smaller.

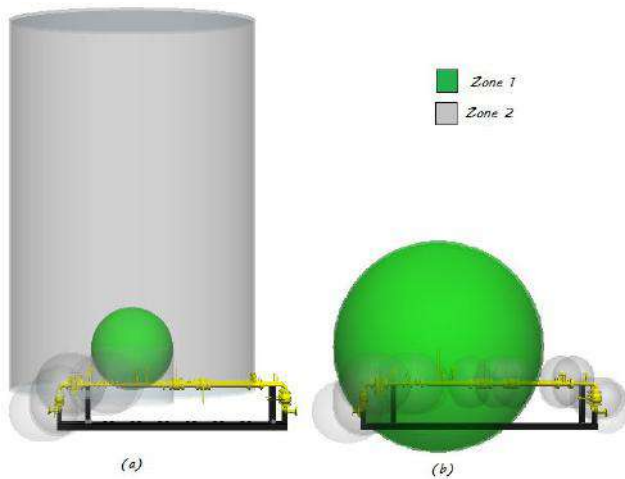


Fig. 5: Area classification according to IGM code (a) and IEC code (b).

VI. CONCLUDING REMARKS

The second edition of the IGM/SR/25 standard complements the ABNT-NBR-IEC-60079-10 standard, helping mainly in the natural gas distribution sector, since this fluid has different properties from other flammable fluids. Piped gas distributors are responsible for the joint and continuous implementation and discussion of such concepts for their validation, as well as the discussion of notable points, including the classification of small sheltered stations (residential/commercial segment). The benefits of applying the IGM standard are diverse, including greater safety in the installations; better documentation of classified areas; and good possibilities for reducing the costs of installing and operating the infrastructure. With automation, and as a consequence of the need for electric energy present in the stations, the area classification in gas stations has become a matter of responsibility, security, network integrity and cost reduction.

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Reliability of prestressed concrete girders design: Comparison between NBR and Eurocode codes

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Keywords— bridge, Eurocode, NBR, precast
beam, reliability.

Abstract— This work evaluates the reliability index of prestressed girders beams of highway bridges designed according to Brazilian and European codes concerning the bending ultimate limit state. A model was used to verify the resistant capacity of the beams in the bending ultimate limit state and to evaluate the live load models proposed by the regulations studied. The bridge studied spans 27.4 meters, and four T section prestressed concrete girders support it. To obtain the reliability index β , the First Order Reliability Method (FORM) was used, which proved to be very fast and efficient. The values collected by the analytical method are validated using the Monte Carlo simulation method. For all cases, the reliability index value was higher than 5.5, showing that the two normative recommendations for the design of girders beams guarantee a very conservative level of safety.

I. INTRODUCTION

It is called a bridge, the structure to overcome obstacles, such as rivers, deep valleys, other roads, and other cases. Bridge failures can cause great losses and inconvenience to people around them and the economy. Therefore, it is of great importance to study these structures' safety to avoid such adversities.

The most used method for evaluating the safety of bridges is structural reliability. Its main objective is to determine the probability of structural failures, which is related to the reliability index.

The structural reliability method requires the statistical definition of the parameters included in the model, which depends on the quality of the statistical data referring to the problem and the precision of the mathematical model used to verify the limit state equations.

Some codes, such as the Eurocodes from Europe and the "Load and Resistance Factor Design" from the United

States, define a target reliability index according to the importance of the structure or structural element.

The main Brazilian codes for bridge design are NBR 7187 [1] and NBR 7188 [2], entitled "Design of concrete bridges, viaducts and footbridges", and "Road and pedestrian live load on bridges, viaducts, footbridges and other structures", respectively. In Europe, the Eurocode 1 [3] and Eurocode 2 [4] codes, entitled "Actions on structures" and "Design of concrete structures", respectively, are used for the design of such structures.

Brazilian and European design codes take into account numerous uncertainties associated with the materials used in the construction of the structure and the actions that will be applied through the limit state method. This method involves establishing boundaries between desirable and undesirable behavior of the structure.

In this format, partial safety factors are proposed to reduce the strength of the structural elements and increase the actions, creating a safety margin.

In Brazilian design codes, the live load model consists of a 3-axle vehicle plus a distributed load, applied in the region outside the vehicle boundaries, and multiplied by a dynamic amplification factor, called impact coefficient, which is a function of span length, number of spans and material used in the structure.

The European design codes define four vertical load models that must be considered on road bridges. It's also defined horizontal forces associated with two of these models due to braking, acceleration, and centrifugal forces. The loads are then combined in groups of traffic loads, and the worst case is included in the load combinations.

This work aims to compare, based on structural reliability, the principal Brazilian and European codes used for the design of prestressed concrete bridges, with the main differences being the partial safety factors and the live load models applied. Thus, it will be possible to observe which code provides greater security in relation to the other through its regulations.

II. METHODOLOGY

2.1 Structural analysis and design of the bridge

Two prestressed concrete bridge girders were designed, one based on Brazilian codes NBR 7187 [1] and NBR 7188 [2] and another based on European regulations Eurocode 1 [3] and Eurocode 2 [4]. For both structures, the same cross-section and the same properties of the bridge materials were adopted.

2.1.1 Geometric characteristics and properties of bridge materials

The bridge studied, shown in Figure 1, is a single-span bridge with prestressed precast beams and an "in loco" casted slab and has a span of 27.4 m. Four prestressed precast beams support the bridge, with an "in loco" casted slab 21 cm thick and the asphalt layer 7 cm thick. The precast prestressed beam has a height of 2 m. The dimensions of the prestressed precast beam and the guardrail are shown in Figure 2. For the analysis, beam number 1 was considered.

It was used seven high-strength wire strands for both design examples. Wire strands with a 12.7-millimeter diameter, designated as "Y1860S7G" were selected. Table 1 shows the values of the main properties of the bridge materials.

2.1.2 Structural internal forces in beam number 1

The analysis of transverse load distribution is performed using the Fauchart Method, used for bridges without intermediate crossbeams. This method provides simple modeling and results very close to those obtained by a process with greater precision, such as the Finite Element Method, according to Moura et al. [5].

The Fauchart Method allows converting a two-dimensional loading model into a one-dimensional one by considering the stiffness of the girders based on the use of springs (FONTANA [6]).

Heinen [7] states that the Fauchart Method is used in decks with several beams without intermediate crossbeams. The longitudinal beams must be simply supported, have constant inertia, and behave according to the rules of Strength of Materials (linear elastic behavior). In this method, the longitudinal behavior of the slab is neglected.

The Fauchart Method suggests calculating a plane structure corresponding to one meter in width of the slab's cross-section. The beams are replaced by springs that have resistance to vertical displacement and in-plane rotation. The spring constants are obtained by applying the Euler-Bernoulli beam theory and the elastic torsion theory. Their resolution is given using the Fourier series, resulting in Equation 1 and Equation 2.

$$k_v = \left(\frac{\pi}{L}\right)^4 \cdot E_{cs} \cdot I \quad (1)$$

$$k_t = \left(\frac{\pi}{L}\right)^4 \cdot G \cdot J \quad (2)$$

Where L is the span length in meters, I is the moment of inertia of the beam section in m^4 , J is the torsion constant of the beam in m^4 , E_{cs} is the secant modulus of elasticity of the beam's material in kN/m^2 , G is the transverse modulus of elasticity of the beam's material in kN/m^2 , k_v is the coefficient of the vertical spring in kN/m and k_t is the coefficient of the torsion spring in $kN \cdot m/rad$ (STUCCHI [8]).

The influence lines and the reactions on the supports are obtained by solving the structure on elastic supports for different positions of a unit load, as shown in Figure 3 (HEINEN [7]).

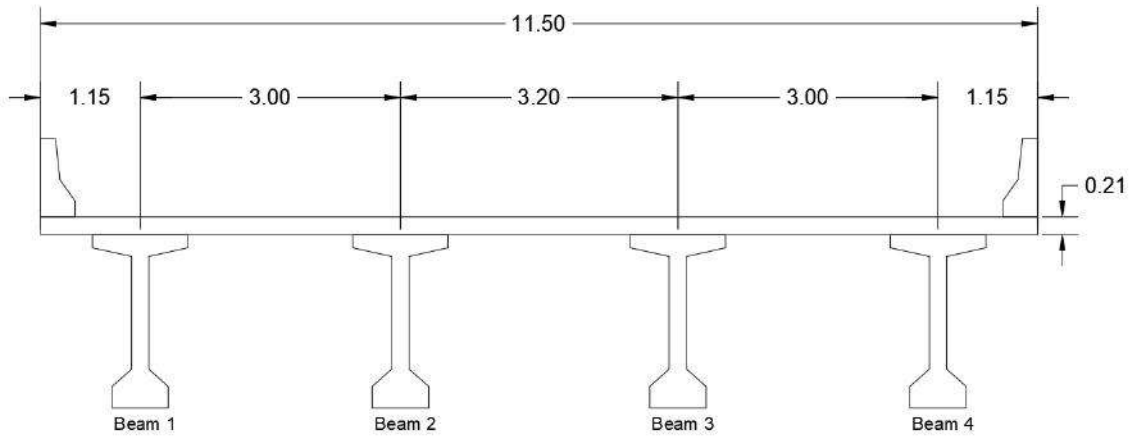


Fig.1 - Bridge cross section (dimensions in meters)

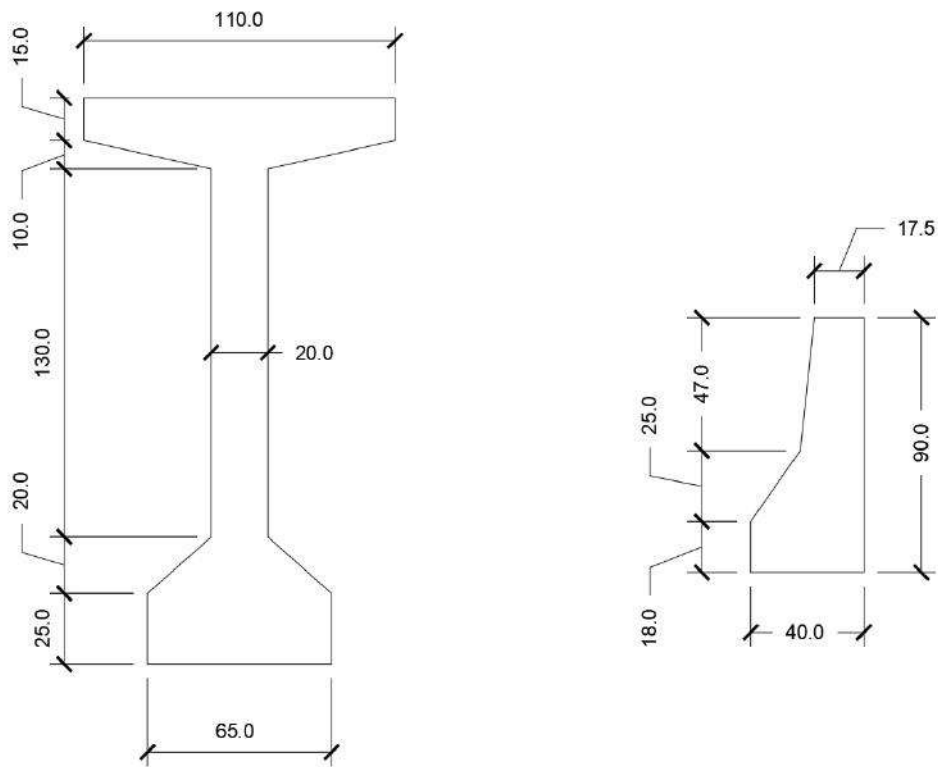


Fig.2 - Cross-section of the bridge girders and guardrail (dimensions in centimeters)

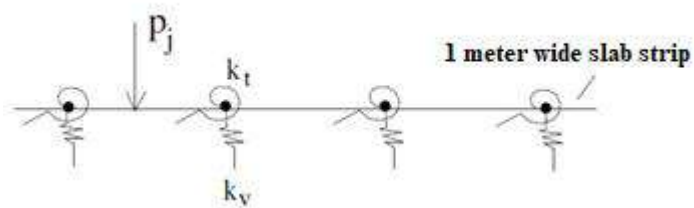


Fig.3 - Transverse structural scheme for a unitary strip (HEINEN [7])

Table 1 - Properties of bridge materials

Data	Symbol	Value	Unity
Beams concrete compressive strength	f_{ck}	50	MPa
Slab concrete compressive strength	f_{ck}	30	MPa
Characteristic tensile strength of prestressing steel	f_{ptk}	1860	MPa
Characteristic resistance to yielding of prestressing steel	f_{pyk}	1610	MPa
Prestressing steel modulus of elasticity	E_p	195	GPa
Steel crosssectional area per strand	A	112	mm ²
Characteristic value of maximum prestressing force	P_u	208	kN
Characteristic value of initial prestressing force	P_i	153	kN

Table 2 shows the values of the constants of the vertical springs (k_v) and the constants of the torsion springs (k_t), calculated with the formulas presented above, based on the T section previously shown. The parameters $L = 27.4$ m, $f_{ck} = 50$ MPa, $E_{cs} = 29402.92$ GPa, $G = 12251.22$ GPa, and the Poisson's coefficient equal to 0.2 are common to all the girders.

Figure 4 shows the beams representing the bridge to be analyzed, with the spring connections in place of the girders and their respective constants

2.1.3 Design of beam number 1 prestressing force

Table 3 presents the data used for the prestressing force design and the resulting number of strands for each case.

Table 2 - Values used in the Fauchart Method

Data	Beam 1 and 4	Beam 2 and 3
I (m ⁴)	0.7446	0.7772
J (m ⁴)	0.0135	0.0149
k_v (10 ³ kN/m)	3.784	3.949
k_t (10 ³ kN.m/rad)	2.176	2.400



Fig.4 - Beam representing the four girders bridge

Table 3 - Design of prestressing according to Brazilian codes

Description	Symbol	Brazilian codes	European codes
Number of prestressing strands	-	44 strands	52 strands
Distance from prestressing steel to the top of the beam	d_p	206 cm	201 cm
Total value of initial prestress force	P_i	6732 kN	7956 kN

2.2 RELIABILITY

The design based on technical codes applies the limit states format, which approximates the uncertainties in the design variables by using safety factors. The properties of materials, geometry, and loading are, in reality, random variables that can be specified through probability distributions. A structure is considered reliable if it performs the proposed function during the prescribed service life. The reliability analysis provides the probability of failure of the structure concerning a specified limit state. The probability of failure (p_f) and the reliability index (β) are related according to Equation 3.

$$\beta = \Phi^{-1}(1 - p_f) \tag{3}$$

Being Φ^{-1} the inverse standard normal distribution function. In this study, the reliability index (β) is calculated using the first-order reliability method (FORM) and validated using the Monte Carlo simulation method.

According to Beck [9], the FORM method calculates the reliability index β through the first-order approximation of the performance function. It converts all non-normal distributions into equivalent normal distributions at the point of failure x^* illustrated by Figure 5.

The FORM procedure consists of defining the limit state equation $G(x)$; assuming an initial point of failure x^* ; then calculating, as a function of x^* , the corresponding mean ($\mu_{X_i}^N$) and standard deviation ($\sigma_{X_i}^N$) of each variable not normally distributed, calculating the partial derivatives of $G(x)$ at point x^* ; calculating the director cosines α_i ; and getting the new failure point, according to Equation 4.

$$x_i^* = \mu_{X_i}^N - \alpha_i \cdot \beta \cdot \sigma_{X_i}^N \tag{4}$$

Finally, calculate the updated β value; and repeat the previous steps until convergence between β and x^* is reached.

The FORM requires the analysis to be carried out in the standard space. The statistical parameters of random variables with the most diverse probability distributions must be transformed into normal equivalents (BECK [9]).

The Monte Carlo method can be summarized in obtaining an estimate of the probability distribution of the response of a system by randomly generating the input parameters according to their probability distributions and performing N simulations of the system performance and then carrying out statistical analysis (MOURA [11]).

The reliability study for engineering structural systems basically consists of three possible responses of the performance function $G(x)$: in safety ($G(x) > 0$), limit state ($G(x) = 0$) and failure ($G(x) < 0$).

The probability of failure can be determined by Equations 5 and 6.

$$p_f = \frac{1}{N} \cdot \sum_{i=1}^N I_g(x_i) \tag{5}$$

$$I_g(x) = \begin{cases} 0, & \text{if } G(x) > 0 \\ 1, & \text{if } G(x) < 0 \end{cases} \tag{6}$$

For the Monte Carlo analysis, the importance sampling method was used to accelerate the simulation convergence, adopting the probable failure points of each random variable provided by the FORM method (BECK [9]).

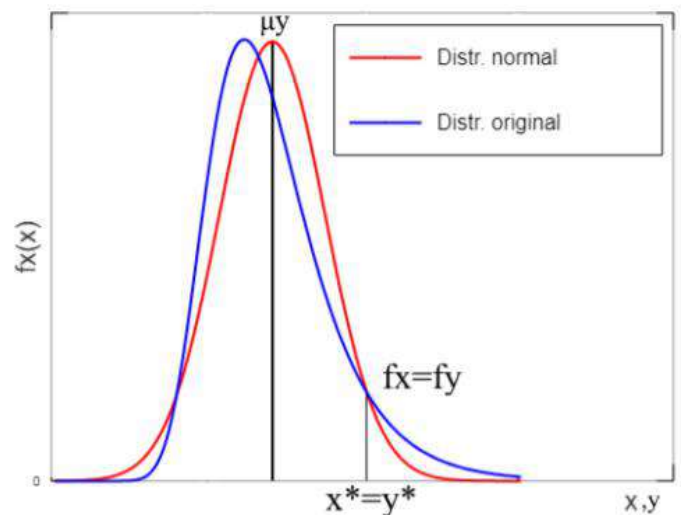


Fig.5 - FORM method for non-normally distributed variables (SILVA JÚNIOR [10])

2.2.1 Limit state equation

The limit state function used is defined by the difference between the resistance capacity and the sum of the loading actions and is mathematically expressed by Equation 7.

$$g(x) = R - S = 0 \tag{7}$$

For the use of the reliability method, a deterministic model that adequately represents the structure's response to be studied is essential. In this way, according to Moura [11], a mechanical model was developed, which calculates the resistant bending moment of cross-sections of prestressed concrete beams. The model developed can calculate the ultimate resistant bending moment of T sections.

In this work, the load-bearing capacity of prestressed concrete beams is defined by its resistant bending moment, M_r , multiplied by the model error estimate, θ_r , and the loading actions are represented by the sum of the bending moments caused by the permanent load, M_g , and the variable load, M_q , multiplied by a factor due to the uncertainties of the actions, θ_s , so that Equation 8 results.

$$g(x) = \theta_r \cdot M_r - \theta_s \cdot (M_g + M_q) = 0 \quad (8)$$

The calculation of the bending moments caused by the loading actions was carried out as follows. The bending moment due to permanent load is calculated according to Equation 9.

$$M_g = \frac{g \cdot l^2}{8} \quad (9)$$

Being l the design span, and g is the permanent load.

The moment due to variable load is calculated using the Fauchart Method, using the live load models recommended by the corresponding design code.

III. RESULTS AND DISCUSSIONS

3.1 Probability distributions and parameters of random variables

Using the Fauchart Method, implemented using the FTOOL software [12], the internal forces caused by the structure's self-weight and the live load models on beam number 1 were determined. The live load models TB-450 of the Brazilian code and the LM1 of the European standard were considered for the reliability analysis.

For the Brazilian live load model, the load train TB-450 was considered, as illustrated in Figure 6. It is defined by a three-axle vehicle, with a total load of 450 kN, evenly distributed on each wheel and surrounded by a constant uniform distributed load of 5 kN/m². It was also considered that the vehicle transits leaning against the guardrail, which is the most unfavorable position for the loading, to generate the greatest internal forces on the bridge.

The values of the live load applied to the level of the pavement are then multiplied by the Vertical Impact Coefficient (CIV), the Number of Lanes Coefficient (CNF), and the Additional Impact Coefficient (CIA), defined by Equations 10 to 12. An increase of 10% in the loading was also considered because the designed structure is placed at a distance of less than 100 km from port terminals.

$$CIV = \begin{cases} 1.35 & L_{iv} < 10m \\ 1.0 + \left(\frac{21.2}{L + 50}\right) & 10m \leq L_{iv} \leq 200m \end{cases} \quad (10)$$

$$CNF = 1.0 - 0.05 * (n - 2) > 0.9 \quad (11)$$

$$CIA = \begin{cases} 1.25 & \text{for reinforced concrete structures} \\ 1.15 & \text{for steel structures} \end{cases} \quad (12)$$

The European model consists of a tandem system (TS) and uniformly distributed load (UDL) in each lane with a maximum of three notional lanes. The two axles are 1.2 meters apart for each tandem system, with the wheels spaced at 2.0 meters, as shown in Figure 7. The axles should be centered in the lanes, and the lanes should be positioned to produce the most severe effect. The position of the UDL and TS longitudinally along the lanes should also be the most unfavorable. To this effect, it is not required to apply the UDL to the full width or span of a lane (DIETRICH [13]).

Table 4 presents the values for the axle loads and uniformly distributed loads (UDL) in each lane.

The self-weight of the structure generated a uniformly distributed load (g) on beam number 1 of 42.68 kN/m. The TB-450 mobile load model resulted in a total moment (M_q) of 3728.3 kN.m on the same equivalent part. The LM1 mobile load model resulted in a total moment (M_q) of 4194.1 kN.m.

For the bending moment due to the Brazilian live load model (M_q) a bias factor (λ) was considered, the ratio between the characteristic value and the mean, equal to 1.615, coefficient of variation equal to 0.18, these values were based on Lyra [14]. The live load was considered as obeying a probability distribution of Extreme Values of Type I (Gumbel).

For the bending moment due to the European live load model (M_q) a bias factor (λ) was considered equal to 1.885, a coefficient of variation equal to 0.18, and the distribution of Extreme Values of Type I (Gumbel) was adopted. These values were based on Caprani [15].

The mean, standard deviation, or coefficient of variation and the probability distribution law of the variables considered are contained in Table 5.

3.2 Reliability index

To determine the β reliability index, four different situations were adopted. The following cases were considered:

1. Bridge designed according to the Brazilian code and applied the TB-450 live load model for reliability analysis;
2. Bridge designed according to the Brazilian code and applied the LM1 live load model for reliability analysis;
3. Bridge designed according to the European code and applied the TB-450 live load model for reliability analysis;
4. Bridge designed according to the European code and applied the LM1 live load model for reliability analysis.

The reliability methods used in this study, FORM and Monte Carlo simulation, were both implemented using the PYTHON programming language.

Table 6 presents the results of the reliability index using the First Order Reliability Method (FORM) and the Monte Carlo simulation method.

The results achieved show that the values of the reliability indices calculated using the FORM method and the Monte Carlo simulation method are close, which confirms the validation of the models.

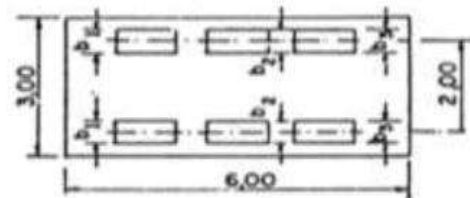
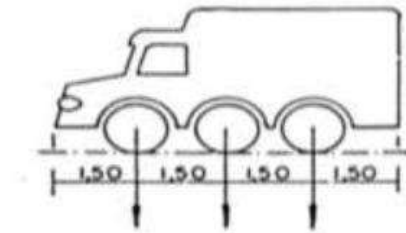


Fig.6 - Truck used in the TB-450, according to NBR 7188 [2]. Quotas in m.

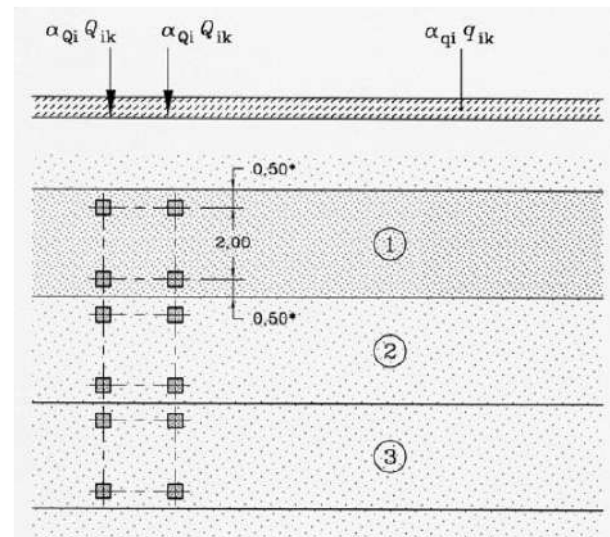


Fig.7 - Application of LM1(Eurocode 1 [3])

Table 4 - LM 1 - Characteristic values and adjustment factors (Eurocode 1 [3])

Description	Tandem System			UDL		
	$Q_{ik} (kN)$	α_{Qi}	$Q_{ik} * \alpha_{Qi} (kN)$	$q_{ik} (kN)$	α_{Qi}	$q_{ik} * \alpha_{Qi} (kN)$
Lane 1	300	1.00	300	9	0.61	5.5
Lane 2	200	1.00	200	2.5	2.2	5.5
Lane 3	100	1.00	100	2.5	2.2	5.5
Other Lanes	0	-	-	2.5	2.2	5.5
Remaining Area	0	-	-	2.5	2.2	5.5

Table 5 – Distributions for the random variables used in the reliability analysis

Variable	Mean μ	Standard deviation σ	Coefficient of Variation $V = \sigma/\mu$	Type of Distribution	Reference
f_c	$1.22 \cdot f_{ck}$	-	0.15	Normal	Santiago [16]
f_{pt}	$1.07 \cdot f_{ptk}$	-	0.015	Normal	Santiago [16]
A_p	$1.03 \cdot A_{p,nom}$	-	0.01	Log-Normal	Santiago [16]
d_p	$d_{p,nom}$	1.00	-	Normal	JCSS [17]
θ_r	1.044	0.092	-	Normal	San Martins [18]
θ_s	1.00	-	0.10	Log-Normal	JCSS [17]
g	$1.06 \cdot g_{nom}$	-	0.12	Normal	Santiago [16]
M_q	$M_{q,nom}/1.615$ or $M_{q,nom}/1.885$	-	0.18	Gumbel	Lyra [14] and Caprani [15]

Table 6 - Reliability index of the bridges studied

Method	Brazilian code designed bridge		European code designed bridge	
	TB-450	LM1	TB-450	LM1
FORM	5.60	5.68	6.20	6.28
Monte Carlo	5.63	5.71	6.25	6.33

Furthermore, it is possible to notice that the bridge designed according to the European codes resulted in safety levels higher than those obtained by the structure designed according to the Brazilian regulations. Even with such differences, very conservative values of the structure's safety were still obtained.

3.3 Analysis of sensitivity

A sensitivity analysis was performed by calculating the Importance Index, which is a function of the sensitivity factor and is defined by Equation 13 (NOVA [19]):

$$I_i = \alpha_i^2 \tag{13}$$

Sensitivity analysis makes it possible to determine the uncertainties that influence the failure event under investigation and then locate those variables that present greater effect in the response.

The sensitivity factor was obtained by implementing the FORM method, and it is presented in Table 7.

According to Table 7, the variables that most influence the probability of failure of the structure are the resistance error model, the bending moment caused by the live load,

Table 7 - Importance index for each random variable (%)

Variable	Brazilian code designed bridge		European code designed bridge	
	TB-450	LM1	TB-450	LM1
M_q	29.34	27.71	29.71	27.79
θ_r	41.99	43.32	44.63	46.36
θ_s	21.75	21.79	19.84	19.78

g	6.58	6.84	5.50	5.75
f_c	0.04	0.04	0.05	0.05
f_{pt}	0.04	0.04	0.04	0.04
d_p	0.05	0.05	0.05	0.05
A_p	0.21	0.21	0.19	0.19

and the loading error model. Therefore, the parameters of these variables should be determined very carefully.

IV. CONCLUSIONS

Using the First Order Reliability Method (FORM), the reliability index was determined, and the degree of safety of prestressed concrete bridges designed according to Brazilian and European codes was verified. The values obtained by the FORM method were validated through the Monte Carlo simulation method since they presented similar results.

It was possible to verify that structures designed according to European codes provide higher safety degrees than those designed according to Brazilian regulations. In addition, the LM1 mobile load model generates bending moments in the structure more elevated than those caused by the TB-450.

Through sensitivity analysis, it was shown that the random variables of the moment due to the moving load (M_q), the resistance model error estimate (θ_r) and the loading model error estimate (θ_s) have more significant contributions to the failure probability. On the other hand, the permanent load (g) has a smaller contribution to the probability of failure, and the other variables have minimal contributions.

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Determination of Stiffness and Hardness of Glasses by using Acoustic Waves Testing

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Keywords—Soda-lime Glass, Elastic Properties, Non-Destructive Testing, Acoustic Wave.

Abstract—In this study we sought to develop a non-destructive test that uses the propagation of acoustic waves to characterize the stiffness and hardness of flat glasses. For this purpose, three different glass samples were investigated by using acoustic waves resulting from the impact caused by a steel sphere in free fall on the samples surface. As a result, it was found that the glass samples have different vibration frequency and this behavior is associated to the Young's modulus and microhardness, values. The values calculated by the ultrasonic transmission method indicated that the increase in stiffness is related to the appearance of amplitude peaks in the acoustic signal of the samples, attesting to the possibility of the method for characterizing the mechanical properties of glasses used in civil building.

I. INTRODUCTION

Flat glass, known as float glass, stands out in the building market due to the growth of glazed areas that represent a characteristic of modern architecture. In contrast to the architectural beauty, the increase in glazed areas leads civil building professionals to several questions about safety and the increase in internal temperature in buildings, which in turn, favors greater consumption of electricity with refrigeration equipment.

Float glass is a soda-calcium silicate glass, transparent, colorless or colored in its mass, with parallel and flat faces. This type of glass is obtained by continuous melting and solidification inside a bath of molten metal [1]. Besides to being applied in civil building, they are also used as a basis for obtaining other types of commercial glasses. The chemical compositions of colorless, smoked and green glasses are well known, with only small variations found in their main constituent elements, such as: 68-75%

SiO₂, 10.2-17% CaO, 6-12.4% Na₂O, 0-4% Al₂O₃, 0-5.5% MgO and 0-3% K₂O [2-6].

With regard to colorless glass, it has generally low percentages of Fe₂O₃ or the absence of this oxide among its main constituent elements, but additions between 0.25% and 0.65% can favor the coloring of the smoked glass [4, 6, 7]. The greenish color can be obtained by keeping the percentage range of Fe₂O₃ and adding 1% cerium oxide (CeO₂) and 1% titanium oxide (TiO₂) [3]. Values between 0.002% and 0.06% of CrO₂ are also responsible for the coloring of some green glasses [8].

The colors variety of float glass allow its use in situations where it is desired to reduce the entry of light into buildings, controlling solar radiation, since part of the radiation will be reflected to the external environment and the other part will be absorbed by the glass [8].

It is important to know some properties when using float glass. Among them, the following stand out: flexural

strength, hardness, electrical resistivity and optical absorption. These properties provide important information on glass performance in different usage situations [5, 9, 10, 11]. However, knowledge of these properties is still insufficient to characterize glasses more comprehensively, being necessary to carry out studies on dimensional analysis, mechanical shock resistance, thermal shock resistance, fragmentation and safety tests.

The majority of mechanical tests for the characterization of glass are destructive, in other words, they damage the investigated samples. These tests also require more time and cost to acquire the results and to produce samples that will be destroyed. On the other hand, there are non-destructive tests capable of investigate a material without having to destroy it. For example, acoustic waves propagated through a ceramic material can provide important information about its mechanical characteristics and structural integrity [12,13]. In this way, some studies have shown a simple and accessible methodology to investigate the mechanical properties of materials with acoustic waves. [14, 15].

The development of a non-destructive testing and low-cost methodology were the main motivators of this study that aimed to investigate the use of acoustic waves as an alternative to characterize the hardness and stiffness of glasses used in the civil building.

II. EXPERIMENTAL

2.1 Samples characteristics

To perform the acoustic waves testing, three samples of window glasses were commercially acquired in a common glazing company. The glasses were one colorless, one smoked and one green. After cutting, the samples were weighted in an analytical balance with resolution equal to 0.001 g and their dimensions were measured using a digital caliper. All the samples had clean and smooth surface. Moreover, they were free of flaws or cracks. The volume of each sample was calculated by the product: length (l) x width (w) x thickness (t). Table 1 shows the dimensions, weigh and volume for each glass sample.

The density (ρ) of the samples was calculated using Equation 1, which represents the ratio between weight (W) and volume (V). The calculated values were assumed to be uniform, since samples with constant inertia and homogeneous weight distribution were considered.

Table. 1: Weight and Volume of glass samples

Glass	Weight (kg)	l (m)	w (m)	t (m)	Volume ($10^{-5}m^3$)
Colorless	0.207	0.2200	0.1050	0.0036	8.3160
Smoked	0.195	0.1999	0.0998	0.0037	7.3815
Green	0.193	0.1998	0.1000	0.0035	6.9930

$$\rho = \frac{W (kg)}{V (m^3)} \quad (1)$$

2.2 Mechanical properties by using ultrasonic testing

In isotropic materials several mechanical properties can be calculate using the density (ρ) of material and ultrasonic longitudinal (V_L) and shear (V_S) wave velocities [16-21]. Thus, Equations 1, 2 and 3 were used to determine the Young's modulus (E), Poisson's ratio (ν) and microhardness (H) of the glass samples, respectively.

$$E = \rho V_S^2 \left(\frac{3V_L^2 - 4V_S^2}{V_L^2 - \rho V_S^2} \right) \quad (2)$$

$$\nu = \frac{V_L^2 - 2V_S^2}{2(V_L^2 - V_S^2)} \quad (3)$$

$$H = \frac{(1 - 2\nu)E}{6(1 + \nu)} \quad (4)$$

To measure the ultrasonic signals propagated through the glasses an electronic system emitter and detector of longitudinal ultrasonic waves was previously developed. The signals were generated using a piezoelectric transducer with a diameter of 0.02 m and 125 kHz frequency, being captured with another identical transducer. The measurements were made based on the transmission method [22, 23]. In this procedure, the transducers are placed at the ends of the samples (Figure 1). Bee honey was used as a couplant between the transducers and the glass surface.

The travel time, in microseconds (ms), between the emitted and received ultrasonic wave was measured on an oscilloscope screen (Tektronix TBS1062) and exported to OpenChoice Desktop program that is connected to the electronic system. Figure 2 shows a measurement of the longitudinal ultrasonic wave travel time through the glass sample. The length measured between the centers of transducers was 0.18 m. This value was admitted as distance traveled by the ultrasonic wave.

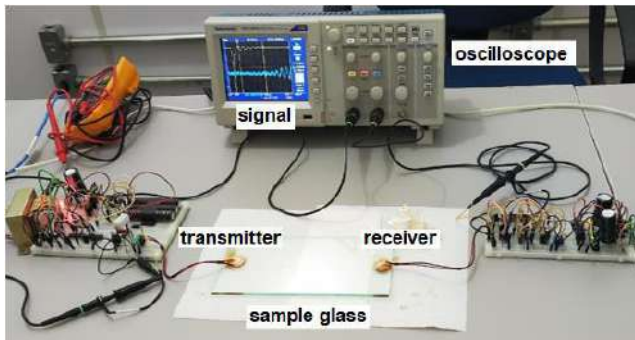


Fig.1: Transmission ultrasonic method

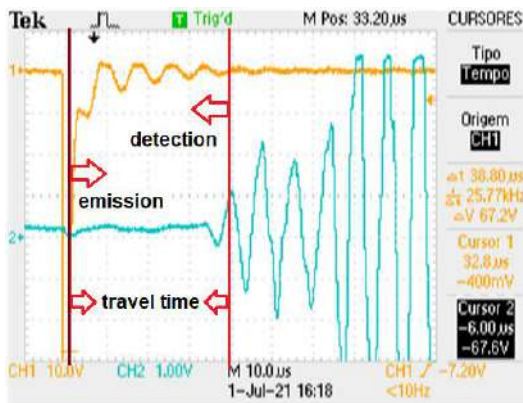


Fig.2: Travel time of ultrasonic wave through the glass

To calculate the velocity of longitudinal wave (V_L) the Equation 5 was used. In this equation, d = distance traveled by the ultrasonic wave and t = travel time through the sample. The mean value of V_L was obtained from three reproducible measurements that were performed by removing and repositioning the transducers at the ends of the samples.

$$V_L = \frac{d (m)}{t (s)} \tag{5}$$

The velocity of shear wave (V_S) was estimated by the relationships that exist between V_S and V_T for the glasses. In several studies it can be seen that the ratio between V_S and V_T for soda-lime glass is around 0.60 [5, 7,23]. This behavior is also observed in tellurium, lead, zirconia or boron glasses and also in fused silica glass [17, 18, 23,24]. Therefore, the shear velocity wave was estimated by Equation 6.

$$V_S = 0.6V_L \tag{6}$$

The values of V_L , V_S and ρ were used to determine the mechanical properties presented by Equations 2, 3 and 4. After that, the results were compared with the acoustic signals obtained in the glass samples.

2.3 Generation and acoustic signal capture

For analyze the propagation of acoustic waves on the surface of the samples was used a free software. The Soundcard Oscilloscope software has been used in the study of acoustic wave propagated in different materials, such as ceramic brick, tiles, concrete and steel. In the present study, the samples were impacted with a stainless steel sphere (weight = 9 g, diameter = 12.7 mm) abandoned in free fall. To ensure that the sphere was always abandoned from the same position, a PVC tube with 0.02 m high and 0.0254 m diameter was used. The acoustic signals generated were captured with the Soundcard Oscilloscope software that represents a digital oscilloscope. Then, average acoustic signal for each sample was obtained from 20 measurements.

The amplitude of the signals measured (in the arbitrary unit a.u.) was investigated as a function of the acoustic wave propagation time in the range between 0 and 30ms. An earphone stereo Plug P2 was used as a receiver for the acoustic signals. The earphone was positioned in one of the ends to capture the signal produced by impact with the sphere at the other end of the sample. The setup of the experiment is illustrated in Figure 3. Figure 3(a) shows the computer with Soundcard Oscilloscope software. The impact locations with the sphere and the capture of acoustic signals on the glass samples can be seen in the top view shown in Figure 3(b).

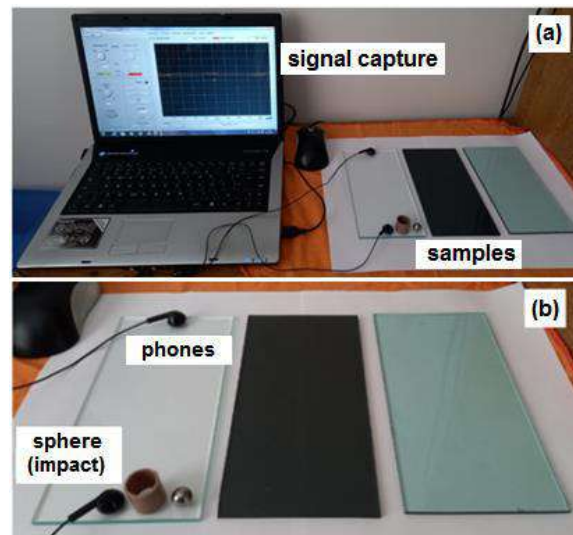


Fig.3: Acoustic waves testing: (a) system used for signal capture, (b) measurement procedure

Figure 4 shows an acoustic wave signal captured and displayed on the computer screen. In this experiment, the type of phone used as a signal receiver is not sensitive enough to capture external noise or vibrations that could be transmitted to the digital oscilloscope and interfere with

the measurements. This fact can be evidenced by the red line presented just below the acoustic signal in Figure 4. The red line represents the signal before the measurements, while the green line represents the acoustic signal after the impact. Thus, there is no external noise or vibrations before the measurements.

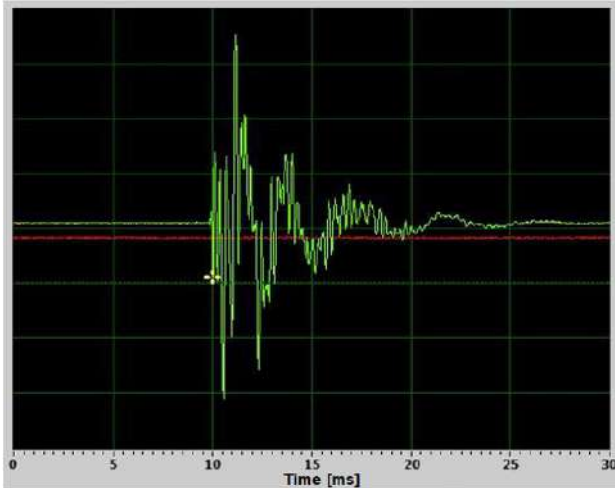


Fig.4: Example of the acoustic signal captured on the glass surface

The acoustic signals were also analyzed as a function of the vibration frequency. For this, Fast Fourier Transform (FFT) method was used, that is widely used in the study of signal processing and several other applications in physics and engineering. This procedure was performed to observe the excited frequencies in the glass samples during the propagation of the acoustic wave.

III. RESULTS AND DISCUSSION

The results obtained with the propagation of acoustic waves on the glasses surface are shown in Figure 5. In Figures 5(a), (c) and (e) are shown the overlapping acoustic signals, resulting from 20 measurements, as well as the average acoustic signal. Analyzing the results, it is possible to observe that all measurements were reproducible in each of the investigated glasses with only a small variation in the amplitude.

Small variations in the amplitude occurs due to procedure adopted for the abandonment of the steel sphere in free fall. Even using a PVC pipe as an artifice to maintain a constant height millimeter changes in free fall height may occur. The average acoustic signal for the colorless, smoked and green glasses are shown in Figures 5(b), (d) and (f). Analyzing the results, it can be seen that the amplitude of the acoustic signal decreases from colorless glass to smoked and from smoked to green. This

fact can be verified by analyzing the values on the vertical axes of amplitudes in the figures.

In general, the behavior of the signals obtained on the glass samples is similar and the largest amplitudes are observed in the region situated on the time axis between 9.78 ms and 12.5 ms. In the region above 12.5 ms, the signals of acoustic waves are attenuated and the decay of the amplitudes is observed. To verify this behavior more clearly, the average acoustic signals were overlapping and shifted along the vertical axis of the amplitudes (Figure 6). After that, the region on the time axis between 9.78 ms and 12.5 ms was enlarged for comparative purposes (Figure 7).

From the enlargement of the signal obtained in the colorless glass, it was found that the investigated region of the acoustic wave consists of 10 amplitude peaks identified on the time axis. These peaks were named from P1 to P10 and are shown in Figure 7(a). In the result, it is still possible to observe a tendency of overlapping between P3 and P4, and also between peaks P6 and P7.

In the enlargement of the signal obtained for the smoked glass, it was found that the investigated region consists of only 7 amplitude peaks, as shown in Figure 7(b). The P1, P2, P4 and P5 peaks are located in the same positions as P1, P2, P5 and P7 peaks, present in the signal obtained for the colorless glass. Furthermore, P3 in the smoked glass signal resembles a complete overlapping between P3 and P4 shown in the colorless glass signal. This behavior also occurs in P5, which corresponds to the complete overlapping between P6 and P7 peaks observed in the colorless glass signal. The overlapping of peaks in the smoked glass signal reduces the number of visible peaks in the investigated region and favors the appearance of wider peaks, when compared to the peaks present in the acoustic signal of the colorless glass.

According to Figure 7(c), only P1 is not in overlapping with the other peaks present in the signal measured for the green glass. In addition, P1 is the only peak observed at the same position in all signals obtained on the samples.

In the acoustic signal of the green glass, Figure 7(c), a greater number of overlapping peaks results in wider peaks than those observed on the colorless and smoked glass signals. This indicates that acoustic signal on the green glass is more attenuated than signals observed on the other glass samples shown in Figures 7(a) e 7(b).

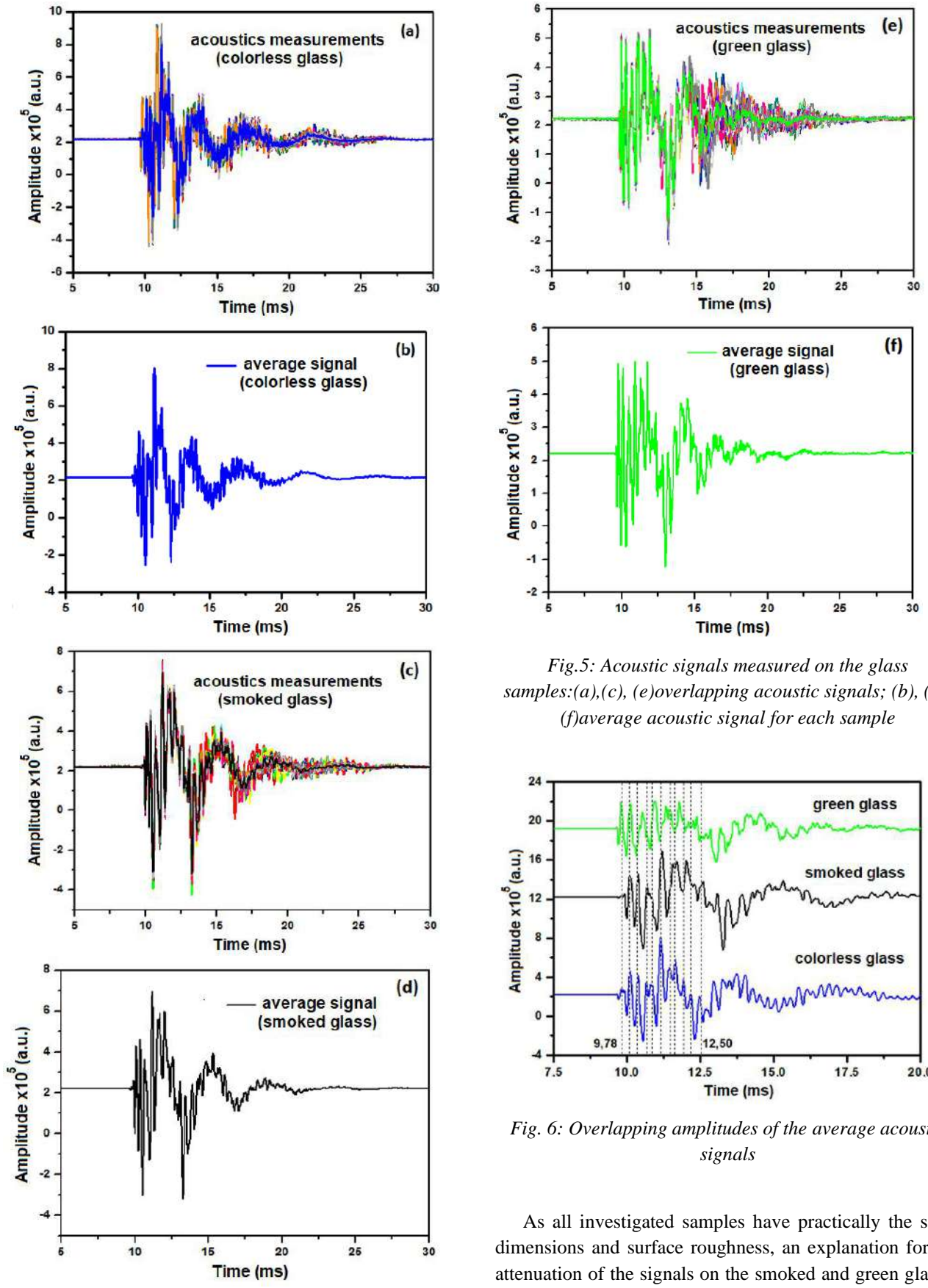


Fig.5: Acoustic signals measured on the glass samples:(a),(c), (e)overlapping acoustic signals; (b), (d), (f)average acoustic signal for each sample

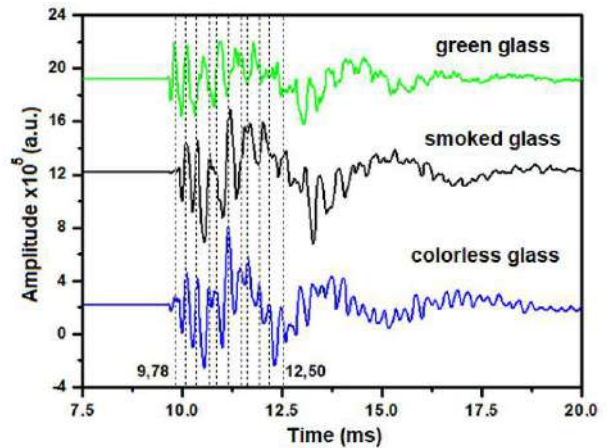


Fig. 6: Overlapping amplitudes of the average acoustic signals

As all investigated samples have practically the same dimensions and surface roughness, an explanation for the attenuation of the signals on the smoked and green glasses could be in their different chemical compositions, which could influence the stiffness values.

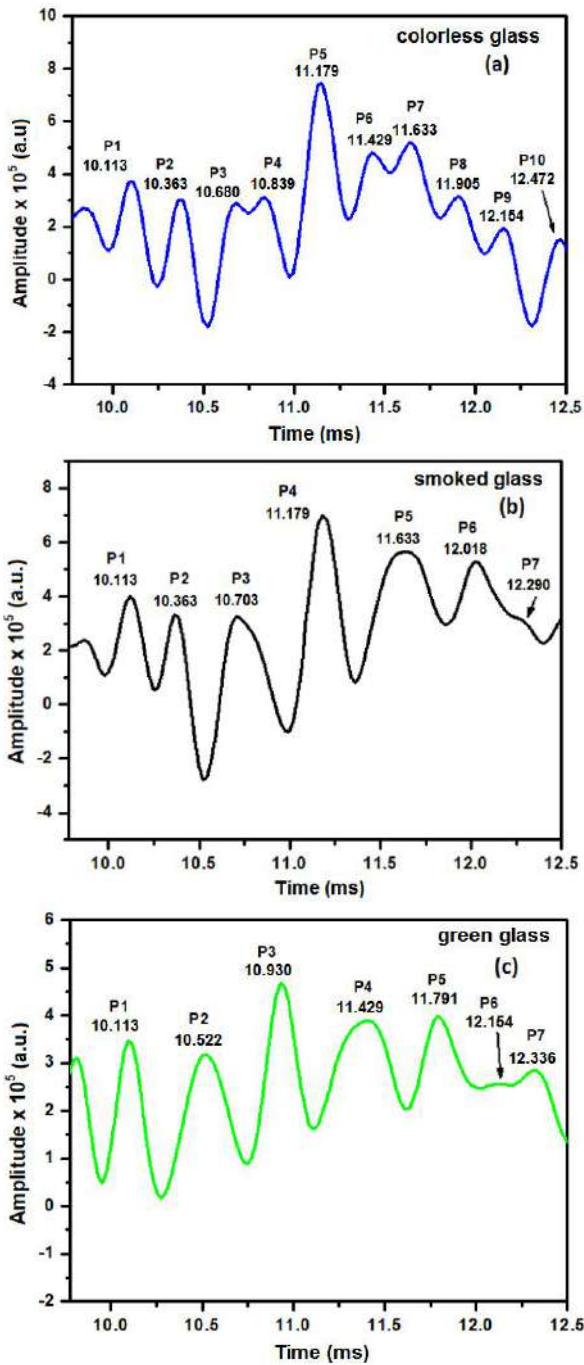


Fig. 7: Enlargement to acoustic signals obtained on the glass samples: (a) colorless, (b) smoked and (c) green

The results obtained for the mechanical properties calculated by Equations 2, 3 and 4 are presented in Table 2. Analyzing the results of V_L and V_S it is noticed that they are smaller for the samples with higher values of E and H . This behavior was also observed in boron-based glasses, when they are doped with different percentages of zinc oxide (ZnO) or lead oxide (PbO) [19].

In solid materials, the values of E are associated with their stiffness. Therefore, colorless glass has less stiffness

than smoked glass, which in turn is less stiffness than green glass. These results also agree with the microhardness H , whose values are higher in the more stiffness glasses. In soda-calcium glass, the values of Poisson's ratio are between 0.20 and 0.22. Thus, the results obtained for $\nu = 0.22$ shown in Table 2 were expected [6].

The values found for the E and H can explain the attenuation and the overlapping peaks presents in acoustic signals of glass samples. For example, in the colorless glass ($E = 49.01$ GPa and $H = 3.75$ GPa) the effects of attenuation and overlapping peakswere smaller than those observed in the green glass signal ($E = 51.06$ GPa and $H = 3.91$ GPa). Therefore, the results suggest that the attenuation of acoustic signals is influenced by the increase in stiffness and microhardness of the glasses.

In order, to analyze the acoustic signals without the effects of overlapping peaks, the average signals in Figure 6 were investigated as a function of vibration frequency. For this purpose, the Fast Fourier Transform method was used. Figure 8 shows the signalobtained as a function of frequency for glass samples, where each amplitude peak represents an excitation frequency resulting from the impact of the steel sphere on the samples surfaces.

In colorless glass, whose acoustic signal is shown in Figure 8(a), 05 characteristic peaks were identified, being three of them located between 0.0020Hz and 0.0050Hz frequency. The other two peaks were identified between 0.0060Hz and 0.0100Hz frequency. Some peaks of smaller amplitude can be observed above of 0.0100 Hz. However, these peaks are located at the region of greater attenuation on the acoustic signaland were discarded from the following steps of analysis of the results.

Figures 8(b) and 8(c) show the acoustic signals for the smoked and green glass, respectively. These results also present a behavior similar to that reported for colorless glass. However, in the green glass, 04 characteristic peaks were found between 0.0020 Hz and 0.0050 Hz. Although the acoustic signals for smoked and green glasses are similar to the signal of the colorless glass, comparing the amplitude peaks it is noticed that these are shifted to lower frequencies. To more clearly analyze the displacement of the signals, the location values peaks on the frequency axis are in Table 3.

The appearance of a peak in the signal of green glass, whose presence is not observed in the colorless and smoked glass, was disregarded for the comparative analysis of the peaks and their respective frequency values.

Table. 2: Properties calculated for the glass samples

Glass	ρ (kg/m ³)	V_L (m/s)	V_T (m/s)	E (GPa)	ν	H (GPa)
Colorless	2489.18	4736.84	2842.10	49.01	0.22	3.75
Smoked	2660.76	4639.18	2783.51	50.25	0.22	3.84
Green	2759.90	4591.84	2755.10	51.06	0.22	3.91

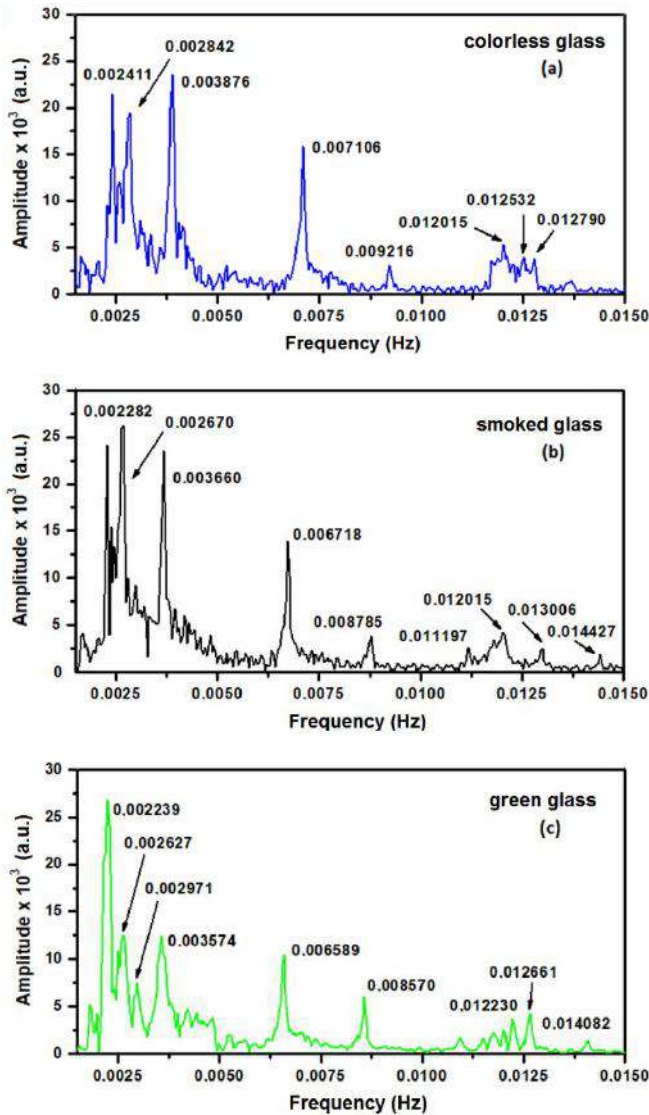


Fig.8: Acoustic signal as a function of frequency

It is believed that the appearance of a new peak observed in the signal of green glass may be associated with an intrinsic characteristic of the chemical composition of the sample. Colorless and smoked glass have similar chemical compositions, different only in the highest percentage of Fe₂O₃ present in smoked glass [4, 6, 7]. This fact may explain why the signals of colorless and smoked glass are similar in the number of amplitude peaks on the non-attenuated region. Therefore, the appearance of a new

peak at 0.002971 Hz frequency in the green glass signal may be associated with the presence of chemical elements such as CeO₂, TiO₂ or Cr₂O₃, commonly observed in this type of glass.

Table. 3: Amplitude peaks on the frequency axis

Peaks	Frequency (Hz)		
	Colorless	Smoked	Green
1	0.002411	0.002282	0.002239
2	0.002842	0.002670	0.002627
3	0.003876	0.003660	0.003574
4	0.007106	0.006718	0.006589
5	0.009216	0.008785	0.008570
H (GPa)	3.75	3.84	3.91
E (GPa)	49.01	50.25	51.06

It is important to emphasize that this hypothesis was based on reports found in the literature on the general chemical composition of colorless, smoked and green glass, but it will only be proved with a chemical analysis of the samples.

Similar to what was observed for the acoustic signals as a function of time, the signals as a function frequency seem to be related to the stiffness and microhardness of the glass samples. It is believed that, in the more stiffness glass (green glass), characteristic peaks arise at lower frequencies due to the greater attenuation in the propagation of acoustic waves, as discussed earlier. Therefore, from the results presented in Table 3 it is possible to associate the frequency peaks with some mechanical characteristics of the samples as Young's modulus (E) and microhardness (H).

IV. CONCLUSION

In this study, it was possible to verify in glass samples that the attenuation of acoustic signals is associated with higher values of Young's modulus and microhardness. The signals with higher attenuation showed characteristic peaks at lower frequencies, suggesting a possibility to identify

and characterize some mechanical properties of soda-lime glass by means of acoustic signal analysis.

Although the glass samples presented different of density and ultrasonic velocities values, the calculated value for the Poisson's ratio was the same for all glasses. This result is in agreement with what was expected for soda-lime glasses and reinforces the use of ultrasonic waves for a reliable estimate of the Young's modulus and microhardness in the glasses used in civil building.

The results were obtained with a rapid method that attests to the possibility of using acoustic signals as a non-destructive technique for characterizing the mechanical properties of soda-lime glasses. In the future studies, acoustic signals will be also used to investigate other properties such as compressibility and shear modulus.

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Intracranial hemorrhage in the preterm infants: An integrative literature review

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Keywords— **Intracranial hemorrhages, Infant premature, Cerebrovascular Disorders, Intracranial Pressure, Diseases of the newborn.**

Abstract— *Intracranial hemorrhage (ICH) is one of the main reasons for morbidity and mortality in model newborns, being considered the biggest problem of prolonged treatment for units in the world. The research aims to review and analyze, through the relationship of intracranial hemorrhages in preterm newborns. Method: This is a study of bibliographic, descriptive, literature review type, with searches carried out in virtual libraries Scientific Electronic Library Online (SciELO), Biblioteca Virtual em Saúde (BVS) and PubMed database. Ten full articles were selected, available in open access in Portuguese, English and Spanish and published in the years 2015 to 2022. Results: Based on the analysis of the classes, three categories emerged, described below: Class 1 - Factors Associated with Intracranial Hemorrhage in Newborns, Class 2 - Comorbidities Associated with Intracranial Hemorrhage, Class 3 - Outcome of Intracranial Hemorrhage in Child Development. Conclusion: it is essential to understand the risk variables for the development of ICH for the recognition of the choice criteria and the therapeutic conducts in the care of the neonate, as well as the adequate follow-up to alleviate possible injuries.*

I. INTRODUCTION

Intracranial hemorrhage (ICH) is one of the main reasons for morbidity and mortality in premature newborns. The etiology of this hemorrhage is multifactorial and includes the cerebral vascular fragility inherent to prematurity, changes in blood flow and changes in intracranial pressure. The greater the prematurity, the greater the possibilities of developing ICH (Amaral, J, et al, 2022).

The severity of intracranial hemorrhage is associated with its extent, and can range from grade I, mild hemorrhage, to grade IV, severe hemorrhage. Thus, grade I is restricted to the subependymal germinal matrix (caudothalamic sulcus); grade II, without intraventricular ventricular dilatation; grade III, intraventricular with ventricular dilatation; grade IV, parenchymal hemorrhage corresponding to periventricular venous infarctions with hemorrhagic progression (Neves, LAT, et al, 2007).

Clinically, ICH is most commonly asymptomatic, but it can manifest as a subacute intermittent neurological syndrome or, less frequently, when ICH is more significant, as a catastrophic acute neurological deterioration syndrome. (Amaral, J, et al, 2022).

Intracranial hemorrhage is an expressive problem in premature newborns (PTNB) and with birth weight below 2,500 g, called low birth weight newborns (LBW). ICH has great relevance for its immediate and future severity, considering the subsequent neurological disorders (Seki, TN; Balieiro, MMFG, 2009).

Several cases of ICH occur soon after birth or on the first day after birth, therefore, it is closely associated with perinatal aspects. Regarding the moment of occurrence of ICH, almost all of it happens in the first seven days of life, with more than 95% in the first 72 hours of life. (Amaral, J, et al, 2022).

ICH in NB can cause failures in the neuropsychomotor development of these children, mainly because they are associated with prematurity. In this way, the neuropsychomotor development of preterm infants with ICH is present in approximately 30% to 60% of severe cases of ventriculomegaly related to developmental sequelae, such as insufficient muscle tone, inadequate strength and reflexes, and delay in controlling the blood pressure. head (Cerisola, A, et al, 2019).

Trans fontanellar ultrasound (TFUS) is the test of choice for diagnosing intracranial hemorrhages. In addition to the diagnosis, the USTF assists in the staging of ICH and provides information regarding the immediate and long-term prognosis. TUS must be performed, through the anterior or bregmatic fontanelle, in all

premature NBs with birth weight below 2,500 g, between 3 and 5 days of life, and reinforced weekly until hospital discharge, regardless of the appearance of symptoms. (Cerisola, A, et al, 2019).

The relevance of ICH in the prognosis of neuropsychomotor development of premature and low birth weight newborns has become more noticeable as diagnostic methods have become more sophisticated and clinical and epidemiological findings have become better known (Neves, LAT, et al, 2007).

According to Amaral, J, et al, (2022), some research shows that there is a tendency for a time of low brain flow that precedes ICH in preterm infants. And that these ranges of vascular passivity to pressure are usual in preterm infants, and are significantly related to low birth weight, low gestational age and systemic hypotension.

Intracranial hemorrhage decreased its incidence by 20% in the late 1980s. However, in the last two decades the occurrence of ICH has remained stationary. In newborns with extremely low birth weight (<750g) it reaches 45%. ICH remains the biggest neurological problem for premature infants in intensive care units worldwide (Neves, LAT, et al, 2007).

II. METHOD

In this sense, the present work aims to review and analyze, through the literature, the relationship of intracranial hemorrhages in preterm newborns, as well as recommendations to prevent them.

This is a bibliographic, descriptive analysis of the integrative literature review type, which made it possible to explore and understand a particular topic based on another independent research. It is revealed that the execution of the research was carried out in five main stages: recognition of the guiding question of the study; research in the literature; establishment of inclusion and exclusion criteria; information analysis; discussion of results and presentation of the review. In this sense, the following guiding question was applied to guide the research: What is the relationship between intracranial hemorrhages in preterm newborns?

To carry out the research, the Scientific Electronic Library Online (SciELO) and Virtual Health Library (BVS) and PubMed databases were consulted. For the search, the descriptors in Health Sciences (DeCS) were used, namely, "intracranial hemorrhages" and "premature infant", using the Boolean "AND" to process the associations of all the descriptors with each other.

The search was carried out from November 18 to 26, 2021. For the selection of material, the following

inclusion criteria were considered: complete articles, available in open access in Portuguese, English and Spanish and published in the years from 2015 to 2022.

Initially, 2,073 publications were found, however, after applying the inclusion criteria, this number decreased to 291 articles. 178 articles were found in PubMed, 64 in VHL and 49 in SciELO, with 24 duplicate articles in PubMed, 13 in VHL and 7 in Scielo. Thus, after reading the titles, 108 articles were selected and 34 articles by the abstract, leaving 10 studies chosen for reading in full. 1,782 journals were excluded because they were not complete or did not answer the research question. Figure 1 shows the flowchart of the article selection process.

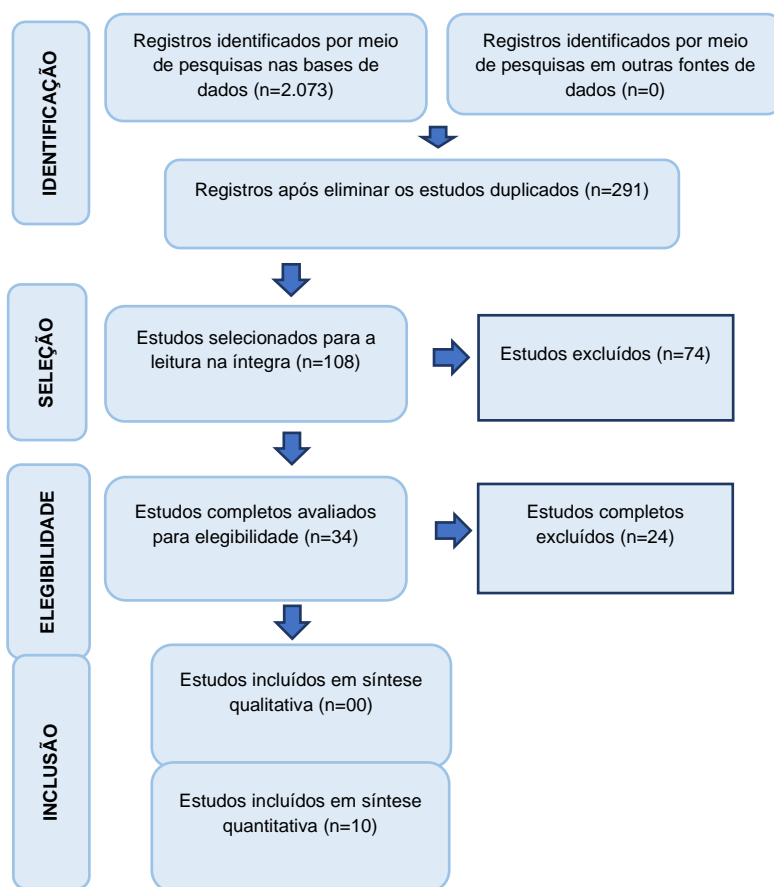


Fig.1: Shows the flowchart of the article selection process.

Source: Study selection flowchart adapted of Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA 2009). Belém (PA), Brasil, 2022.

From the pre-reading of each article selected in the research, it was possible to analyze and characterize them in terms of authorship, year of publication, title, virtual libraries, method, levels of evidence.

Studies considered as high evidence quality (meta-analysis of multiple controlled studies - level 1; individual studies with experimental design - level 2), moderate evidence quality (study with quasi-experimental design as a study without randomization, with single test groups before and after, time series or case-control – level 3; studies of non-experimental designs, such as descriptive correlation and qualitative studies or case studies - level 4; case reports or systematically obtained data - level 5), low evidence quality (an authority opinion based on clinical competence or expert committee opinion, including interpretation of non-research-based information - level 6) (Duncombe D. C, 2018).

The textual corpus was elaborated with the conclusions of the articles, organizing it in a single text file for Bardin's processing and analysis. According to Bardin (2016), it consists of a method divided into stages: organization of analysis, coding and categorization. Thus, the organization of the analysis is characterized by the exhaustive reading and treatment of the results obtained for interpretation. In addition, in the coding, the units of records in the transcribed material will be classified and in the categorization, the observed results are listed in categories.

In this sense, after the described phase, the studies were analyzed by means of a critical reading of the chosen studies, in order to extract information regarding intracranial hemorrhages in preterm newborns, according to the content of the literature.

III. RESULTS AND DISCUSSION

After selection, only 10 articles met the criteria established in this review, one in 2020 (10%), four in 2019 (40%), one in 2018 (10%), one in 2017 (10%), two in 2016 (20%) and one in 2015 (10%). It was noted that two journals are in the SciELO virtual library (20%), two in the VHL (20%) and six in PubMed (60%).

Regarding languages, six studies were recorded in English (60%), three studies in Portuguese (30%) and one study in Spanish (10%). Regarding the methodology used, all studies were classified as quantitative (100%). Therefore, the articles included in this review are presented, thus exposing the specifications regarding the code of each article, author, year, title, database, method, and levels of evidence (Table 1).

Based on the analysis of the classes, three categories emerged, described below: Class 1 - Factors Associated with Intracranial Hemorrhage in Newborns, Class 2 - Comorbidities Associated with Intracranial Hemorrhage,

Class 3 - Outcome of Intracranial Hemorrhage in Child Development.

Table 1: Integrative review articles

Autor/ Ano		Título	Biblioteca Virtual	Método	Níveis de Evidência
A1	SILVA, Lisandra Radaelli da, et al. 2015.	Pregnancy aspects related to intracranial hemorrhage in newborns of very low weight in South Brazil	SCIELO	Quantitative Analytical Cross-sectional Study, case-control type	Level 2
A2	MARTINO, Márcia Salim de, et al. 2019.	Comparison on cognitive performance among schoolchildren born prematurely according to the presence of intracranial hemorrhage in the neonatal period	SCIELO	Quantitative Analytical Cross-sectional Study, cohort type	Level 2
A3	GRANDI, Carlos, et al. 2016.	Perinatal factors associated with neonatal mortality in very low birth weight infants: A multicenter study	BVS	Quantitative Analytical and Retrospective Study, cohort type	Level 2
A4	SANTOS, Denise Santana Silva dos; PRADO, Marcelle Sanjuan Ganem. 2017.	Occurrence of neurological injuries in newborns diagnosed by transfontanelar ultrasound	BVS	Descriptive and Retrospective Quantitative Study, of the cohort type	Level 3
A5	KATHERIA, Anup, et al. 2019	Association of Umbilical Cord Milking vs Delayed Umbilical Cord Clamping with Death or Severe Intraventricular Hemorrhage Among Preterm Infants	PUBMED	Randomized clinical trial	Level 1
A6	MAHANEY, Kelly B et al. 2020	Intraventricular Hemorrhage Clearance in Human Neonatal Cerebrospinal Fluid: Associations with Hydrocephalus	PUBMED	Quantitative Analytical and Prospective Study, case-control type	Level 2
A7	GOTARDO, Juliana Wendling, et al. 2019	Impact of periventricular haemorrhage and periventricular leukomalacia in the neurodevelopment of preterms	PUBMED	Meta-analysis	Level 1
A8	HUANG, Jinglan, et al. 2019	Antenatal infection and intraventricular hemorrhage in preterm infants	PUBMED	Meta-analysis	Level 1
A9	CARDOSO, Gaëlle Pinto, et	Association of Intraventricular Hemorrhage	PUBMED	Quantitative Analytical and Prospective Study,	Level 2

	al. 2018	and Death with Tocolytic Exposure in Preterm Infants		cohort type	
A10	Lu, Hongyan et al. 2016	Risk Factors for Intraventricular Hemorrhage in Preterm Infants Born at 34 Weeks of Gestation or Less Following Preterm Premature Rupture of Membranes.	PUBMED	Quantitative Analytical and Prospective Study, case-control type	Level 2

Source:Own authorship. Belém (PA), Brasil, 2022.

Class 1 - Factors Associated with Intracranial Hemorrhage in Newborns.

ICH is a disease of multifactorial etiology, associated with intrinsic fragility of the vasculature of the germinal matrix, changes in cerebral blood flow and hemostasis and coagulation disorders, which may be symptomatic or asymptomatic, depending on the area and extent of the lesion(Santos, GC, 2019).

Therefore, among the reasons that correlate with the genesis of ICH are maternal or obstetric, prenatal, perinatal conditions, those typical of preterm newborns and those associated with ventilatory support and systematizations and techniques commonly performed in Neonatal Intensive Care Units (Santos, GC, 2019). By analyzing A10 based on the logistic regression performed in the study, the lower gestational age, low birth weight, the greater the risk of developing ICH, in addition, asphyxia resuscitation and maternal chorioamnionitis were evaluated as independent risk factors for ICH.

According to the A3, Low Weight Preterm Newborns (PTNB) tend to have a higher positive predictive factor for the frequency of ICH as well as higher associated mortality, which may also be related to maternal characteristics such as age, which include pregnant women under 18 years of age or over 30 years of age, prenatal characteristics, such as length of gestation, which is related to a greater chance of developing ICH, given that preterm neonates with a GA of less than 28 weeks had higherintracranial hemorrhageproportions(Santos, GC, 2019).

In this way, maternal risk factors are understood above all with the circumstances that result in premature birth, such as low adherence to adequate prenatal care, previous hypertensive disorders (systemic arterial hypertension - SAH) and those that originate from pregnancy (Hypertensive Disorders of Pregnancy - HDP), in addition to preeclampsia and eclampsia (Santos, GC, 2019). Factors that include inflammatory markers and oxidative stress are

also associated, such as those related to maternal infections during pregnancy, accounting for 40% of preterm births (López, CC&Vólquez, RSC, 2019).

In addition, recent research indicates that exposure to intrauterine infection/inflammation results in more serious injuries than just preterm birth, including neonatal sepsis, bronchopulmonary dysplasia, and patent ductus arteriosus, and a higher incidence of intraventricular hemorrhage has been found. This last factor is justified because the preterm newborn does not have a mature self-regulation function in relation to cerebral blood pressure, which can be induced to instabilities of this factor and consequently leading to an increased risk of HIV, which was recorded in about 24% of subjects evaluated in A10 after Premature Membrane Rupture, while the incidence of maternal chorioamnionitis was 43.8%(López, CC&Vólquez, RSC, 2019).

Low APGAR scores can be considered a good measure of the gestational and intrapartum events that result in ICH, as the effects of perinatal asphyxia, such as the presence of hypoxemia, acidosis and hypercapnia, often reduce platelet survival, its aggregatory purposemodifying the balance between bleeding and the coagulation cascade. These disorders impair the homeostasis of newborns affected by asphyxia and may be involved in the etiology of ICH.(Santos, GC, 2019).

In addition, in A1, it was highlighted that the characteristic of the mode of delivery does not significantly interfere with the occurrence of ICH. Differently from what other studies address, which report that it was determined in the analysis of the study that cesarean delivery has a protective factor related to intraventricular hemorrhage, since premature vaginal delivery presented frequent complications in the survey, excoriations and ecchymosis, clavicle fracture, brachial plexus injury , respiratory failure, difficulty in sucking, rupture of the large venous sinuses of the brain and a higher number of deaths. It is worth mentioning that there was a difference between the number of cesarean and

normal deliveries performed in the compared studies (Sanchez, YBV, 2020).

In view of these risk factors, A9 identifies tocolysis as a measure to alleviate negative outcomes for Preterm Newborns and women in preterm labor, as it is associated with a decrease in death or severe ICH in preterm infants, suggesting that tocolysis is safe and may even bring neonatal benefits, such as the use of nifedipine and atosiban in the development of the central nervous system. Tocolytics do not act directly on the uterus and cross the placental barrier. Thus, they have multiorganic effects and can bypass molecular pathways that result in a mature functional blood-brain barrier.

Such aspects are relevant for conducting comparative research, since another treatment with high-dose erythropoietin to extremely preterm infants up to 32 weeks, administered within 24 hours after birth, did not result in a lower risk of high neurodevelopmental impairment or of death at two years old (Juul, SE, et al, 2020).

In addition, we compared cord milking versus delayed cord clamping among preterm infants born at less than 32 weeks' gestation, noting that there was no statistically significant difference in the composite outcome rate of death or severe intracranial hemorrhage, but there was a statistically significantly higher rate of severe intraventricular hemorrhage in the cord milking group (Katheria, A, et al, 2019).

Class 2 - Comorbidities Associated with Intracranial Hemorrhage.

The greater the degree of hemorrhage, the more frequent complications such as hydrocephalus and encephalomalacia, which can cause severe cognitive and motor impairments(A6). According to Ezperanza, MA (2014), any degree of intracranial hemorrhage predisposes to neurocognitive developmental dysfunctions with later rates of cerebral palsy for grades I (8%), II (11%), III (19%) and IV (50%).

Neurological damage resulting from ICH can be varied, such as cerebral palsy, visual and hearing impairment, mental retardation, post-hemorrhagic hydrocephalus, and periventricular hemorrhagic infarction, the last two being very frequent complications. ICH is also described as the main cause of brain death. (A6).

In some newborns they present themselves as subtle changes in the level of consciousness, tone, movement, breathing; and eventually there is catastrophic deterioration happening like coma, decerebrate posturing,

generalized tonic seizures and quadriplegia (Amaral, LF, 2016).

One of the important mediate complications of intracranial hemorrhage is post-hemorrhagic hydrocephalus. This can be a communicative or non-communicative manner that happens because of impaired CSF (Cerebrospinal Fluid) reabsorption or obstruction of the foramen of Monroe. Posthemorrhagic hydrocephalus should be suspected in any preterm infant with ICH who has a rapidly growing head circumference. There are several suggested treatment strategies for hydrocephalus with elevated intracranial pressure, including subgaleal shunt placement, ventricular reservoir placement, or ventriculoperitoneal shunt placement(Esperanza, MA, 2014).

The prognosis of neonates with ICH varies by initial identification, but is generally good (Amaral, LF, 2016). Thus, diagnostic methods are important not only for improving the prognosis and future quality of life of newborns, but also essential for interventions in the progress of intracranial hemorrhage(A4).

Class 3 - Outcome of Intracranial Hemorrhage in Child Development.

Prematurity and the existence of intracranial hemorrhage in the neonatal period are causes of risk for development at different stages of development, particularly at school age, when cognitive adversities are more pronounced.(A2).

According to Santos DSS dos & Prado MSG (2017), situations may be responsible for changes in global development when genetic or acquired causes occur in limiting circumstances in structural and functional fields of the nervous system, as can occur with intracranial hemorrhages.

It is still not adequately understood whether children who were born preterm and manifested ICH in the neonatal period, when they reach school age, will or will not present changes in the cognitive assessment (A2). However, studies indicate specific cognitive alterations, such as memory, attention, visual-motor skills, difficulty with numerals and deficits in function(A7).

Considerable inequalities are found in the general cognitive ability (IQ), language, phonetics, sensitization, articulation and school development of children born extremely preterm and/or with intracranial hemorrhages, compared to their age-matched peers who were born without any pathology (Martino, MS, et al, 2019).

Martino, MS, et al, (2019), it is estimated that a considerable number of children who were born

prematurely with ICH manifest subtle developmental disorders, which are often not observed or are diagnosed late. It also pointed out that premature children with ICH are at risk for behavioral disorders with a prevalence of attention deficit, autism and hyperactivity.

In this way, verifying and monitoring the development of these children is important, since the various types of diseases, whose effects appear throughout the child's life, can be prevented early, through guidance to parents and assistance from specialized professionals (Santos DSS dos, Prado MSG, 2017).

As a result, parents or guardians need to receive guidance on essential developmental stimulation. Thus, actions such as playing, reading, and having a motor and tactile stimulus aimed at the period of early childhood, from zero to three years, contribute to improving neuro-cognitive functioning throughout life (A7).

IV. CONCLUSION

Considering the NB in all its peculiarities from pregnancy to the birth process, there are numerous changes that make them susceptible to complications such as intracranial hemorrhage, prematurity and low birth weight.

Among the factors related to the occurrence of intracranial hemorrhages, associated conditions such as maternal, obstetric, prenatal, perinatal and those of the preterm newborn, which result in weaknesses that favor the involvement of ICH.

In view of this, it is essential to understand the risk variables for the development of ICH (5th minute Apgar score below six, low birth weight, modes of delivery, maternal age greater than 30 years or less than 18, prenatal care). in appropriate Christmas, etc.). Thus, well-defined clinical approaches and effective prophylactic strategies still need to be established.

The recognition of factors associated with ICH reinforces the criteria for choosing and therapeutic approaches in the care of the neonate, as well as in the management, with the aim of preventing future comorbidities associated with adequate follow-up to alleviate possible injuries.

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Attitudinal Accessibility in Inclusive Education for Transdisciplinarity and Learning

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Keywords— **education, inclusion, transdisciplinarity, accessibility.**

Abstract— *Education has even become present in academic debates, always with relevant themes related to accessibility and teaching. This study will address fundamental issues with regard to a greater appreciation of students with disabilities in school spaces, proposing attitudinal, conceptual, methodological and structural changes in pedagogical environments. The student-teacher relationship in the classroom will also be discussed, prosing general changes in the educational process, adapting the students' reality to the environment in which they find themselves, in order to generate greater engagement and development of the learning process.*

I. INTRODUCTION

In Brazilian legislation, the enrollment and retention of student with disabilities, regardless of the

nature of their special education needs, is ensured, requiring the school to (re) organize to offer an inclusive, humane and universal education. Specialized education

service for students with disabilities carried out by specific professionals from different areas is part of the way to make possible the school inclusion of students with disabilities, but it is not only step on the path of formal education to provide conditions for learning. More than the permanence of students with disabilities in the physical school space, it is necessary to review paradigms, seek and apply educational alternatives that contribute to the construction of knowledge of all parties involved and especially of the student with disabilities, which aims to meet a certain need.

The school's political-pedagogical project must be built with the effective participation of the school community, which goes beyond school employees and reaches other members of the community such as parents and students. The political dimension of what is idealized for Brazilian education must be taken into the pedagogical project, seeking to open paths for its practical application. In this project, the special educational needs of students are reflected to provide access to the curriculum and appropriate conditions for student learning, favoring their development while respecting the needs, potentialities and educational and social background of the student.

II. THEORETICAL REFERENCE

What some call Inclusive Education ends up being limited to the physical insertion and integration of students with disabilities into the common classroom. A lot is required of the student to adapt to the common class without any adjustments on the part of the authorities, the school and the educators. When the proposal for the inclusion of students with disabilities began, it sought to innovate in relation to the proposal of integration that was applied. The inclusive proposal aimed to make the success of students with specific needs more significant, as it seeks to contribute to student learning and development. In this sense, we argue that the

[...] inclusion proposal proposes that educational systems become responsible for creating conditions to promote quality education for all and make adjustments that meet the special educational needs of students with disabilities (SILVA,2006, p.15).

As can be seen, in inclusive education, it is essential that the educational system adapts to the educational needs of students and, for this, educational practice needs to be designed to accommodate the human diversity that manifests itself in the classroom. Therefore, "Educating means leading young people to dialogue with knowledge. Taking care of self-referentiality through multi-referentiality. Caring for unity through diversity."

Insisting on standardizing practices compromises learning by disregarding the peculiarities of the parties involved in the educational process. Students with educational needs specific to their disability must be offered the conditions for learning, development and educational success. Accessibility needs to be practiced in the removal of architectural barriers, in the adaptation of furniture, in the production and availability of didactic materials adapted to the needs of the student, activities designed according to the universal design for the construction of student knowledge and work in the attitude of everyone involved with school inclusion.

The effectiveness of action in the face of Inclusive Education implies attitudinal, conceptual, methodological and structural changes in the educational space (BRASIL, 2015). At school, an educational paradigm based on the process of building knowledge and respect for differences is necessary. In addition to training educators to work with students with special educational needs, there is the development of the object of knowledge, that is, leading the student to the reconstruction and internalization of knowledge through their way of thinking and the formation of critical thinking fostered by the theorist that lead to a contextualized way of thinking that perceives the relationship between ideas, objects, knowledge and events. (SANTOS; SOMMERMAN. 2009).

In terms of attitude, it is necessary to reject a welfare educator's behavior that is philanthropic and paternalistic along with the disbelief in the individual's ability to learn, that learn, that learning is not the simple and mechanical act of memorizing data. There is no single way to learn. Learning is linked to contexts that flow when explaining and making sense of phenomena. In it, the dynamics of knowledge, previous knowledge and exposure to information in real time are related to create a new whole, adapting and reconstructing individual knowledge. When realizing the relationship between the current level of their knowledge and the relationship with the current knowledge to which they are exposed, students with disabilities as well as others internalize a meaning for learning. (SANTOS; SOMMERMAN,2009).

The educator must guide his students, in order to welcome and understand the physical limitations of colleagues and the different means of communications used by them, so that there is a better social interaction among all. It should seek ways to find out the characteristics of each of its students with or without disabilities, aiming to understand their potential and needs (SILVA, 2006, p.15).

In view of this theoretical reflection, it is clear that resources to facilitate the student's learning process can

be developed, sought, acquired and adapted when necessary and finally used. Alternative communication is one of those resources that can be beneficial to the learning of students who do not articulate speech. Phrasal paste and graphic symbols are examples of resources developed and adapted for teaching and learning in inclusive education. Resources can be created by the educator from dialogue and observation of students' needs in the classroom. The transdisciplinary attitude will lead the educator to transgress the logic of non-contradiction, articulating unity and diversity, the student and object of knowledge, language and calculation, in short, the articulation of opposites for a transversal approach to knowledge that breaks epistemological boundaries and seeks to connect the disciplines of the school curriculum for an inclusive education that focuses on the construction of meaningful knowledge. (SANTOS; SOMMERMAN, 2009).

We will then address how the learning of students with disabilities in the classroom and the construction of knowledge of all parties involved in the inclusive process can be benefited and why the practice of transdisciplinary teaching should be applied in inclusive education that aims to the universal development of students at school. The reader will be led to reflection on the concepts of inclusive practice and transdisciplinary education to meet the specific needs of teaching and learning.

In addition to encompassing a whole range of methodologies, services and activities, the definition of assistive technology involves identifying resources that contribute to the autonomy of the person with a disability (LAVORATO, 2018, p.49) and, thus, some practices using products developed with high complexity or that cannot favor learning processes. The choice of services and methodologies for use as assistive technologies in the classroom must be linked to the pedagogical objectives and interests of students, whether these interest come from factors such as age, life history, or of another nature. (GOMES, 2010).

The work of AEE professionals in regular inclusive schools offers better conditions for learning for students with disabilities, opening new possibilities in the construction of meanings of what is learned in the school environment. Other factors such as an adequate physical space, the proposition of activities consistent with the needs and aptitudes of the student and the adaptation of strategies throughout the learning path promote the success of the inclusive education desired by the school (GOMES, 2010).

Building a learning environment conducive to classroom learning requires educators to seek resources that help students develop the ability to think critically and

use creativity. In the evaluation of students, seen as a continuous and permanent process, the teacher's practice must also contain the continuous and permanent observation of their students in educational activities with the record of their observations that can guide their work to seek to involve the student lead to the learning.

Seeking to fragment knowledge because they believe that teaching in installments in separate areas, would be the best approach, epistemological boundaries were crystallized that made it difficult for educators to establish a flow of relationships between their areas of activity that would allow them to look at knowledge in its fullness as an all. Emphasizing only the parts leads to the formation of people who see fragmented knowledge.

Ignoring the transdisciplinary relationships that the areas of knowledge can establish contributes to the lack of dynamics and contextualization that can give meaning to what students with and without disabilities learn at school. The parts that one seeks to teach in separate disciplines can be better understood when educators work together, connect in discussions and plans to perceive the interrelationships existing in their disciplines that can be brought to the attention of students revealing the meaning of knowledge for the life and the connection between the parts that was hidden (SANTOS; SOMMERMAN,2009).

In the inclusion of people with disabilities, each school student has other experiences, successes, challenges, doubts and knowledge that can also be included as a school educator. Teachers, specialized technicians and other members of the school community can share their visions and experiences with each other so that, as possible, transversal themes to two or more disciplines rescue how relationships between knowledge and professionals can be together in the elaboration and application of work in the community around of a common issue (SANTOS; SOMMERMAN,2009). This constitutes a school challenge for the construction of pedagogical practices at school and is not always included in the planning.

Traditionalist pedagogy, in the educational system, and therefore in schools, contains the mentality of ignorance of diversity and its connection with the processes of knowledge construction. The teacher-student interaction involves the totality of each of these parts and their subjectivities. Erasing the diversity of these parts, their idiosyncrasies and educational needs to establish a homogeneous group, teaching by memorization and the reproduction of information that must be assimilated by the student in a hierarchical relationship of power is an

excluding posture that does not encourage the student to produce the knowledge itself.

Respecting diversity in inclusive education involves knowing and accepting the characteristics of the participants involved in the process, understanding the specific needs of the student, and, in this diversity, students can have different pace and styles of learning. Accessibility will encourage the attitude of seeking to establish dialogues by understanding that everything in the school environment influences learning and that all knowledge is a reconstruction of previous knowledge. The student's learning is a personal construction, through which he modifies his knowledge in the contact of information, school diversity, established relationships, his life history and perceptions (SANTOS; SOMMERMAN, 2009).

The adoption of an inclusive attitude and the promotion of transdisciplinary activities do not guarantee the success of learning, which also depends on those who are open to the construction of knowledge. The methodology itself does not guarantee the reach of all students. Some may remain attached to the conservatism of the traditional model to which they are accustomed and continue to try to meet the teacher's expectations in order to obtain grades and approval without being legitimately involved with the construction of their own knowledge. This will require patience on the part of the teacher to support the change in student's attitudes towards engaging with their own learning. Due to a welfare educational background, barriers established in previous school experiences or other motivations, a student with a disability can also have a posture of seeking approval without worrying about deepening their own learning.

III. CONCLUSION

This study sought highlight aspects considered important for the perspective of inclusive education, and, for that purpose, established a dialogue with the authors' point of view about it. We emphasize that it is considered significant to reaffirm some points. Initially, we reaffirm that, given the right guaranteed by law to access and permanence for students with disabilities, this is understood as independent of the nature of the special needs that are peculiar to them.

This point of view points to the role of studies in search of new perspectives of inclusion, as well as to understand them, because the new scenarios require school reorganization. The restructuring of the school reorganization. The restructuring of the school must occur through the consistent participation of the community, which rebuilds the pedagogical political project and the curricular proposal, among other aspects defined in it. In

addition, the school must have specific professionals from various areas, who can guarantee specialized service to students. Evidently, we emphasize that the complexity of the challenges of building an inclusive school requires gradual efforts, especially with regard to the infrastructural adaptations to be carried out.

It is worth remembering that care with the adoption of an inclusion policy is fundamental so that inclusion is not considered as merely enrolling a student in a common classroom, configuring a merely physical inclusion. However, leaving all students at the mercy of institutional neglect, first from the authorities, second from the school and, finally, from the educators themselves.

This panorama of concern with the construction of a responsive inclusion policy evoked the point of view of Silva(2009), who links the quality of education to the adjustments that need to be made, in the school institution, which requires that they be identified and, therefore, a schedule was drawn up for interventions in the short, medium and long term. The importance of "self-referentiality" was associated with this construction, which allows the dialogue of young people with knowledge through the "multi-referentiality" categorized by Santos, (2009); Sommerman, (2009), as a result of the unity that comes from respect for diversity. Notably, this involves the adoption of assistive technologies. For this reason, this study also called attention to the processes of awareness of students of coexistence with the fact that difference makes everyone unique, and it manifests itself in a way in some students, and it is up to the understanding and understanding of this reality, in the face of the exercise of respect for otherness.

It is worth remembering that respect and otherness make it possible to overcome the stagnant vision regarding the underlying fragmentation of the disciplinary view, since knowledge and the multiple relationships common to it are not dissociated from unity and diversity, propagated by the transdisciplinary logic, by the transversal approach, which gives the curriculum anchorage in epistemological precepts consistent with the construction of significant knowledge. And this is linked to inclusive education.

In view of this, this study emphasizes that services, methodologies, which are linked to the adoption of technologies, which, in order to be elected as facilitators of educational assistance, cannot be dissociated from the pedagogical objectives common to formal education and the interest of students, having in view of your needs. Add to that age, life history, among others, as prescribed by Gomes(2010). And he still characterizes specificities as to AEE.

Also, in this study, regarding the previously outlined aspect, the importance of observation was highlighted because it permeates all evaluation processes, which must be committed to the continuous character and, above all, aimed at redirecting the actions experienced between teachers and students, following a point of view of educational quality, as it makes possible the coexistence with the differences and limitations of different species, assuming a humanistic point of view to guarantee the complete educational and social development. Thus, knowledge for life is situated. Such assumptions must be inherent to the evaluation processes.

Finally, it is necessary to relate inclusive education to the commitment to transdisciplinary as a means to resize learning, boosting accessibility as a set of attitudes, and all this must be perceived as an important facet for quality education.

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Clients' Perception about Self-Service in the Virtual Channels of a Banking Agency in the State of Tocantins

Percepção dos Clientes Sobre o Autoatendimento nos Canais Virtuais de uma Agência Bancária no Estado do Tocantins

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Keywords— Self-service. Customer perception. Marketing of relationship.

Palavras-chave— Autoatendimento, Percepção do cliente, Marketing de Relacionamento.

Abstract— This qualitative, quantitative and descriptive research aims to research and verify the perception of customers regarding self-service in the virtual channels of the Banco Agency in Tocantins. The work initially consisted of a bibliographic survey, analysis of the theoretical framework, preliminary study and application of a questionnaire prepared by the researcher via "Google Forms" in the collection of information with a link sent to customers by electronic communication in 2017 (Project) and completed in 2021 (TCC). Data from 260 customers identified that the majority are aged between 31 and 40 years, male, complete graduation, salary range of 2 and 5 minimum wages and use the virtual channels in self-service/Internet Banking and/or App for Smartphone and use other virtual channels for more than 4 years. They are used daily in payment services, transfers, Pix, balance inquiries and statements. Since most of the services are aware of their need and for security measures, they close the application after finishing operations. Go to the bank if essential, have

confidence in the agency and would recommend it to friends. They presented a level of difficulty in installing, registering the password, first accessing and using the App for the first time. He considers the assistance received by the agency to be of a very good level and that the virtual services have made life easier, saving time and satisfied by following daily movements in real time. It considers that excessive use by virtual channels can indeed influence the relationship with the agency and not its products.

Resumo— *A presente pesquisa qualitativa, quantitativa e descritiva tem por objetivo pesquisar e verificar a percepção dos clientes quanto ao autoatendimento nos canais virtuais de uma agência bancária no estado do Tocantins. O trabalho consistiu inicialmente em levantamento bibliográfico, análise do referencial teórico, estudo preliminar e aplicação de questionário elaborado pelo pesquisador via “Google Formulários” na coleta de informações com link enviado aos clientes por comunicação eletrônica em 2017 (Projeto) e finalizado em 2021 (TCC). Os dados de 260 clientes identificaram que a maioria estão na faixa etária de 31 a 40 anos, sexo masculino, graduação completa, faixa salarial de 2 e 5 salários mínimos e utilizam os canais virtuais no autoatendimento/Internet Banking e/ou App para Smartphone e usam outros canais virtuais a mais de 4 anos. Fazem uso diário em serviços de pagamentos, transferências, Pix, consultas de saldo e extratos. Sendo do conhecimento da maioria os serviços de sua necessidade e por medidas de segurança encerram o aplicativo ao terminar as operações. Vão ao banco se for imprescindível, tem confiança na agência e a indicariam a amigos. Apresentaram nível de dificuldade na instalação, cadastro da senha, primeiro acesso e utilização do App na primeira vez. Consideram de muito bom nível o auxílio oferecido pela agência e que os serviços virtuais facilitaram a vida, na economia de tempo e estão satisfeitos por acompanhar as movimentações diárias em tempo real. Consideram que a utilização excessiva pelos canais virtuais podem sim influenciar no relacionamento com a agência e não nos seus produtos.*

I. INTRODUÇÃO

É cada vez maior o uso de soluções digitais no mundo, no sistema financeiro isto se traduz no uso do autoatendimento pelos canais virtuais. Este cenário é apontado por Setubal (2016) ¹ “tenho certeza que nós, Bancos, temos que correr”. Este cenário resultou na escolha do tema deste artigo onde se pretende alcançar a “Percepção dos clientes sobre o autoatendimento nos canais virtuais de uma agência bancária no estado do Tocantins”. A situação problema apresentada, está no questionamento da percepção do cliente em relação aos canais disponibilizados pela agência para o autoatendimento. O objetivo geral está em levantar a percepção dos clientes sobre o autoatendimento dos canais virtuais de uma agência bancária no estado do Tocantins”.

e objetivos específicos: levantar a percepção dos clientes sobre o autoatendimento dos canais virtuais; compreender a forma como os clientes se relacionam com o Banco por meio destes canais; quantificar quais transações ou serviços os clientes da agência do Banco mais realizam por meio desses canais e analisar a relação entre os clientes e os canais virtuais de autoatendimento disponibilizados pela agência bancária. Os objetivos elencados nesta pesquisa nos levam a observar os enormes desafios e tendências do setor bancário e impactos organizacionais em sua própria estrutura na redução de postos de trabalho relativas às formas de atendimento, haja vista, o próprio cliente com informações direcionadas executa a maioria das transações relativas à sua necessidade.

Os recentes e contínuos avanços tecnológicos nos Bancos têm proporcionado a otimização do tempo dos clientes e funcionários agregando a todos mais comodidade, segurança, agilidade, eficiência, assertividade e consequentemente, maior satisfação dos clientes e

¹ Roberto Setubal – Presidente do Itaú (CIAB-FEBRABAN, 2016). Entrevista REVISTA Época. Disponível em: www.epocanegocios.globo.com Edson Caldas em 21/06/2016. Acesso: 05/2020.

melhores resultados à organização. Justifica-se a escolha do tema e o desenvolvimento deste artigo baseado em que nos últimos anos, com a crescente evolução tecnológica e a severa adaptação do sistema bancário, o perfil do cliente tem se transformado e levado um contingente cada vez maior de pessoas a se relacionar com seus bancos por meio de canais de atendimento não presenciais.

Há ainda a necessidade de trabalhar para que seus meios virtuais de autoatendimento sejam eficazes e seguros contra as investidas de *hackers* e crimes cibernéticos que podem comprometer a imagem e os recursos dos bancos. Salienta-se que a agência citada é considerada pelo regional próximo à capital Palmas, sendo importante ponto de acesso a algumas regiões do estado e do País e atende dezenas de cidades da região bem como aos clientes situados em diversos lugares do Brasil e do mundo por meio dos canais de autoatendimento, além do presencial e personalizado para aqueles que assim preferirem ou necessitarem.

Desta forma, a importância do uso do autoatendimento pelos canais virtuais é demonstrada principalmente por ser um fator de não exclusão dos clientes nestes tempos de diminuição da oferta dos canais tradicionais para a realização dos serviços bancários. Nessa agência, assim como no restante do Brasil, a estratégia destas organizações não é adaptável a esta ou aquela localidade, mas, pensada em um ambiente macroeconômico.

II. METODOLOGIA

A pesquisa realizada teve como público alvo os clientes da agência X no estado do Tocantins, e por conveniência da aplicação da pesquisa se deu pelo fato da agência ser local de trabalho do pesquisador, contudo, não se trata apenas de clientes residentes na cidade citada, mas em várias outras cidades, estados e até no exterior, mas que possuem contas e relacionamento nesta agência.

O desenvolvimento deste artigo será por meio de informações e conhecimentos obtidos via revisão bibliográfica em livros, artigos, monografias, sites de notícias e revistas especializadas, sendo que Oliveira (2004, p. 119) diz “a pesquisa bibliográfica tem por finalidade conhecer as diferentes formas de contribuição científica sobre determinado assunto ou fenômeno”. Também será feita a análise e observação do ambiente visando conhecer e compreender a dinâmica do Banco nos seus níveis de atuação em resposta aos objetivos deste estudo.

Em meados de maio de 2017 na realização e confecção do projeto para início de pesquisas para este

artigo a agência do Banco contava com 10.400 clientes ativos, porém nem todos com uso dos canais virtuais. No momento deste estudo 4.200 clientes (população) já tinham o aplicativo instalado e utilizando o serviço de *internet banking* (computador) ou *mobile* (*Smartphone*) com cadastros ativos na agência e para definição de amostragem será considerado erro amostral aproximado de 5% e nível de confiança de 90%, que aplicados à população de 4.200 clientes resultou na quantidade mínima de 260 respostas obtidas. E em continuidade a este estudo para o TCC em 2021, mais uma remessa de questionários foi enviada para os clientes e destes contatos, resultaram 260 novas respostas obtidas, momento em que a pesquisa foi encerrada, e que serão base para esta análise. Este tipo de amostra constitui uma amostragem por tipicidade, que segundo Gil (2002, p. 97), “constitui um subgrupo da população que pode ser considerado representativo para toda a população”. As respostas dos anos de 2017 e 2021 serão usadas na comparação da evolução da percepção dos clientes no uso dos canais digitais.

O delineamento da pesquisa realizou-se por meio do método de pensamento reflexivo, que compreende a capacidade de analisar e olhar o passado de modo a desenvolver e promover discernimento sobre o que aconteceu visando promover um entendimento concreto de escolha. Sendo este relevante para o tratamento científico das informações, para desenvolver um estudo descritivo e qualitativo.

Para Lakatos e Marconi (2001, p. 155) “É um procedimento formal, com método de pensamento reflexivo, que requer um tratamento científico e se constitui no caminho para conhecer a realidade ou para descobrir verdades parciais”.

As técnicas de observação se dão por meio da coleta de dados visando à obtenção de informações sobre a realidade da empresa estudada, não somente ouvindo e observando os processos, mas também examinando e avaliando os fatos e os processos que se desejam estudar e compreender.

Oliveira, (2006) afirma que: “a pesquisa exploratória não requer muito conhecimento prévio sobre o pesquisado, restringindo-se a definir objetivos e buscar mais informações sobre determinado assunto”, o mesmo afirma que a análise exploratória é recomendada quando há pouco conhecimento sobre o problema a ser estudado.

A técnica de pesquisa que será utilizada é o método de estudo descritivo e exploratório que segundo Oliveira (2004, p. 114) “É um tipo de estudo que permite ao pesquisador a obtenção de uma melhor compreensão do comportamento de diversos fatores e elementos que influenciam determinado fenômeno”.

Cervo e Bervian (2002, p. 66) afirmam que “a pesquisa descritiva observa, registra, analisa e correlaciona fatos ou fenômenos sem manipulá-los”.

A pesquisa aplicada foi um modelo em forma de questionário elaborado pelo próprio pesquisador *online* pela ferramenta “Google Formulários” com questões fechadas (ANEXO I) por meio de *link* enviado a clientes da agência, de forma aleatória por meio de amostragem, via *Whatsapp* e outros meios de comunicação disponíveis. Os clientes foram cientificados de que tal pesquisa tem caráter estritamente acadêmico, não havendo nenhuma ligação comercial com o Banco e que a pesquisa seria anônima, e não seria coletado nenhum tipo de dados pessoais dos mesmos.

Optou-se pela modalidade de questionário, pois para Marconi e Lakatos (2001, p. 100) trata-se de um “instrumento de coleta de dados constituído por uma série de perguntas que devem ser respondidas por escrito”.

A análise de dados para complementação dos procedimentos metodológicos com informações relevantes ao trabalho está amparada no que diz Vergara (2005, p. 59) “O tratamento dos dados refere-se àquela seção na qual se explicita para o leitor como se pretende tratar os dados a coletar, justificando por que tal tratamento é adequado aos propósitos do projeto”.

Segundo Oliveira (2004, p. 48) “a pesquisa de levantamento busca ir além da descrição das características de um grupo e procura verificar o que é que determina aquela característica dos sujeitos”.

A pesquisa formalizada para o presente artigo tem o objetivo de levantar a percepção dos clientes quanto ao uso dos canais virtuais de autoatendimento e ou *App* para *Smartphones* disponibilizados pelo Banco como estratégias de diversificação, grau de satisfação e economia de tempo para as pessoas. Também se espera demonstrar que as inovações tecnológicas chegaram ao sistema financeiro para ficar e despertaram grande interesse nos consumidores agregando maiores perspectivas no relacionamento.

III. REVISÃO DE LITERATURA

3.1 Mercado nacional e sistema financeiro

De início, vamos nos reportar ao mercado nacional e o sistema financeiro de 1964 a 1975 - os bancos tinham operações vinculadas ao mercado escolhido: crédito imobiliário, crédito comercial de curto prazo e os financiamentos de médio e longo prazo e ainda as que atendiam a créditos para fomento. Metzner e Matias (2015), afirmam que o modelo de banco especializado acabou e não se mostrou como melhor opção para o setor

bancário no Brasil desde então. De 1976 a 1987 - os bancos Brasileiros se adaptaram e passaram a atuar em vários segmentos do mercado, como estratégia de diversificação e principalmente, rentabilidade.

De 1988 até o fim de 1993 antes do Plano Real - os bancos se tornaram múltiplos: passando a operar várias carteiras sob uma mesma denominação, até então estas instituições faziam uso de vários CNPJ para poderem atuar da mesma forma e após o Plano Real em 1994 - os bancos se reorganizaram no modo de atuação se tornando mais competitivos no incremento de suas carteiras de crédito, sendo o que se faz atualmente (METZNER; MATIAS, 2015).

De 1997 e 2001 - surge a fase de efetivação da entrada de bancos internacionais e também da internacionalização dos bancos nacionais, fato este que acelerou a forma como as grandes crises no sistema financeiro internacional que afetaram a economia interna, o setor bancário passou por forte estagnação até 2004, sem aumento significativo de ativos totais e pouca evolução na oferta de crédito no Brasil (METZNER; MATIAS, 2015).

De 2005 até 2010 – foram favorecidos pela boa expectativa da economia interna e o aumento dos investimentos em obras públicas e a expansão do crédito consignado que favoreceram o setor, embora tenham em 2008 sofrido com a crise financeira dos Estados Unidos que levou a falência vários bancos daquele País. No Brasil o governo agiu rápido com redução das taxas de juros e isenções fiscais para manter o consumo em alta (METZNER; MATIAS, 2015).

A partir desta premissa com o crescente avanço tecnológico exigindo melhor e maior automação bancária e vários implementos necessários à permanência no mercado, foram feitos grandes investimentos no setor de TI e surge então, um novo modelo na conquista e fidelização de clientes. Sob esta ótica, no final de 2019 com o surgimento da pandemia mundial do Covid 19, exigiu-se urgente aceleração em disponibilidade de autoatendimento frente às exigências da Organização Mundial da Saúde (OMS), e toda estrutura organizacional precisou impetrar mudanças na funcionalidade geral e estrutural com altos investimentos em tecnologia e segurança nos canais virtuais.

1.2 A automação bancária no Brasil

Segundo (Diniz, 2004 p. 54-55) “A tecnologia de automação bancária atingiu no Brasil um alto nível de excelência”. Assegura em seu artigo que “o setor bancário pode ser hoje considerado um dos únicos em que o desenvolvimento local de tecnologia se igualou aos equivalentes estrangeiros, ou até mesmo os superou”.

Observa-se que a automação de processos e o uso de ferramentas tecnológicas para realização das etapas dos serviços colocam a mesma a favor dos clientes e dos processos internos da instituição financeira. Sendo possível oferecer serviços de qualidade e mais ágeis, tanto para o cliente quanto para os parceiros comerciais. O tempo necessário para uma tarefa ser realizada cai consideravelmente, criando serviços mais inteligentes e competitivos (STEFANINI, 2019).

A possibilidade de automatizar processos é uma das principais vantagens que a tecnologia fornece para a rotina organizacional. Isso melhora a produtividade, reduz custos e traz mais agilidade para o negócio, como é o caso da automação bancária (STEFANINI, 2019).

Metzner e Matias (2015) afirmam que a tecnologia da informação (TI) promove melhoria no desempenho e na produtividade organizacional.

O setor bancário é um dos setores que mais têm investido em TI, já que grande parte de seus produtos e serviços é dependente da tecnologia. Além disso, a expansão de caixas eletrônicos (*automated teller machine* – ATM) e de serviços realizados por meio de dispositivos móveis, como *internet banking*, transformou as transações automatizadas em uma parcela cada vez mais representativa do total de operações, especialmente por serem realizadas em um período mais amplo do que o horário de funcionamento das agências, proporcionando maior conforto e facilidades aos clientes (METZNER; MATIAS, 2015, p. 431).

Para Madruga (2018, p. 45) o atendimento “começa pelo entendimento de que os diversos tipos de público que interessam à empresa devem ser recebidos de maneira customizada e célere pelos diversos canais de relacionamento.” Os contatos presenciais são realizados através de visitas ao cliente, geralmente feitas por um gerente de relacionamento ou quando o cliente vai até a agência, onde lá recebe atendimento personalizado. Fora estes exemplos, o resto é considerado autoatendimento e realizado pelos mais diversos canais: caixas eletrônicos, aplicativos, gerenciadores financeiros e *whatsapp*, dentre outros.

1.3 Banco do Brasil S.A.

O Banco do Brasil é o mais antigo banco Comercial do país criado em 12 de outubro de 1808 pelo príncipe regente D. João. É uma sociedade de economia mista de capitais públicos e privados, além de ações cotadas na Bolsa de Valores de São Paulo

(BM&FBOVESPA). Trata-se de Pessoa Jurídica de direito privado, Sociedade Anônima de Economia Mista classificada pela Receita Federal do Brasil - RFB como Banco múltiplo, com carteira comercial. Sendo de grande importância no desenvolvimento econômico e social através de linhas de crédito, parcerias com o governo na gestão de recursos e programas de fomento a agricultura, desenvolvimento sustentável e promoção social (BANCO DO BRASIL).

Sua missão: "Ser um banco competitivo e rentável, promover o desenvolvimento sustentável do Brasil e cumprir sua função pública com eficiência". (Missão e Valores do BB). A tríade: Missão, Visão e Valores da organização são conhecidos pelos funcionários e continuamente frisadas através de áudio e videoconferências, normativos, capacitações e informes, como forma de dar visibilidade aquilo que a Empresa acredita.

Tem público-alvo diversificado, com atendimento desde o pequeno ao grande produtor rural, do estudante ao servidor público, do micro empreendedor às grandes corporações, setor público e organizações da Sociedade Civil (Prefeituras, Câmaras de vereadores, associações rurais e escolares), ofertando crédito, soluções financeiras, produtos e serviços bem como assessoria e consultoria através de seus funcionários, aplicativos e sistemas disponibilizados aos que assim necessitarem. A Estratégia Corporativa Banco do Brasil - ECBB permite avanço rápido dado a sua magnitude com quase 100 mil funcionários alinhados às melhores práticas do mercado na busca de simplificação de processos, eficiência, resultados sustentáveis e a satisfação do cliente, sendo essa a maior prioridade: “Cuidar do que é valioso para as pessoas” (BANCO DO BRASIL).

Ademais, a empresa tem passado por mudanças e melhorias profundas no que tange a produtos e processos, avançando muito em termos de produtividade, economia, eficiência, qualidade do atendimento, divulgando novos produtos, serviços e soluções ou inovações nos já existentes que são feitas pelas redes sociais, canais oficiais do banco, *facebook*, *youtube*, TV aberta e, principalmente, nos canais de autoatendimento, caixas eletrônicos, *App BB*, extrato da conta do cliente, bem como em *folders* e *banners* no interior das agências, nos correspondentes bancários e parceiros do Banco do Brasil sendo que a produção do *marketing* externo se realiza por empresas terceirizadas sob a supervisão da Diretoria de *Marketing* e lançada nos instrumentos de comunicação do Banco do Brasil, nos canais de TV, rádio, jornais e *internet*.

Geralmente as ações de marketing são resultados de informações obtidas dos clientes via agências, por questionários, aplicativos, pesquisas de satisfação, e outros meios. Além disso, também é disponibilizada uma moderna ouvidoria, onde se colhem sugestões e possíveis reclamações.

1.4 Atendimento ao público e tecnologia

A palavra atendimento de acordo com o dicionário Michaelis (1998) é: “Dar ou prestar atenção; escutar; ouvir (...). Dar atendimento a: prestar auxílio; socorro; acudir; socorrer”. No quesito realização do atendimento, o funcionário necessita ter conhecimento acerca do que o cliente espera e segundo Tani (2018, p. 9) “Aprender a ouvir o cliente é o primeiro passo para que exista a possibilidade de auxílio, de socorro e de observação”.

O cliente esta inserido no público e pode ser qualquer pessoa que venha em busca de uma necessidade. Já o atendimento ao cliente, segundo Tani (2018, p. 10) “refere-se a ouvir, observar, entender e dar a solução para as pessoas que estão em busca de determinado produto ou serviço”.

Em reforço a este argumento Tani (2008, p. 10) esclarece que “o mais importante passo para o atendimento é deixar o cliente/público à vontade para se expressar com detalhes da sua necessidade e de seus anseios”, ou seja, a qualidade de um atendimento esta diretamente relacionada ao conhecimento do que o cliente quer e todos os detalhes técnicos que a operação exige e, vale ressaltar que conhecimento se adquire com treinamento real, confiável e produtivo aliado a muito estudo e acompanhamento da evolução constante frente ao mercado, leis e tecnologia.

Tani (2018, p. 13) lembra que, “em 1992, foi criado o Código de Defesa do Consumidor, em que é possível identificar o que é justo para o cliente e para a empresa”. A criação deste instrumento foi “um marco na relação entre fornecedor e consumidor”, ali estão definidas as regras da relação de consumo, as obrigações de cada parte e as penalidades ao seu descumprimento.

Para Madruga (2018, p. 2) “a experiência do cliente ganha novos contornos, contando com o relacionamento pessoal e também com tecnologia aplicada, abrindo possibilidades para encantar o consumidor em todo mercado”. A evolução constante nas formas de relacionamento resultou no modelo digital aplicado pelas empresas hoje, foram aprendizados tanto para o consumidor quanto para o fornecedor, que continua trabalhando os novos modelos de atendimento disponíveis, a fim de sua evolução diária.

A criação de novos canais de atendimento por si só não é o bastante, é preciso que sejam disponibilizados de forma integrada para uso (*online, off-line*) em (celulares, *smartphones, tablets*, computadores), conforme destaca Madruga (2018, p. 6) “Um bom exemplo é quando a empresa começa a conhecer seus consumidores integrando os canais de contato em uma visão *Omnichannel*²” que é uma estratégia de conteúdo e integração de canais por plataformas que permitem melhorar experiência com o cliente nos seus pontos de contato resultando em maior proximidade e construção de relacionamentos e consequente aumento de lucro para as instituições financeiras.

Em resumo Madruga (2018, p. 36), afirma que “sem a correta estruturação da tecnologia a favor da Gestão do Relacionamento com Clientes não há como automatizar parte do processo de atendimento”. Para esta estruturação o autor destaca uma sequência de processos que devem ser observados desde acompanhar os projetos de TI e Telecom, estarem atentas as especificações da organização, sua forma de atendimento, acompanhar os requisitos funcionais necessários e também os não funcionais na melhoria das plataformas ligadas ao atendimento tais como: *apps*, redes sociais, *chatbot* e *chat messengers* dentre outros. Acompanhamento diário nas etapas de desenvolvimento que envolve os fornecedores de TI, verificação do nível do serviço adquirido e a implantação das ferramentas tecnológicas solicitadas (MADRUGA, 2018).

1.5 Marketing de serviços e relacionamento

Popularmente, quando as empresas de referem às tratativas com os clientes, elas usam a palavra atendimento. Atendimento ao consumidor, ao fornecedor, ao cliente interno, enfim, a todos os *stakeholders* ligados a ela. Porém considera-se o atendimento apenas uma parte de um todo, este todo é o *marketing*, que engloba todas as formas e estágios de interação com os diversos tipos de clientes de uma organização.

(...) Em um contexto mais específico dos negócios, o *marketing* implica construir relacionamentos lucrativos e de valor com os clientes. Assim, definimos *marketing* como processo pelo qual as empresas criam valor para os clientes e constroem fortes relacionamentos com

² OMNICHANNEL – Conceito: Primeira parte da palavra - *omni* - vem do latim *omnis* ou *omne*, significa “todo” ou “inteiro”; enquanto a segunda parte - *channel* - tem origem inglesa e sua tradução significa “canal”. Assim, temos que o Omnichannel caracteriza-se por ser um “canal inteiro”, integrado e holístico (OKADA, 2016; DE MORAES et. al., 2016).

eles para capturar valor deles em troca (KOTLER; KELLER, 2014, p. 4).

Como visto as empresas não sobrevivem sem *marketing*, independentemente do nível de aplicação, porém é exatamente este nível de desenvolvimento de *marketing* que determinará o tamanho do sucesso do relacionamento com o cliente. “O bom *marketing* é essencial para o sucesso de toda organização. Grandes empresas com fins lucrativos como *Google*, *Target*, *Procter & Gamble*, *Toyota* e *Microsoft* fazem uso do *marketing*” (Kotler; Keller, 2014, p. 4).

Os Bancos e demais formas de instituições financeiras integram o setor de serviços, assim como todo o restante de empresas que vendem algo ao seu cliente sem que este receba algo físico, tangível. A definição de serviço está diretamente ligada a qualquer ato ou desempenho intangível e que não é propriedade específica de ninguém (KOTLER; KELLER, 2012).

No entanto, relevante comentar que segundo, Toledo 25, apud Rocha e Turek, (2004 p. 1) “O *marketing* para bancos é um *marketing* especializado, não só por pertencer ao setor de serviços, mas também por apresentar características peculiares não encontradas em outras categorias de serviços”.

Madruga (2018, p. 83) diz que “a origem do *Marketing* de Relacionamento está ligada a uma necessidade tanto dos clientes quanto das empresas de modificarem as relações comerciais e experiências nos canais de contato”. Atualmente, o *marketing* de transação, voltado somente para o produto já não é mais suficiente para convencer e encantar o cliente, é neste momento que surge o *marketing* de relacionamento.

Mothersbaugh e Hawkins (2019, p. 475) afirmam que “uma tentativa de desenvolver um relacionamento contínuo para expandir os negócios com os clientes de uma empresa é denominada *marketing* de relacionamento”.

O *marketing* de relacionamento então é o lado do *marketing* que se preocupa com o cliente, suas expectativas, satisfação e com a opinião que este irá repassar para outros clientes e para o mercado. Ele precisa ser implantado e colocado em prática, principalmente quando ouvimos que “de fato, o programa de *marketing* desenvolve o relacionamento com o cliente transformando a estratégia de *marketing* em ação” (KOTLER; KELLER, 2014, p.12).

Outro ponto enfatizado por Mothersbaugh e Hawkins (2019) é que o verdadeiro *marketing* de relacionamento está concentrado no atendimento as necessidades dos consumidores em nível individual de suas necessidades acrescentando que:

Nem todos os clientes são igualmente receptivos para os esforços de *marketing* de relacionamentos. As percepções de que tais relacionamentos com a empresa serão inconvenientes e não gerarão benefícios adequados e preocupações com relação à privacidade são alguns fatores que reduzem a propensão de o consumidor se engajar em esforços de *marketing* de relacionamento (MOTHERSBAUGH; HAWKINS, 2019, p 475).

Para Lipinski (2016) o “*Marketing* de Relacionamento é uma estratégia que envolve construção e disseminação de marca, fidelização de clientes e criação de autoridade no mercado” e a instituição financeira tem seu “banco de dados” conforme nos adianta Zenone (2017, p. 59) “o *database* (banco de dados) é responsável pelo armazenamento e pelo percurso das informações pela organização, portanto, deve ser o sistema central para o desenvolvimento de estratégias de relacionamento e servir de ferramenta indispensável para o atendimento”.

O banco de dados possui três funções resumidamente assim definidas: a) receber os dados de todos os contatos realizados através de *Sac*, *e-mail*, redes sociais, colaboradores, ao mesmo tempo devem ser integrados com os sistemas de cobrança, produção, vendas, financeiro e logístico; b) filtrar e armazenar estes dados, de forma organizada e com disponibilidade para consulta em tempo real; c) possibilitar este acesso por todas as áreas da organização, permitindo que cada área tenha acesso ao perfil do cliente, podendo assim criar a estratégia de ação individualizada por cliente (ZENONE, 2017).

Em reforço a este argumento Kotler; Keller (2006) afirmam que:

Um banco de dados de clientes é um conjunto de dados abrangentes sobre clientes atuais ou potenciais atualizados, acessíveis, práticos e organizado para fins de *marketing*, tais como geração de indicações, vendas de um produto ou serviço ou manutenção de relacionamento com os clientes. *Database marketing* é o processo de construir, manter e usar os bancos de dados de clientes e outros registros (produtos, fornecedores, revendedores) para efetuar contatos e transações e para onstruir relacionamentos com o cliente (KOTLER; KELLER, 2006, p. 160).

Conforme argumentam os autores a “*database - banco de dados*” envolve, pelo menos, a administração de um sistema computadorizado/informatizado de dados relacional e em tempo real que contenha abrangência, atualização e dados relevantes sobre os clientes ou de públicos de interesse da empresa ou aqueles que a empresa pretenda ou deseje alcançar e se relacionar. Atualmente as grandes empresas que lideram o mercado, servindo de inspiração para quem ainda está iniciando é o desenvolvimento de novos produtos e serviços levando em conta realmente, a opinião do cliente em suas necessidades (ZENONE, 2017).

Neste sentido de trocas, Mothersbaugh e Hawkins (2019, p. 475) afirmam que “uma quantidade substancial de esforços é atualmente concentrada em programas de fidelização do cliente”. Porém é preciso mais do que somente estes programas, pois “embora programas como esses normalmente sejam eficazes para gerar compras repetidas, eles não criam necessariamente clientes comprometidos e fiéis (Mothersbaugh; Hawkins, 2019, p 475)”.

No que se refere a serviços, não é uma tarefa simples para as instituições mensurar a quantificação dos índices de qualidade do atendimento prestado e a satisfação do cliente. Desta forma, o *marketing* precisa lançar mão das mais modernas ferramentas disponíveis para este fim.

De acordo com Zeithamel; Parasurman; Berry, (2014, p. 23) para os clientes “avaliar a qualidade em serviços é mais difícil do que avaliar a qualidade de bens tangíveis; portanto, seus critérios para a avaliação da qualidade dos serviços que consomem podem não ser facilmente compreendidos pelos profissionais de *marketing*” Acrescentam ainda os autores que “Apenas os clientes julgam a qualidade; todos os outros julgamentos são essencialmente irrelevantes”.

Por fim, é relevante acrescentar que os assuntos do *marketing* de serviços na internet estão entre as primeiras ferramentas pensadas quando a opção é incrementar o relacionamento com o cliente. O setor de serviços segundo Hoffman; Bateson (2003, p. 69 apud Arantes 2012 p. 123) “continua a crescer em grande parte devido aos desenvolvimentos tecnológicos verificados nas últimas décadas”.

IV. DISCUSSÃO E ANÁLISE DOS RESULTADOS

Realizou-se a presente pesquisa na Agência X em uma cidade do estado do Tocantins X, Região Norte do Brasil, denominada “Pesquisa sobre o uso do *Internet Banking e/ou App para Smartphone* do Banco X”, sendo

previamente informado aos clientes que a pesquisa se referia a parte integrante de um Trabalho de Conclusão de Curso (TCC), esclarecendo ainda que a contribuição deste teria efeito meramente educativo, sobre a percepção dos clientes quanto ao uso de canais virtuais de autoatendimento pelo Banco a seus clientes.

E para tanto foi utilizado o resultado obtido pela pesquisa anteriormente enviada ao público alvo deste estudo, clientes da agência X. Para tal levantamento responderam aos questionários respectivamente em 2017 e 2021, o número de 260 clientes em representação da população considerada para análise neste artigo.

Os dados coletados aqui apresentados obedecerão à análise estatística com frequência simples demonstrando o percentual de cada questionamento. Embasados no entendimento de Oliveira (2004, p. 48) “a pesquisa de levantamento busca ir além da descrição das características de um grupo e procura verificar o que é que determina aquela característica dos sujeitos”.

Para as perguntas: 1, 2, 3, 4 e 5, as respostas apontam que a maioria dos entrevistados em 2017 (37,8%) se encontrava na faixa etária de 21 a 30 anos e em 2021 a maioria (34,8%) se encontra na faixa etária entre 31 e 40 anos, nos dois períodos a maioria é do sexo masculino, com graduação completa, o que pode ser explicada devido à cidade ter muitas instituições de ensino, indústrias, agroindústrias e proximidade com a capital de Palmas. A maioria possui renda salarial de 2 a 5 salários mínimos e começaram a utilizar os canais digitais da *Internet Banking e/ou App para Smartphone* por outras opções em 2017 (34,1%) e em 2021 (39,1%) por oferta da agência do Banco com mais opções de produtos e orientação para uso dos serviços.

A 6ª pergunta: “De que forma você mais utiliza os serviços do Banco X”? Conforme dados obtidos tanto em 2017 como em 2021 na média a maioria (46,6%) utilizam o *Internet Banking e/ou APP* e menos a agência, (29,5%) praticamente só utilizam o *Internet Banking e ou/APP* e outros (23,9%) se dividem entre utilização do Caixa eletrônico/*Internet Banking e ou/APP*, uma minoria possui, mas, não usa.

A 7ª pergunta: “Você utiliza algum outro *Internet banking* ou *APP* de banco além dos oferecidos pelo Banco X”? Em resposta temos que a maioria utiliza também outros *Apps*, a Caixa em relação a 2017 de (17,1%) evoluiu para (52,2%) em 2021; Bradesco em 2017 (11%) e em 2021 (23,9%) e Outros *App* (Itaú, Santander, Nubank, C6, Inter, Next, etc) em 2017 (63,4%) e em 2021 (21,7%).

Este resultado pode ser explicado devido à migração dos clientes para os canais virtuais por conta da mudança de autoatendimento pelas agências bancárias, recebimentos de auxílio do governo federal, demanda por melhores produtos e serviços que podem ser realizados pelo celular e outros equipamentos e também demonstra que as pessoas estão se adaptando a este novo modelo de atendimento.

Em reforço a este entendimento Madruga (2018, p. 2) diz que “a experiência do cliente ganha novos contornos, contando com o relacionamento pessoal e também com tecnologia aplicada, abrindo possibilidades para encantar o consumidor, seja em lojas, hotéis, sites ou nas centrais de atendimento”.

A Figura 1 – especifica a 8ª e 9ª pergunta. Para a análise fez-se a junção “de tempo e frequência” com agrupamento de dados:

Figura 1 Tempo e frequência de utilização Internet Banking e/ou APP para Smartphone Banco X

PERGUNTA	2017	%	2021	%
8ª. Há quanto tempo você utiliza a Internet Banking e/ou APP para Smartphone do Banco?	Menos de 1 ano	30,5	Menos de 1 ano	17,4
	1 a 2 anos	34,1	1 a 2 anos	23,9
	3 a 4 anos	23,2	3 a 4 anos	19,6
	Mais de 4 anos	12,2	Mais de 4 anos	39,1
9ª. Com que frequência você utiliza o Internet Banking e/ou APP para Smartphone do Banco?	Possui/não usa	0,00	Possui/não usa	0,00
	Esporadicamente	0,00	Esporadicamente	9,80
	1 ou 2 / semana	0,00	1 ou 2 / semana	8,50
	1 ou 2 / mês	32,6	1 ou 2 / mês	20,7
	Diariamente	47,8	Diariamente	54,9

Fonte: Pesquisador 2017/2021.

As respostas respectivamente em 2017 e 2021 confirmam o seguinte resultado: os dados indicam dos (12,2%) em 2017 utilizavam a mais de 4 anos evoluindo em 2021 para (39,1%) no mesmo critério, indicando considerável evolução; De (34,1%) em 2017 para (23,9%) em 2021 usam de 1 a 2 anos; De 3 a 4 anos em 2017 (23,2%) para (19,6%) em 2021 e por menos de 1 ano em 2017 (30,5%) para (17,4%) em 2021 que usam por menos de um ano. O resultado com maior utilização pelos clientes em 2021 pode encontrar sua explicação pela evolução da internet, maior conhecimento pelos clientes dos recursos oferecidos pelos aplicativos e benefícios de nível pessoal e financeiro. Em relação aos que possuem o aplicativo e não usam, a explicação pode estar relacionada aos pensionistas, aposentados e beneficiários de bolsas que preferem sacar os recebimentos em espécie e para isso usam os caixas eletrônicos ou agências lotéricas. Em relação aos dados acima indicando que a maioria utiliza os canais digitais com mais frequência e diariamente vem agregar ao que diz Rolli (2017), ao afirmar que a abertura deste espaço se dá em detrimento do crescimento da cultura digital:

Com o crescimento dessa cultura digital principalmente com as instituições financeiras, o setor de regulação bancária modernizou a legislação vigente em busca da maior eficiência, menos burocracia e mais segurança para os consumidores e investidores (ROLLI, 2017, p.7).

Na 10ª pergunta: “Para quais destas operações você usa o *Internet Banking* e/ou *APP* para *Smartphone* do Banco X”?

Os dados obtidos indicam que as operações mais utilizadas pelos clientes no aplicativo em 2017 (80,5%) eram a *Internet Banking* e/ou *App* sendo mais para ver saldo de conta e em 2021 o equivalente a (71,7%) continuam a fazer consultas, enquanto que (74,4%) em 2017 já utilizavam para fazer pagamento e transferências e em 2021 alcançou (80,4%) de utilização para pagamentos, transferências e mais recentemente o PIX³ configurando desta forma evolução nas transações bancárias e utilização da

³ Sistemas de Pagamentos Instantâneos- Fonte: <https://www.bcb.gov.br/>

internet na realização de operações demonstrando considerável aumento na percepção, conhecimento e confiabilidade nos produtos disponíveis nos canais digitais em atendimento as suas necessidades.

O resultado da 10ª pergunta complementa dos dados da 11ª pergunta: “Você conhece todos os recursos disponíveis para seu uso no *InternetBanking* e/ou *APP* para *Smartphone* do Banco X”? As respostas de 2017 mostram que (23,2%): conheciam os recursos disponíveis, outros (28%) não conheciam e (48,8%) conheciam todos que precisavam; já em 2021 (32,6%) confirmam conhecer, (26,1%) não conhecem e (41,3%) conhece todos que precisam. Frente aos resultados de 2017 e 2021 observa-se que o perfil do cliente continua sendo aquele que busca conhecer os produtos de acordo com a sua necessidade e que buscam no momento da necessidade em orientação pelos canais de comunicação disponibilizados pela agencia ou auxilio dos funcionários na agencia de relacionamento.

A 12ª pergunta: “Quais das medidas de segurança abaixo você adota ao usar a *Internet Banking* e/ou *APP* para *Smartphone* do Banco X”?

Em relação à preocupação com as medidas de segurança os dados obtidos em 2017 representam que a maioria (68,3%) dos clientes “encerra a sessão ao sair do aplicativo” e em 2021 evoluiu para (71,7%) nesta modalidade; já em 2017 (41,5%) “Conferem o certificado do banco” e em 2021 apresentou índice aproximado de (41,3%); em 2017 (47,6%) “Não utilizam em computador compartilhado” com acréscimo em 2021 para (50%); em 2017 (12,2%) responderam em “Outras” e em 2021 (15,2%) e outros (2,2%) possui o aplicativo, porem, não usa.

A 13ª pergunta vem de encontro a uma problemática que todos estão propensos a passar: “Quando você está sem sinal da *Internet* e precisa

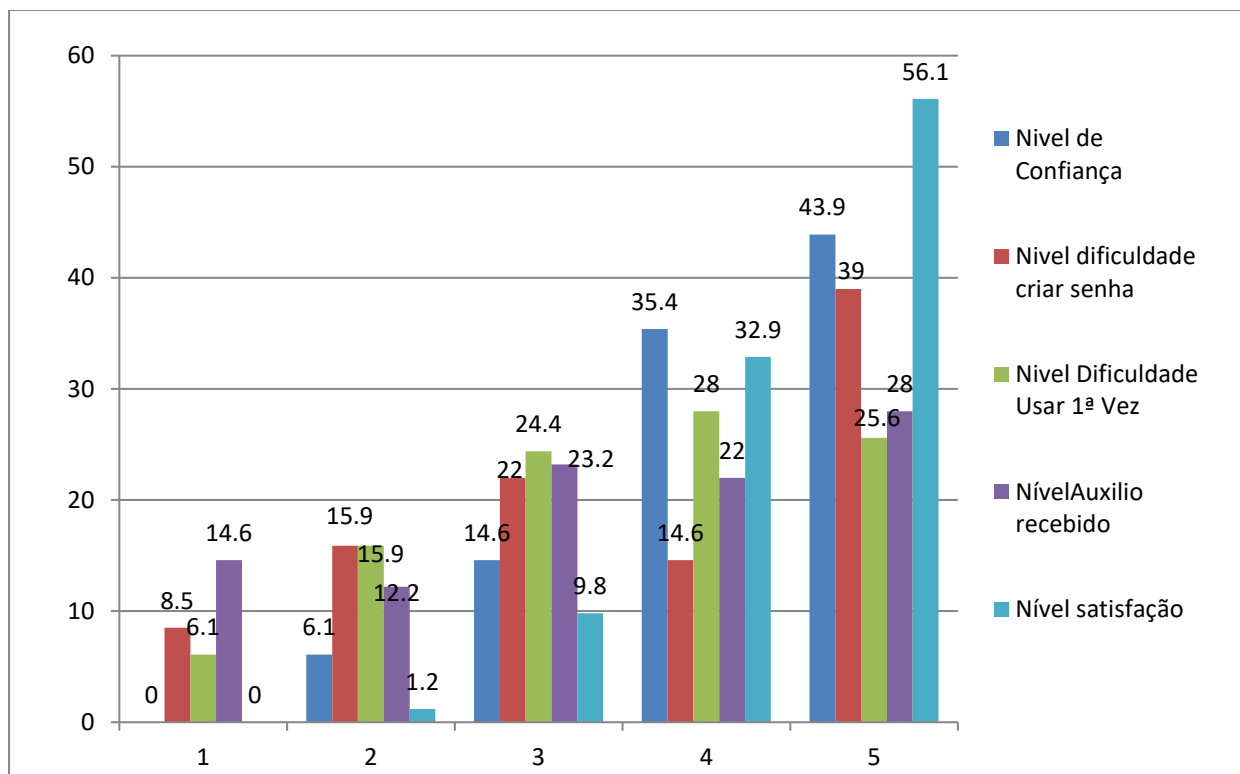
realizar uma operação bancária, o que você faz”? Em 2017 os dados obtidos indicaram que (54,6%) vão ao Banco se for imprescindível, (25,8%) espera reestabelecer o sinal e (19,6%) vão ao banco e resolve no momento. Em 2021 os dados encontrados não apresentaram diferença significativa, sendo que (54,3%) vai ao banco se for imprescindível, (26,1%) espera reestabelecer o sinal e (19,6%) vão ao banco e resolve no momento.

As respostas acima retratam conhecimento pelos clientes sobre as medidas de prevenção adotadas pelas instituições financeiras, recorrendo ao espaço físico quando for absolutamente necessário, claro que outras medidas precisam ser adotadas para maior adesão e confiança nos canais digitais pela *internet* e tudo isso é possível mediante uma correta estruturação da rede bancária (MADRUGA, 2018).

Nas perguntas: 14, 15, 16, 17 e 25 as respostas foram complementadas pela proximidade do nível e percepção onde se pede; Marque numa escala de: 1 – 5: 14 - “o seu nível de confiança na *Internet Banking* e/ou *APP* para *Smartphone* do Banco X”; 15 - “nível de dificuldade que você teve para cadastrar a senha”; 16 - “nível de dificuldade que você teve para usar pela 1º vez.”; 17 - “Nível de Auxilio recebidos dos funcionários da agência do Banco X”; e 25 - “Nível de satisfação com o uso do *Internet Banking* e/ou *APP* para *Smartphone* do Banco X”:

Dos clientes que responderam a pesquisa no ano de 2017, a maioria dos dados aponta que (43,9%) dizem confiar na *Internet Banking* e/ou *App* para *Smartphone* do Banco X, enquanto que (39%) responderam terem tido alto nível de dificuldade no cadastro da senha, e outros (25,6%) tiveram dificuldade para usar pela primeira vez, (28%) consideraram muito bom o nível de auxilio recebido dos funcionários da agencia e a maioria de (56,1%) respondeu estar muito satisfeito ao usar o aplicativo para *Smartphone* do Banco X.

Gráfico 1 – Nível de uso/confiança/dificuldade/auxilio/utilização e satisfação/2021.



Fonte: Pesquisa 2021.

Os dados do gráfico-1 acima são das respostas de clientes em 2021 os dados demonstram que a maioria (54,3%) confia nos aplicativos, (43,5%) responderam que “tiveram dificuldade ao cadastrar a senha no aplicativo” (45,7%) afirmam que tiveram “dificuldade ao usar na primeira vez”; (39,1%) responderam estar “satisfeitos com nível de auxilio recebido pelos funcionários da agência” e a maioria (76,1%) respondeu estar “muito satisfeitos na utilização do App para Smartphone” demonstrando evolução na percepção dos clientes comparando os resultados de 2017 a 2021.

As perguntas: 18ª “Marque na escala abaixo o quanto você considera intuitivo e fácil de usar a *Internet Banking* e/ou *App* para *Smartphone* do Banco X”. A 19ª "Se eu morasse em um grande centro urbano, usaria muito mais a *Internet Banking* e/ou *App* para *Smartphone* do Banco X". Marque na escala “Concordo/Não concordo” e 20ª "Sabendo que ao usar a *Internet Banking* e/ou *App* para *Smartphone* do Banco X não pago para realizar operações, eu daria preferência a ele e não ao caixa tradicional".

Os dados das respostas da 18ª, 19ª e 20ª pergunta foram agrupadas por se tratarem de opiniões “Concordam ou Não Concordam”.

Em 2017 50% concordavam ser “Muito intuitivo e fácil de usar a *Internet Banking* e/ou *App* do Banco X”; 36% concordavam ser “Intuitivo” 11% concordavam ser “Razoavelmente intuitivo” e 1,2%

igualmente concordavam ser “Muito pouco intuitivo de usar.” Em 2021, 63% concordam ser “Muito intuitivo e fácil de usar a *Internet Banking* e/ou *App* do Banco X”; 28,3% concordam ser “Intuitivo”; 4,3% responderam ser “Razoavelmente intuitivo” e 2,2 % igualmente concordam ser “Muito pouco intuitivo de usar”.

Conforme dados das respostas a pesquisa indica maiores níveis de concordância de 63% igualmente em 2021 que diz ser muito intuitivo e fácil de usar o *App* do Banco X para *Smartphone* e que usariam muito mais o aplicativo se residissem num grande centro, neste sentido, observa-se visível evolução quanto à percepção frente ao ano de 2017.

Os dados em resposta a 20ª pergunta apontam que a maioria de (73,9%) concorda na percepção de que não pagam na utilização da *Internet Banking* e/ou *App* para *Smartphone* do Banco X e, portanto dão preferência a ele na realização de suas operações e não ao caixa tradicional em clara evolução quanto ao ano de 2017 (69%). Quanto aos dados dos que concordam, são neutros ou apenas discordam ou discordam totalmente não apresentando variação significativa de 2017 para o ano de 2021. Os dados analisados representam que a maioria de clientes demonstra estar bem adaptada na utilização dos canais digitais oferecidos pela agencia do Banco X e pelo resultado apresentaram ser perceptíveis ao benefício

econômico quanto à utilização dos canais digitais mais especificamente para o *Smartphone*.

Na 21ª pergunta: Numa escala marque “o nível de facilidade que o uso do *Internet Banking* e/ou *App* para *Smartphone* do Banco X traz para sua vida”.⁴

Nesta referência sobre nível de facilidade na utilização a maioria 54,3% respondeu que o uso facilita muito sua vida, e esta opinião traz indícios de que a confiança está atrelada a percepção, conhecimento e familiarização quanto à utilização dos aplicativos pelos clientes.

Na 22ª pergunta: “Marque na escala abaixo sua percepção em relação à economia de tempo que a *Internet Banking* e/ou *App* para *Smartphone* do Banco X traz para sua vida”; e 23ª “(...) sua percepção em relação à economia financeira (exemplo: combustível para ir ao banco, etc...) que a *Internet Banking* e/ou *App* para *Smartphone* do Banco X traz para sua vida”.

O ano de 2017 traz que (57,3%) concordavam totalmente na economia de tempo e financeira, enquanto outros (24,4%) concordavam (15,9%) são neutros e (2,4%) discordavam totalmente.

As respostas 22ª e 23ª do ano de 2021 foram agrupadas no Gráfico 2 por se relacionarem a “percepção de economia do tempo e financeira na utilização dos canais da *Internet Banking* e/ou *App* do Banco X para *Smartphone*”. Conforme dados representados abaixo, observa-se que a maioria de (67,4%) em 2021 responderam economizar muito com o “tempo e finanças” e os dados de (19,6%) estão vinculados à economia de tempo e finanças, (10,9%) são neutros e outros (2%) responderam que “não economizam nada financeiramente”.

Comparando os dados de 2021 com dados de 2017 a maioria diz “economizar tempo e finanças” com indicação de considerável variação em detrimento do restante que se encontram no termo “economizo tempo”, “neutros” e a minoria “não economizar nada financeiramente”.

A 24ª pergunta: Marque na escala abaixo sua opinião de acordo com a seguinte afirmação: "Com o uso do *Internet Banking* e/ou *App* para *Smartphone* do Banco X consigo realizar uma melhor gestão financeira pessoal". Quanto mais perto das extremidades, mais você concorda com a afirmação.

De acordo com dados acima o equivalente a (56,5%) concordam totalmente que o uso da *Internet Banking* e/ou *App* para *Smartphone* do Banco X possibilita acompanhamento diário permitindo melhor gestão financeira, enquanto que 34,8% apenas concordam com a afirmação acima, o restante de 8,7% é neutro. Comparando o ano de 2017 em que (42,7%) concorda totalmente é perceptível a evolução da percepção em relação ao ano de 2021 de (56,5%).

Na 26ª: Marque na escala abaixo se você indicaria a um amigo o uso do *Internet Banking* e/ou *App* para *Smartphone* do Banco X. Quanto mais perto das extremidades, mais você concorda com a afirmação.

E resposta a este questionamento em 2017 (79,3%) com certeza indicaria o uso do aplicativo a um amigo para (78,30%) em 2021 houve pequena variação de opinião. As pesquisas de 2017 e 2021 indicam que a instituição está alinhada a percepção dos clientes frente suas necessidades e bom relacionamento.

Na 27ª: Marque na escala abaixo sua opinião de acordo com a seguinte afirmação: "Ao usar a *Internet Banking* e/ou *App* para *Smartphone* do Banco X tenho a sensação de acompanhar as mudanças que a tecnologia oferece".⁵ Os dados relativos ao ano de 2021 de (56,5%) concordam plenamente que acompanham as mudanças que a tecnologia oferece outros, 37% apenas “concordam”, 6,5% são neutros. Comparando 2017 com 2021 pode-se dizer que a maioria acompanha as mudanças da tecnologia o que significa que houve percepção de vantagem pelos clientes.

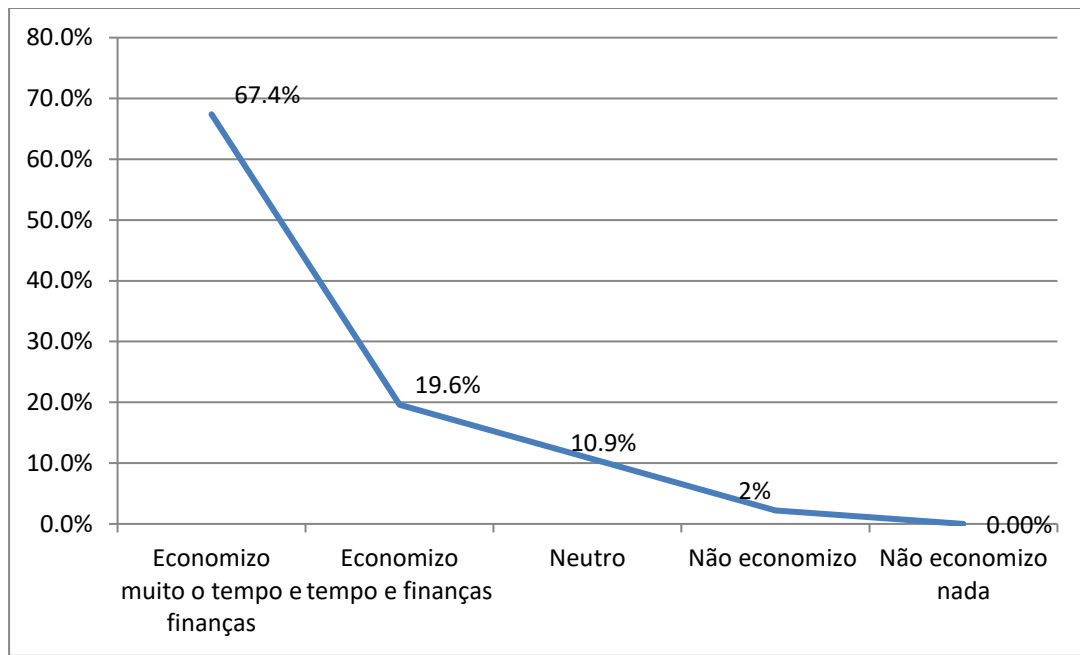
Na 28ª: Marque na escala abaixo sua opinião de acordo com a seguinte afirmação: "O uso excessivo do *Internet Banking* e/ou *App* para *Smartphone* do Banco X pode ser prejudicial, pois reduz meu relacionamento com a agência".

Em resposta a 28ª pergunta utilizou-se os dados do gráfico 4 abaixo representado por (34,8%) que discordam totalmente que o uso excessivo interfira no relacionamento com a agência, (6,5%) apenas discordam (19,6%) são neutros, (15,2%) concordam que o uso reduz o relacionamento e outros (23,9%) concordam totalmente que pode ser prejudicial no relacionamento. Estes resultados podem representar indícios de fragilidades ou dificuldades que ainda não foram corrigidas pela instituição financeira ou se referem a dificuldades operacionais dos usuários.

⁴ Escala de 1-5: Quanto mais perto das extremidades, mais você concorda com a afirmação.

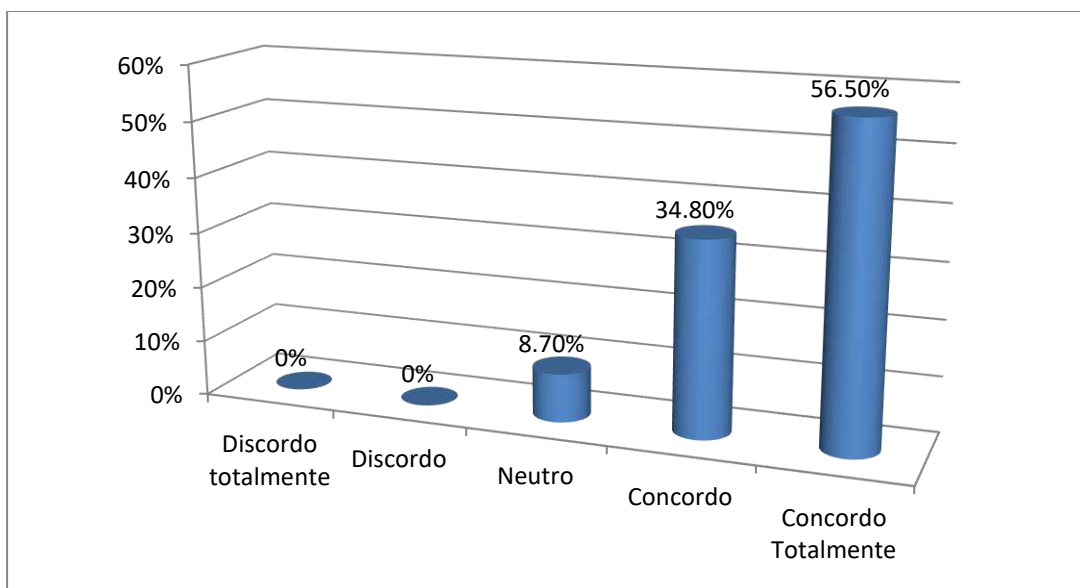
⁵ Quanto mais perto das extremidades, mais você concorda com a afirmação.

Gráfico - 2 - Percepção de economia do tempo /economia financeira para sua vida



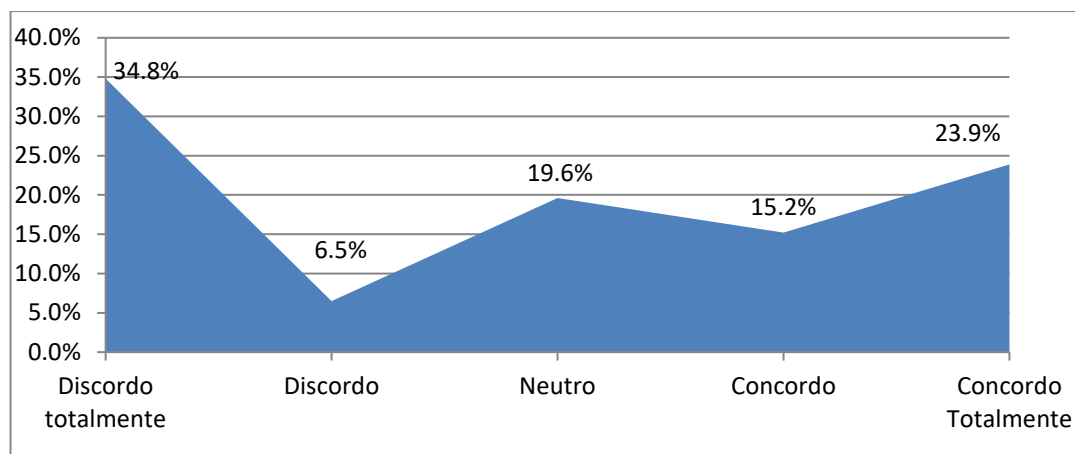
Fonte: Pesquisa, 2021.

Gráfico 3 - Opinião sobre uma melhor gestão financeira



Fonte: Pesquisa, 2021.

Gráfico 4 – Utilização em excesso e relacionamento com agência



Fonte: Pesquisa, 2021.

V. CONCLUSÃO

Em atendimento a problemática deste artigo de alcançar a “Percepção dos clientes sobre o autoatendimento nos canais virtuais da agência do Banco X”, foram resgatados os elementos textuais iniciais usados na elaboração do referencial teórico e apoio nas citações. A população alvo desta pesquisa são os 4.200 clientes que possuem uso ativo do *Internet Banking* e/ou *App* para *Smartphone* instalado e na definição de amostragem considerou-se erro amostral aproximado de 5% e nível de confiança de 90%, que aplicados à população de 4.200 clientes resultou na quantidade de 260 respostas obtidas em 2017 e em 2021. Estes dados possibilitaram verificar que a maioria está na faixa etária de 31 a 40 anos, sexo masculino, graduação superior e faixa salarial de 2 a 5 salários mínimos, a maioria utilizam os canais virtuais. Os objetivos, geral e específico, foram alcançados mediante dados contemplados na pesquisa, relativos à percepção, relacionamento, transações e serviços mais realizados, satisfação na utilização dos canais virtuais de autoatendimento ou *Smartphone* disponíveis pela agência bancária indicando que a maioria realiza e conhece as transações relativas à sua necessidade.

Em reforço a esta afirmação nos embasamos no resultado da Pesquisa “FEBRABAN de Tecnologia Bancária 2021 (ano-base 2020)”⁶, que revela que os canais digitais (*internet banking* e *mobile banking*) somaram 68,7 bilhões no ano passado e concentraram (67%) de todas as transações bancárias realizadas no Brasil com crescimento de (20%), o maior dos últimos anos, com uso expressivo do *Mobile Banking* demonstrando expressivo aumento em comparação ao ano de 2017 de (35%) para (51%) em 2020 (FEBRABAN, 2021).

Embora alguns dados da pesquisa realizada em 2017 e 2021 revelem certa resistência aos canais virtuais de autoatendimento, possivelmente relativos à questão da segurança que com certeza serão reduzidos à medida que todos forem se adaptando na utilização. Os dados mostram que apesar do número crescente de utilização nos canais virtuais, uma parte dos clientes ainda dá preferência para o atendimento tradicional nas transações mais complexas e com valores maiores. Com certeza esta utilização mais profunda ainda deve levar algum tempo, quem sabe até os bancos tornarem a operacionalização mais intuitiva e segura aos clientes. As instituições financeiras criam suas estratégias não de forma específica, mas sim adaptável a esta ou outra localidade pensado em ambientes macroeconômicos.

O grau de conhecimentos dos clientes quanto aos serviços e produtos ofertados no autoatendimento demonstra que a maioria conhece os serviços oferecidos pelo Banco e outros dizem não conhecerem os serviços, a maioria já utiliza canais digitais de outros bancos a mais de 4 anos. Fazem uso diário em serviços de pagamentos, transferências, Pix, e consultas de saldo e extratos, dentre outros.

Também são do conhecimento da maioria os serviços de sua necessidade e por medidas de segurança encerram o aplicativo assim que terminam as operações.

Só vão ao banco se for imprescindível, tem confiança na agência e a indicariam a amigos, apresentam certo nível de dificuldade na instalação, primeiro acesso e utilização do *App* e *Internet Banking*, consideram muito bom o nível de auxílio recebido pela agência e consideram que os serviços virtuais facilitaram a vida com economia de tempo, além disto, se sentem confortáveis por acompanhar as movimentações em tempo real.

⁶ Pesquisa Mobile Banking/composição de Transações Divulgada: <https://portal.febraban.org.br/>.

Quanto à utilização excessiva dos canais virtuais os dados contemplados apontam que a maior parte dos clientes acredita que pode sim influenciar no relacionamento com a agência e não nos seus produtos.

Em detrimento da evolução diária da tecnologia no mundo todo, aumento da cultura digital, relevância do referencial teórico e análise geral dos resultados desta pesquisa pode-se confirmar o pressuposto inicial do artigo em saber qual a percepção dos clientes sobre o autoatendimento dos canais virtuais mais especificamente dos clientes da agência do Banco X. A presente pesquisa sobre percepção indica que entre a teoria e prática ainda teremos muita evolução exigindo mais estudo, conhecimento e evolução.

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Management of the Sepsis Protocol: An integrative literature review

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Keywords — *Sepsis, Management, Hospital Infection.*

Abstract — *This study aims to analyze the scientific evidence regarding the management of the Sepsis Protocol from an integrative literature review. This question guided a search in the electronic databases: SciELO, MEDLINE, LILACS and PubMed, all present in the Virtual Health Library and Web of Science. Ten publications were analyzed, from 2017 to 2021. Most of the results indicate that sepsis management is necessary to improve patient management, rapid identification of signs and symptoms and contribute to increasing the effectiveness of the multidisciplinary team. It is concluded that sepsis is a serious pathology, which affects most patients admitted to the Intensive Care Unit. It shows the need for hospital services to standardize and institute sepsis management protocols, since there are currently many existing control mechanisms, involving increasingly sophisticated and low-cost technologies.*

I. INTRODUCTION

Healthcare-Associated Infections (HAI) are a major challenge for the health sector in terms of patient safety and recovery during the hospitalization period. These diseases can even prolong the patient's length of stay, cause new diagnoses or worsen those already established, which can lead to death. [1]

Ordinance No. 2,616/98 of the Ministry of Health defines HAI as an infection acquired after 72 hours of hospitalization, being related to any procedure performed on the patient. Often leading to the need for treatment in the Intensive Care Unit (ICU). [2, 3]

Sepsis is the presence of life-threatening organ dysfunction, secondary to the body's dysregulated response to infection, which may arise from HAI or from pre-existing disease. Brazil has the second highest mortality rate from sepsis in the world, with rates reaching 60%,

being one of the main causes of in-hospital death and considered a highly complex condition. [4, 5]

One of the ways to reduce these numbers, as well as to qualify the service, is that the multidisciplinary team is attentive to the suggestive signs of sepsis and in the prevention of HAI, since these situations are interconnected. These actions contribute to rapid intervention and patient recovery, preventing the case from getting worse. [4, 6]

In this sense, management strategies and the elaboration of management protocols are of paramount importance for the organization of the health team, training and measurement through indicators of results. In order to improve the identification of sepsis and HAI treatment in the hospital environment. [5, 6]

Therefore, the relevance of this article lies in the need to discuss scientific advances regarding the management of sepsis, whose objective is to analyze the scientific

evidence regarding the management of the Sepsis Protocol from an integrative literature review.

II. METHOD

This article is an Integrative Literature Review (INR), this research method allows the synthesis of multiple published studies and allows general conclusions about a particular area of study. It is a valuable method for nursing, as professionals often do not have time to read all the scientific knowledge available due to the high volume, in addition to the difficulty in performing a critical analysis of the studies.

The RIL has been proposed by different authors who differentiate the methodological procedures (number of steps, form of development and presentation). [7, 8, 9] However, this study basically followed six phases: the 1st Phase elaborated the guiding question; in the 2nd Phase, the search or sampling of references; in the 3rd Phase, data collection took place; in the 4th Phase, the critical analysis of the included studies; in the 5th Phase, the results were discussed; 6th Phase, the presentation of the integrative review was formulated.

In Phase 1: the following question was formulated: What is the scientific evidence on the management of the Sepsis Protocol published between 2017 and 2021? This question guided a bibliographic search, filtering the articles that were coherent with the object of study.

In the 2nd Phase: a search was carried out in electronic databases: Scientific Electronic Library Online (SciELO), Medical Literature and Retrieval System on Line (MEDLINE), Latin American and Caribbean Literature on Health Sciences (LILACS), PubMed, ScienceDirect, all present in the Virtual Health Library and Web of Science, being used in the search the descriptors: Sepsis, Management, Hospital Infection., associated with the Boolean operators "AND, NOT, OR". Thus, ten scientific articles were selected for analysis.

The following inclusion criteria were applied: complete and freely available articles that covered the theme and objective of the study, with relevance to the proposed theme, published between 2017 and 2021 in Portuguese, English and Spanish.

Exclusion criteria were: repeated articles, publications with abstract only, literature reviews, reflections, reviews and that were not in Portuguese, English and Spanish.

A data collection form was used, an instrument validated by Ursi [10] and adapted by the authors, to complete each article in the sample.

In the 3rd Phase: the articles were selected and analyzed, according to the proposed theme. After the selection of the indexed articles, an evaluation and analysis of the material obtained was carried out, to select what was of interest to the researchers, then a thorough reading was carried out, in order not to miss important aspects for the enrichment of the study and preparation of the final research writing.

In the 4th, there was the compilation and organization of articles that presented data in line with the general objective of this work.

In the 5th Phase, the review was presented, in which the articles were compiled in the form of a table, exposed in the results of this research, containing the objective, method, results and conclusion. Finally, the 6th Phase consisted of discussing the results found.

III. RESULTS AND DISCUSSION

Ten publications were analyzed, arranged in Tables 1 and 2, which met the inclusion criteria proposed in this research. Being that, the authors of all of them are of the professional area of medicine. As for the year of publication, 6 of the 8 articles were published in 2021, while the rest in 2020. As for the country, the experiments were carried out in Brazil (1, 4, 6), China (2), England (3), Thailand (5), Norway (7), United States (8).

All studies employed the same investigation model (laboratory experiment). And they presented different ways of managing the occurrence of sepsis, such as testing, impact and implementation results of different protocols and technologies with the purpose of controlling the occurrence of sepsis at the research site.

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

Article	Title	Author/ Year	Objective
1	Improvement of 1st-hour bundle compliance and sepsis mortality in pediatrics after the implementation of the surviving sepsis campaign guidelines.	Gustavo Rodrigues-Santos, <i>et al.</i> (2021)	To study the impact of implementing the Pediatric Surviving Sepsis Campaign protocol on early sepsis recognition, 1-hour treatment package, and mortality.
2	Effect of simple-bundles management vs. guideline-bundles management on elderly patients with septic shock: a retrospective study.	Qian Yang, Zhong Wang, Jian Guan (2021)	To compare the effects of simple package management and guideline package management in elderly patients with severe sepsis and septic shock.
3	A simple measure to improve sepsis documentation and coding.	Jamie Arberry, Zanya Henry and Tumena Corrah (2021)	Identify the gaps that existed in our system when it came to sepsis diagnosis and accurate coding so that we could implement simple measures to improve our service.
4	Implementation of the sepsis protocol in a large hospital in Belo Horizonte - MG.	Alexandre da Silveira Sete, Vania Regina Goveia, Adriane Vieira (2021)	To analyze the implementation and adherence to the sepsis protocol by the nursing and medical teams in the Emergency, Inpatient and Intensive Care Units of a large hospital in Belo Horizonte/MG.
5	Effectiveness of a sepsis programme in a resource-limited setting: a retrospective analysis of data of a prospective observational study (Ubon-sepsis).	Suchart Booraphun <i>et al.</i> (2021)	To assess the effectiveness of the Sepsis Fast Track (SFT) program initiated at a regional referral hospital in Thailand in January 2015.
6	Managed clinical protocol: impact of implementation on sepsis treatment quality indicators.	Camila Brito Borguezam <i>et al.</i> (2020)	To evaluate the impact of the implementation of a managed clinical protocol for sepsis on the quality indicators of the treatment of septic patients treated in the urgency and emergency sector of a university hospital.
7	Promoting leadership and quality improvement through external inspections of management of sepsis in Norwegian hospitals: a focus group study.	Gunnar Husabø <i>et al.</i> (2020)	Explore how external inspections can promote clinical improvement in hospitals.
8	Association Between Implementation of the Severe Sepsis and Septic Shock Early Management Bundle Performance Measure and Outcomes in Patients With Suspected Sepsis in US Hospitals.	Chanu Rhee <i>et al.</i> (2021)	To assess the association of SEP-1 implementation with sepsis treatment standards and outcomes in different hospitals.

9	Sepsis – Conduct based on the Clinical Protocol used at Unimed Recife	Branco CA, Costa JS, Arruda GB, (2021)	Establish a clinical decision support protocol, ideally recorded in the electronic medical record with screening, triggering the immediate start of treatment for sepsis, with conduct based on scientific evidence standardized by the technical committee and managers, in order to ensure good care practices.
10	Implementation of artificial intelligence algorithm for sepsis detection	Luciana Schleder Gonçalves et al. (2020)	To present the experience of nurses with computational technological innovations to support the early identification of sepsis.

Source: Prepared by the authors, 2022.

Table 2: Management of sepsis.

Article	Evidences
1	84 patients were studied before and 103 after implementation of the protocol. There was an increase in the recognition of sepsis, adherence to the one-hour bundle as a whole and with its three components: fluid resuscitation, blood culture and antibiotics. There was also a significant reduction between the recognition of sepsis and fluid resuscitation and the administration of antibiotics. The risk of death before protocol implementation was four times greater, and the absolute risk of death reduction was 9%.
2	There were no significant differences between the two groups in demographic and clinical characteristics at baseline ($P>0.05$). There were no significant differences between the two groups in APACHE-II scores and lactate concentration at 6, 24, 72 hours after handling and before handling ($P>0.05$). There were also no significant differences between the two groups in mortality at 30, 60 and 90 days ($P>0.05$).
3	59% of the 29 patients were found to have sepsis, but only 10% had documented it in their discharge summary and 17% had coded it. After implementing the model, 38% of the 52 patients had documented sepsis, but only 20% of them coded for it. After delivering a training session to coders on the importance of sepsis, 38% of patients diagnosed with sepsis coded for sepsis.
4	About 29,343 episodes of clinical deterioration were identified with an increase in the Sequential Organ Failure Assessment score of at least 2 points, of which 14,869 (50.7%) were associated with antibiotic escalation and thus met the Sepsis-3 criteria for sepsis. A total of 4,100 sepsis episodes (27.6%) were associated with the use of vasopressors and lactate greater than 2.0 mmol/L and therefore met the Sepsis-3 criteria for septic shock. ICU mortality from sepsis source was highest for ICU-acquired sepsis (23.7%; 95% CI, 21.9–25.6%), followed by hospital-acquired sepsis (18.6%; 95% CI, 17.5–19.9%) and community-acquired sepsis (12.9%; 95% CI, 12.1–13.6%) (for comparison less than 0.0001).
5	Of the 3806 patients with sepsis, 903 (24%) were detected and enrolled in the SFT program at the study hospital (SFT group) and 2903 received standard care (unexposed group). Patients in the TFS group had more organ dysfunction, were more likely to receive measured sepsis treatment, and were more likely to be admitted directly to the ICU (19% vs 4%). Patients in the TFS group had a higher chance of survival (adjusted HR 0.72, 95% CI 0.58 to 0.88, $p=0.001$) adjusted for year of admission, sex, age, comorbidities, modified SOFA score, and direct admission in the ICUs.
6	The study sample included 631 patients, 95 from the pre-intervention phase and 536 from the intervention phase. The implementation of the protocol increased the chances of patients receiving the recommended treatment by 14 times. The implementation of the protocol reduced the period of hospitalization by 6 days ($p<0.001$) and decreased mortality ($p<0.001$).
7	Three themes emerged as central to understanding how inspections can contribute to clinical improvement in emergency departments: (1) raising awareness of the need to improve the quality of care by providing data on clinical performance, (2) building acceptance for improvement through

	professional credibility and focus on clinical practice, and (3) promoting leadership commitment. These findings suggest that inspections have the potential to improve hospital management and staff understanding of complicated care processes and help strengthen organizational commitment to bring about systemic quality improvements.
8	The cohort included 117,510 patients (median age [IQR], 67 years [55-78] years; 60,530 [51.5%] men and 56,980 [48.5%] women) with suspected sepsis. Lactate test rates increased from 55.1% (95% CI, 53.9%-56.2%) in the 4th quarter of 2013 to 76.7% (95% CI, 75.4%-78.0 %) in Q4 2017, with a significant level change after September 1 implementation (odds ratio [OR], 1.34; 95% CI, 1.04-1.74). There was an increase in the use of anti-MRSA antibiotics (19.8% [CI 95%, 18.9%-20.7%] in the 4th quarter of 2013 to 26.3% [CI 95%, 24.9%-27.7%] in the 4th quarter of 2017) and antipseudomonal antibiotics (27.7% [CI 95%, 26.7%-28.8%] in the 4th quarter of 2013 to 40.5% [CI 95%, 38.9%-42.0%] in Q4 2017), but these trends preceded SEP-1 and have not changed with SEP-1 Implementation. Unadjusted short-term mortality rates were similar in the pre-SEP-1 period (Q4 2013 to Q3 2015) versus the post-SEP-1 period (Q1 2016 to Q4 2017) (20.3% [95% CI, 20.0%-20.6%] vs 20.4% [95% CI, 20.1%-20.7%]), and SEP-1 implementation was not associated to changes in level (OR, 0.94; 95% CI, 0.68-1.29) or trend (OR, 1.00; 95% CI, 0.97-1.04) for short-term mortality rates risk-adjusted term.
9	Patients with suspected sepsis, based on the SIRS (systemic inflammatory response syndrome) criterion, are widely identified in the emergency department and account for 30% of patients admitted to the ICU. Accurate screening, rapid recognition, early resuscitation, prompt initiation of antibiotics, and eradication of the source of infection are key components in quality sepsis care.
10	They describe the motivation for creating and using the algorithm, the role of nurses in the development and implementation of this technology and its effects on the nursing work process. Technological innovations need to contribute to the improvement of professional health practices. Thus, nurses must recognize their role in all stages of this process, in order to ensure safe, effective, patient-centered care. In the case presented, the participation of nurses in the process of technological incorporation enhances rapid decision-making in the early identification of sepsis.

Source: Prepared by the authors, 2022.

Article 1 studied the implementation of a protocol for the identification of sepsis in a children's hospital and obtained a positive result, because after joining the package, the number of deaths due to sepsis reduced from 10 to 3 and the identification of the signs of sepsis occurred in a different way. faster and more agile by the team of professionals. [11]

Article 2 showed that there was no difference in the percentage of death from sepsis with the use of the simple management pack or guidelines. [12]

The evidence from article 3 shows that the management of sepsis in the unit surveyed evolved from the implementation of a discharge summary and the training of professionals to correctly fill out this document. Subsequent audits showed progress in identifying the diagnosis of sepsis in patient discharge summaries. [13]

Article 4 points out the importance of knowledge of the sepsis management protocol by the medical and nursing teams, the latter mainly because they are in direct contact

and for the entire length of the patient's stay and must be able to recognize the signs and symptoms of sepsis. [14]

In article 5, the effectiveness of the SFT program for the improvement of the patient is observed, since the group participating in this program received adequate management for the treatment of sepsis, that is, they were better managed by the multidisciplinary team. [15]

Study 6 corroborates the findings of studies 1 and 3, as it points to positive results with the implementation of a protocol for managing sepsis, increasing the patient's chances of receiving effective measures within 1 hour by 8 times. [6]

The findings of article 7 agree with article 5, since they demonstrate how inspections and audits collaborate with the improvement of clinical practice and serve as a warning alert for professionals who deal with the diagnosis of sepsis, so that they pay attention to the management of care. [16]

Article 8, in turn, provides results that, similar to article 2, show that there was no significant change in death

indicators, changes in lactate levels and use of broad-spectrum antibiotics with the implementation of the protocol for managing sepsis. [17]

Article 9 addresses the qSOFA score, which is a novelty in the field and serves as a screening for patients at risk of developing sepsis. The great utility of qSOFA does not use any laboratory variables, making it very easy to use at the bedside. If at least 2 of the 3 variables are found, it is recommended to investigate organ dysfunction by SOFA, reassess therapy, increase monitoring, and consider referring the patient to an Intensive Care Specialist. Therefore, in a patient without suspected infection, a positive qSOFA should raise the possibility of infection. The criteria used are: Systolic blood pressure less than 100 mmHg; Respiratory rate greater than 22/min; Mental status change (GCS <15). Each variable counts one point in the score, therefore, it ranges from 0 to 3. A score equal to or greater than 2 indicates a higher risk of death or prolonged ICU stay. [18]

Finally, article 10 shows that the nurses' participation started in the system development phase, or pre-implementation, from the sharing of scientific, theoretical and practical knowledge related to the health area, with technology professionals. This sharing guides the team of developers not only in the creation, but also in the improvement of the proposed computational solutions, as they bring the user experience, promoting the meeting of the needs of health professionals, with the possibilities of the technologies, in order to facilitate the adoption of the tool in professional nursing practice.[19]

Furthermore, the study points out that the use of a computational decision support tool in nurses' clinical practice enhances their role in the early identification of sepsis, providing visibility and professional satisfaction. [19]

Studies show hospital lethality rates due to sepsis are higher than 40%. The lack of a biological marker and the heterogeneity of what constitutes a suspicion of infection bring limitations in studies on sepsis. The definitions of sepsis and septic shock have been revised, considering recent advances in understanding the pathophysiology, management, and epidemiology of sepsis. [18]

Another relevant point common to the publications of this review is the documentation of the care provided and the clinical evolution of patients hospitalized in any health service, which is an obligation and necessity for the continuity of care, but it is a challenge: at first, doctors and nurses are trained to act proactively and resolve critical clinical situations before recording their performance in the information system. Thus, we understand the need to improve the process of collecting and recording patient

data in hospital information systems, whether computerized or not. [19]

Studies indicate a high prevalence of nosocomial sepsis, found in 50.2% of patients. The problem related to nosocomial infections is much more serious in ICUs, due to the exposure to risks due to their clinical condition and the use of invasive procedures, and therefore they are five to ten times more likely to contract an infection.[20]

As a cause of ICU admission, there was a prevalence of respiratory complications (19.5%), which shows that the pulmonary site has increasingly been implicated in the source of the infectious process and that the use of mechanical ventilation is indispensable.[20]

The use of mechanical ventilation in septic patients can have an impact on improving their prognosis, however, if this is not performed adequately and safely, it can cause serious injuries to patients.[20]

Therefore, the evidence of the articles, for the most part, confirms that the management of sepsis is necessary to improve the management of patients, rapid identification of signs and symptoms and contribute to increasing the effectiveness of the multidisciplinary team.

IV. FINAL CONSIDERATIONS

The present study made it possible to analyze the scientific evidence regarding the management of the Sepsis Protocol from an integrative literature review.

Thus, in this review, the evidence indicates that sepsis is a serious pathology, which affects most patients admitted to the ICU. It shows the need for hospital services to standardize and institute sepsis management protocols, since there are currently many existing control mechanisms, involving increasingly sophisticated and low-cost technologies.

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Multi-objective optimization of parameters in drilling of natural fibre Composites (Kenaf) using Taguchi and Grey relational analysis

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Abstract— Taguchi and Grey Relational Analysis (GRA) are used in this study to reduce thrust force, torque, surface roughness, and roundness in drilling natural fibre composites. Drilling parameters, such as cutting speed, feed, point angle, and chisel angle, were used in this investigation. Experiments were conducted in accordance with Taguchi's experimental design using an L18 orthogonal array. Mathematical formula ANOVA was performed to determine how much each process parameter contributes to the responses. The results show that point angle, chisel edge width, feed, and speed have the greatest impact on the multi-performance characteristics.

I. INTRODUCTION

Natural composite materials have recently become more popular with researchers because of their advantages over conventionally reinforced alternatives. Low density and high specific qualities make these materials perfect for lightweight structural components such as door panels, seat backs and headliners as well as dashboard and other interior components in automotive. [1-4]. The natural fibres like sisal, jute, kenaf, Palmyra, etc., used for making natural composites are biodegradable, economically favourable, eco-friendly and have good specific, mechanical, thermal and acoustic properties [5]. In view of gaining importance for natural composites in engineering applications, now, these considered as an alternative to synthetic fibres [6-8]. Therefore, a detailed study of their machining characteristics is needed. Drilling is one of the common and complex machining processes which is widely used in various manufacturing industries including aerospace, automotive, machinery manufacturing, etc. An equation for torque and thrust

forces could be difficult to draw if the cutting tool material, cutting process parameters, and their combinations are taken into account [9]. The tensile, compressive, and wear characteristics of hibiscus sabdariffa fibre reinforced polymer composites were studied in depth. When urea-formaldehyde was bonded with fibre, the mechanical characteristics were noticeably better. It was reported that the elastic modulus and strength properties of commodities were boosted by reinforcing the vinyl ester (VER) eco-composites and VER eco-nano-composites with both recycled cellulose fibre (RCF) and Halloysite nanotubes (HNTs) [10].

The short fibre reinforced polymer composite under investigation made with hibiscus cannabinus (kenaf) is very attractive because of their ease of fabrication, economy, good mechanical properties etc [11] [12]. This technology was used to improve the drilling process parameters for Al/Sic Metal matrix composites. [13] Taguchi technique was used to improve drilling process parameters for GFRP composites. Drilling process

parameters such as spindle speed, feed rate, drill, and mica mass fraction can be optimised using Taguchi and Grey relational analysis based on the results of this study. According to the study's findings, feed rate and type of drill have a considerable impact on the drilling process [14].

The present study's purpose is to use Taguchi and Grey Relational Analysis to optimise multiple drilling process parameters on natural fibre composites in order to reduce thrust force, torque, surface roughness, and roundness.

II. METHODOLOGY

2.1 Selection of process parameters

The Taguchi technique makes use of orthogonal arrays derived from experiment design in order to examine the whole parameter space with fewer experiments. After an experiment has been completed, the data is translated into a signal-to-noise ratio (SNR). Compared to the desired values, the S/N ratio is a measure of quality [15].

In this study, the machining process parameters speed, feed, point angle, and chisel edge width were recognized. Three levels and four parameters were chosen for this study's L18 Taguchi orthogonal array [16]. Factors and their related levels can be shown in Table1.

Table.1: Levels of selected process parameters for drilling

Code	Variable	Level1	Level 2	Level3
1	Feed (mm/rev)	0.15	0.2	
2	Speed (rpm)	290.0	580	890
3	Point angle (deg)	98.0	108	118
4	Chisel edge width (mm)	1	1.5	2

2.2 Grey Relational Analysis

In his Grey theory, Dr. Deng proposes Grey relational analysis and Grey modelling as well as Grey prediction and decision-making for systems when the model is uncertain or the knowledge is insufficient [17]. A number of scholars have effectively applied this theory over the past two decades to a wide range of applications in the fields of business and social systems as well as ecological and the environment. [18-20]. Grey relational analysis, also known as Grey relational generation, is used to examine the data. The grey connection coefficient, which is based on normalised data, depicts the relationship between the expected and actual outcomes of an

experiment. For each performance, the average of the Grey relational coefficients is utilised to get the Grey relational grade. The Grey relational grade calculated for each response determines the overall performance qualities of several responses. As a result of this strategy, the optimization of several responses is reduced to just one. The best parametric combination can be identified using Grey's highest relational grade. The normalised data for the Higher-the-Better (HB) criterion can be written as follows in grey relational generation.

$$x_i = \frac{\max y_i(k) - y_i(k)}{\max y_i(k) - \min y_i(k)} \quad (1)$$

Lower-the-Better (LB) criterion can be expressed as:

$$x_i = \frac{y_i(k) - \min y_i(k)}{\max y_i(k) - \min y_i(k)} \quad (2)$$

Nominal-the-better (NB) criterion can be expressed as

$$x_i = \frac{y_i(k) - y_0}{\max y_i(k) - y_0} \quad (3)$$

Grey relational generation produces $x_i(k)$ where $x_i(k)$ represents the data sequences and $y_i(k)$ reflects the values of $y_i(k)$ for the k th response. It is necessary to perform data processing prior to calculating the Grey relational coefficient (GRC).

The Grey relational coefficient $\xi_i(k)$ can be expressed as

$$\xi_i(k) = \frac{\Delta_{\min} + \zeta \Delta_{\max}}{\Delta_{0i}(k) + \zeta \Delta_{\max}} \quad (4)$$

Where $\Delta_{0i} = \|x_0(k) - x_i(k)\|$ = difference of the absolute value between $x_0(k)$ and $x_i(k)$

ζ = distinguishing coefficient (0 ~ 1)

$\Delta_{\min} = \forall j^{\min} \in i \forall k^{\min} \|x_0(k) - x_j(k)\|$ = smallest value of Δ_{0i}

$\Delta_{\max} = \forall j^{\max} \in i \forall k^{\max} \|x_0(k) - x_j(k)\|$ = largest value of Δ_{0i}

The grey relational grade γ_i is calculated using the following equation after obtaining the average of the grey relational coefficients.

$$\gamma_i = \frac{1}{n} \sum_{k=1}^n \xi_i(k) \quad (5)$$

Where γ_i is Grey relational grade and n is number of responses

The weight factor is assigned to the quality characteristics in the following condition

$$\sum_i^n W_i = 1 \tag{6}$$

The Grey relational grade is calculated by averaging the correlation coefficients for each response variable. Grey relational grades can be used to identify desirable process variables. In order to determine which factors have the most influence, an analysis of variance is carried out further onwards.

III. EXPERIMENTAL WORK

In this study, natural fibre reinforced polymeric (NFRP) composite was prepared using short fibre reinforced of kenaf fibre and isophthalic resin by hand lay-up process. Composite was used to cut the 50X100X8mm mm specimen size from the work piece material specimen. Following the L18 orthogonal array given in Table 2 on NFRP laminates with a 10-mm diameter HSS (M2) drill, the drilling experiments were conducted. Each experiment was repeated twice to reduce the possibility of an error in the data. In Fig. 1, the radial drilling machine is shown in operation as the experiment was conducted. The axial thrust and torque were measured using a syscon two-component tube strain gauge type drilling dynamometer. (model: SI-674). Thus, an amplified output signal was produced that corresponded with the amount of load being applied, which was supplied into the dynamometer's percentage voltage input (model SI-223 D). The database information on force and torque was recorded using digital amplifiers. Surtronic 3 and Taylor Hobson Talysurf surface profilo meters were used to measure the quality of drilling holes in relation to their final surfaces. CMM (model: BH 303) was used to gauge the amount of roundness that had been lost during the drilling process.



Fig. 1: Experimental setup

Table .2: The basic Taguchi L18 orthogonal array

Expt.	Control factors and Levels
-------	----------------------------

No	A	B	C	D
1	1	1	1	1
2	1	1	2	2
3	1	1	3	3
4	1	2	1	1
5	1	2	2	2
6	1	2	3	3
7	1	3	1	2
8	1	3	2	3
9	1	3	3	1
10	2	1	1	3
11	2	1	2	1
12	2	1	3	2
13	2	2	1	2
14	2	2	2	3
15	2	2	3	1
16	2	3	1	3
17	2	3	2	1
18	2	3	3	2

III. RESULTS AND DISCUSSION

3.1 Optimization of Process Parameters

Gray relational analysis is utilised in the following steps to optimise the drilling parameters. [16].

- Normalize the data.
- Grey relationship coefficients must be determined.
- Calculate the Grey relational grade
- Perform statistical analysis of variance (ANOVA).
- Select the optimum levels of process parameters

Table 3 shows the results of the thrust force, torque, surface roughness and circularity of each sample for varied process parameters. Quality increases with decreasing thrust force, torque, surface roughness and circularity of the machined surface. All responses were standardized using the Grey relational analysis approach using the LB criterion, which states that the lower the response, the better (LB).

Table. 3: Taguchi's L_{18} standard orthogonal array with responses

Expt. No	Thrust force	Torque (Kgf-m)	Surface roughness (μm)	Circularity (mm)
1	5.0	0.03	7.002	0.0857
2	9.2	0.04	4.544	0.0432
3	9.0	0.04	6.314	0.2168
4	5.0	0.03	7.157	0.0555
5	7.0	0.08	8.817	0.1482
6	10.0	0.07	9.554	0.0462
7	4.0	0.04	9.216	0.0671
8	4.6	0.06	10.004	0.0880
9	5.0	0.05	8.228	0.1209
10	4.0	0.07	6.284	0.1261
11	6.1	0.07	5.287	0.0545
12	5.1	0.16	8.300	0.3211
13	4.0	0.05	6.859	0.0625
14	5.1	0.07	8.118	0.1018
15	4.9	0.08	8.055	0.1547
16	5.0	0.07	6.668	0.1437
17	6.1	0.06	6.031	0.0960
18	6.1	0.07	3.642	0.0360

Table .4: Grey relational generation of each performance characteristics

Expt. No	Thrust force (Kgf)	Torque (Kgf-m)	Surface roughness (μm)	Circularity (mm)
1	0.1666	0.0000	0.5281	0.1743
2	0.8660	0.0769	0.1417	0.0252
3	0.8330	0.0769	0.4199	0.6341
4	0.1666	0.0000	0.5524	0.0683
5	0.5000	0.3846	0.8134	0.3935
6	1.0000	0.3076	0.9292	0.0357
7	0.0000	0.0769	0.8761	0.1090
8	0.1000	0.2307	1.0000	0.1823
9	0.1666	0.1538	0.7208	0.2977
10	0.0000	0.3076	0.4152	0.3160
11	0.3500	0.3076	0.2585	0.0648

12	0.1833	1.0000	0.7321	1.0000
13	0.0000	0.1538	0.5056	0.0929
14	0.1833	0.3076	0.7035	0.2307
15	0.1500	0.3846	0.6936	0.4163
16	0.1666	..3076	0.4756	0.3777
17	0.3500	0.2307	0.3755	0.2104
18	0.3500	0.3076	0.0000	0.0000

The data was normalised using Eq. (5) to obtain Grey relational generation. The normalised data and Δ_{0i} for each of the responses are presented in Table 4 and Table 5 respectively.

Δ_{0i} for each of the responses has been calculated as follows.

$$\Delta_{01}(1) = (|x_0(k) - x_i(k)|) = \|1.0000 - 0.1666\| = 0.8334$$

$$\Delta_{01}(2) = (|x_0(k) - x_i(k)|) = \|1.0000 - 0.0000\| = 1.0000$$

$$\Delta_{01}(3) = (|x_0(k) - x_i(k)|) = \|1.0000 - 0.5281\| = 0.4719$$

$$\Delta_{01}(4) = (|x_0(k) - x_i(k)|) = \|1.0000 - 0.1743\| = 0.8257$$

Therefore $\Delta_{0i} = (0.8334, 1.0000, 0.4719, 0.8257)$

Table 5 shows the outcomes from all $i=1-18$ studies that made use of a continuous contract. Everything that goes into conducting this study has an impact on the results. Because each performance criterion was given equal weight ($=0.25$), the Grey relational coefficients were calculated and reported in Table 6. As you can see, the Grey connection coefficient is calculated in this method.

$\Delta_{\max}(k)$ and $\Delta_{\min}(k)$ are taken as follows

$$\Delta_{\max}(k) = \Delta_{06}(1) = \Delta_{12}(2) = \Delta_{08}(3) = \Delta_{12}(4) = 1.000$$

$$\Delta_{\min}(k) = \Delta_{10}(1) = \Delta_{01}(2) = \Delta_{18}(3) = \Delta_{18}(4) = 0.000$$

$$\xi_{01}(1) = \frac{0.0 + 0.25 \times 1.0}{0.8338 + 0.25 \times 1.0} = 0.2307$$

$$\xi_{02}(1) = \frac{0.0 + 0.25 \times 1.0}{1.0 + 0.25 \times 1.0} = 0.2000$$

$$\xi_{03}(1) = \frac{0.0 + 0.25 \times 1.0}{0.4719 + 0.25 \times 1.0} = 0.3463$$

$$\xi_{04}(1) = \frac{0.0 + 0.25 \times 1.0}{0.8257 + 0.25 \times 1.0} = 0.2324$$

Table. 5: Evaluation of Δ_{0i} for each of the responses

Expt. No	Thrust force	Torque (Kgf-	Surface roughness	Circularity (mm)
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	(Kgf)	m)	(μm)	
1	0.8334	1.0000	0.4719	0.8257
2	0.1340	0.9231	0.8583	0.9748
3	0.1670	0.9231	0.5801	0.3659
4	0.8334	1.0000	0.4476	0.9317
5	0.5000	0.6154	0.1866	0.6065
6	0.0000	0.6924	0.0708	0.9643
7	1.0000	0.9231	0.1239	0.8910
8	0.9000	0.7693	0.0000	0.8177
9	0.8334	0.8462	0.2792	0.7023
10	1.0000	0.6924	0.5848	0.6840
11	0.6500	0.6924	0.7415	0.9352
12	0.8167	0.0000	0.2679	0.0000
13	1.0000	0.8462	0.4944	0.9071
14	0.8167	0.6924	0.2965	0.7693
15	0.8500	0.6154	0.3065	0.5837
16	0.8334	0.6924	0.5244	0.6223
17	0.6500	0.7693	0.6245	0.7896
18	0.6500	0.6924	1.0000	1.0000

Table. 6: Grey relational coefficient of each performance characteristics

Expt. No	Thrust force (Kgf)	Torque (Kgf-m)	Surface roughness (μm)	Circularity (mm)
1	0.2307	0.2000	0.3463	0.2324
2	0.6510	0.2131	0.2255	0.2041
3	0.5995	0.2131	0.3011	0.4059
4	0.2307	0.2000	0.3583	0.2115
5	0.3333	0.2888	0.5726	0.2918
6	1.0000	0.2652	0.7793	0.2058
7	0.2000	0.2131	0.6686	0.2191
8	0.2173	0.2452	1.0000	0.2341
9	0.2307	0.2280	0.4724	0.2625
10	0.2000	0.2652	0.2994	0.2676
11	0.2777	0.2652	0.2521	0.2109
12	0.2343	1.0000	0.4827	1.0000
13	0.2000	0.2280	0.3358	0.2160
14	0.2343	0.2652	0.4574	0.2452
15	0.2272	0.2888	0.4492	0.2998

16	0.2307	0.2652	0.3228	0.2865
17	0.2777	0.2452	0.2858	0.2404
18	0.2777	0.2652	0.2000	0.2000

Grey relation coefficients were calculated using the same method for $I = 1-18$. Table 6 represents the conclusions of all of the studies. Each experiment's Grey relation grade was calculated based on the overall performance characteristic of all responses. With the Taguchi technique and Grey relational analysis, the multi-criteria optimization issue might be reduced to a single equivalent optimization problem for an objective. The higher the Grey relationship grade, the nearer the experiment's performance was to being optimal [21]. For each trial, the grey relation grade is shown in Table 7. Experiment 12 is revealed in Table 7 to have the maximum grey relationship grade.

Table. 7: Grey relational grade

Expt. No	Grade	Rank
1	0.2523	14
2	0.3234	7
3	0.3799	4
4	0.2501	16
5	0.3716	5
6	0.5625	2
7	0.3252	6
8	0.4241	3
9	0.2984	10
10	0.2580	13
11	0.2514	15
12	0.6792	1
13	0.2449	17
14	0.3005	9
15	0.3162	8
16	0.2763	11
17	0.2622	12
18	0.2357	18

The average Grey relational grade for each level of process parameter was calculated using the Taguchi technique response table in order to identify the best drilling parameters for thrust force, torque, surface roughness, and roundness. After sorting each column's Grey relationship

grades corresponding to a separate process parameter's level of relevance, average them together was obtained [22]. First, the experimental runs in the orthogonal array numbered 1, 2, 3, 4, 5,6,7,8 and 9 had the feed parameter (F) set to level 1. It is these experimental runs with Grey relationship grades that correspond to F's grade Thus, the average Grey relationship grade for feed (F) at level 1 can be determined as follows:

$$F \text{ (level1)} = \frac{(0.2523+0.3234+0.3799+0.2501+0.3716+0.5625+0.3252+0.4241+0.2984)}{9} = 0.354$$

$$F \text{ (level2)} = \frac{(0.2580+0.2514+0.6792+0.2449+0.3005+0.3162+0.2763+0.2622+0.2357)}{9} = 0.314$$

Similar methods were used to calculate each drilling parameter's Grey relationship grade values. Table 8 and Fig. 2 show the grey relationship values for each level of parameter in respect with each other.

Table 8: Response Table for Grey relational grade

Factors	Grey Relation grade			
	Level 1	Level 2	Level3	Max-Min
Feed	0.354	0.314	---	0.04
Speed	0.357	0.340	0.303	0.054
Point angle	0.268	0.322	0.412	0.144
Chisel edge width	0.272	0.364	0.367	0.095
Total mean Grey relational grade = 0.334				

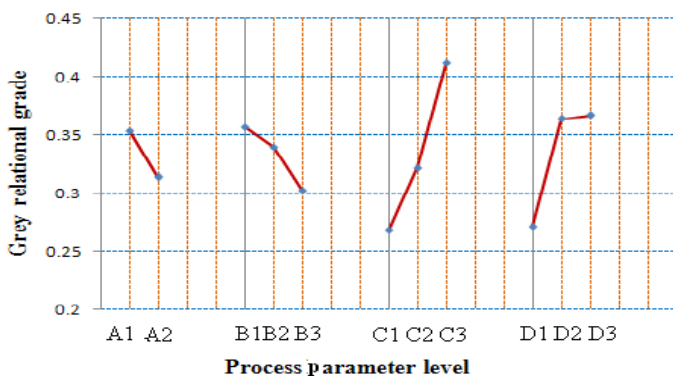


Fig .2: Grey relational grade graph

From the Table 8, the difference between the maximum and the minimum value of the Grey relational grade of drilling process parameters is 0.04 for feed, 0.054 for speed, 0.144 for point angle and 0.095 for chisel edge

width. The significance of each controllable element can be assessed by examining these values. Maximum of these numbers is the most effective and measurable factor. The highest of these numbers is 0.144. According to this value, point angle is the most important process parameter for influencing multi-performance characteristics. As depicted in rational grade graph Fig.2 (the optimal combination of drilling parameters for reducing outcomes), site with the feed at level 1, speed at level 1, point angle at level 3 (1180) and chisel edge width at level 3 is the best combination of parameters (2 mm).

3.2 Analysis of variance (ANOVA)

Experimental data can be analysed with the analysis of variance (ANOVA), which is an established statistical approach for determining the relative contributions of various process parameters to the performance characteristics of significance. 'ANOVA' Overall Grey relational grade variability is achieved by summing squared deviations from the Grey relational grade total mean contributions from all process parameters and error [18]. The Pareto ANOVA technique was conducted and the results are presented in Table 9. It finds the most relevant parameters and determines the proportion of each parameter's effect on different responses. [16].

The overall S/N ratio is expressed from the S/N ratios as

$$\overline{S/N} = \frac{1}{18} \sum_{i=1}^{18} (S/N)_i \tag{7}$$

Here, $\overline{S/N}$ is the overall mean of S/N ratio

$(S/N)_i$ is the S/N ratio for ith parameter

The sum of squares due to variation about overall mean is

$$SS = \sum_{i=1}^{18} \left((S/N)_i - \overline{S/N} \right)^2 \tag{8}$$

where, SS is the sum of squares

The sum of squares due to variation about overall mean for the ith process parameter is

$$SS_i = \sum_{j=1}^6 \left((S/N)_{ij} - \overline{S/N} \right)^2 \tag{9}$$

Where, SS_i is the sum of the square for ith parameter

$(S/N)_{ij}$ is the average S/N ratio of ith parameter of jth level

$$\% \text{ Contribution} = \frac{SS_i}{SS} \times 100 \tag{10}$$

Table 9 Contribution of process parameters

Process parameter	Sum of squares (SS _i)	% Contribution
Feed	0.769	8.2
Speed	0.563	6.0
Point angle	4.837	51.6
Chisel edge width	3.206	34.2

The ANOVA results indicate that point angle (51.6%) has the greatest influence on the responses followed by chisel edge width (34.2%), feed (8.2%) and speed (6.0%).

IV. CONCLUSION

As a conclusion of the Taguchi and Grey relational analysis, the cutting process parameters feed, speed, point angle, and chisel edge were all multi-optimized in drilling of natural fibre composites (Kenaf). At 0.15mm/rev feed rate (290 RPM), point angle of 1180 degrees (and 2mm edge width), these are the optimal processing parameters for drilling natural composites to minimise torque, thrust, surface roughness and roundness. The ANOVA results indicate that point angle (51.6%) is the most significant influence on the responses followed by chisel edge width (34.2%), feed (8.2%) and speed (6.0%).

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Effects of eccentric exercises on tendinopathy of the shoulder rotator cuff: A systematic review

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Keywords— *Shoulder Impact Syndrome;
Therapeutic Exercise; Physiotherapy
Modalities.*

Abstract— *Introduction: Rotator cuff injuries are among the main causes of joint pain and dysfunction. Eccentric exercise is commonly used in tendinopathies. Objective: To evaluate the effects of administering eccentric exercises on the rehabilitation of rotator cuff tendinopathy. Material and Method: This is a systematic review based on randomized clinical trials found in Pubmed/MEDLINE, Science Direct, PEDro and Cochrane Library databases, published in all languages with adult patients, aged 18 to 80 years, presenting signs and symptoms suggestive of rotator cuff tendinopathy. Results: Eccentric exercises have been shown to be effective in the treatment of rotator cuff tendinopathy, however, they are not relevant when compared to other exercise modalities.*

I. INTRODUCTION

Rotator cuff (RC) muscles provide movement, nutrition, and dynamic stability to the shoulder joint, comprising the supraspinatus, subscapular, infraspinatus, and smaller round.^[1] Tendon involvement of this important muscle complex is among the main causes of joint pain and dysfunction.^[2] Thus, as the size of the ruptures, RC degeneration has been increasing along with age 4, up to 54% of adults over 60 years of age have some type of RC rupture.^[2]

RC tendinopathy is one of the main causes of pain and disability in society, and musculoskeletal disease is more commonly diagnosed.^[3,4] It is not necessarily symptomatic, being of multifactorial etiology, including intrinsic, extrinsic and traumatic factors.^[2-4] Among these factors are age, sex, environment and occupation, extrinsic structural changes that can generate mechanical shock, inadequate blood supply, with degenerative

alteration as the predominant lesion.^[2-4]

Physiotherapy aims to reduce the impact exerted on RC tendons and when installed, stimulate the regeneration process of injured tendons, in addition to focusing on reducing impact, should also treat tendon degeneration.^[5] The implementation of therapeutic exercise programs, which diversify muscle strengthening, aim to reduce pain, reduce the inflammatory process, promote healing, preserve and gain range of motion (ROM) and restore glenohumeral and scapular-thoracic balance.^[2]

Eccentric exercise is commonly used in physical therapy interventions for tendinopathy.⁶ Eccentric load exercises include the active stretching of the myotendinous unit, exposing the tendon to a greater load than concentric exercise and, it seems, ends up generating a restorative effect after the production of muscle microruptures.^[2]

Therefore, this systematic review aimed to identify the effects of eccentric exercises when compared to traditional and concentric exercises in relation to pain, function and strength of patients with rotator cuff tendinopathy.

II. MATERIALS AND METHODS

This is a systematic review conducted through searches of bibliographic references of relevant studies in online databases of Pubmed/MEDLINE, Science Direct, PEDro and Cochrane Library, published between 2010 and 2020 in English and Portuguese.

The inclusion criteria adopted were ECRs published from 2010 to 2020, conducted with adult patients (18 to 80 years) presenting signs and symptoms suggestive of rotator cuff tendinopathy, defined as symptom duration greater than three months, minimal pain at rest, widely

preserved shoulder ROM, pain consistently exacerbated by resisted tests and without cervical spine involvement.

The primary result measure was the measurement of shoulder pain intensity and the secondary ones were ROM, muscle strength and function. Studies addressing combined interventions, lack of definition of inclusion or exclusion criteria in the RCT, absence of complete data from the beginning to the end of the follow-up and articles published prior to 2010 were excluded.

Four electronic databases were searched (Cochrane Library, PubMed, PEDro and Science Direct) from October 1 to January 9, 2021. The search strategies are described in Table 1. Thus, based on the published findings, the most relevant data for the construction of this study were collected (Table 1).

Table 1. Flowchart of the Search Strategy in literature.

Database	Strategy	Terms
Pubmed/Medline Cochrane Library	#1	“Rotator Cuff Injuries” [Mesh] OR “Cuff Injury Rotator” [Mesh] OR “Disorders, Temporomandibular Joint” [Mesh] OR “Injuries, Rotator Cuff” [Mesh] OR “Injury, Rotator Cuff” [Mesh] OR “Rotator Cuff Injury” [Mesh] OR “Rotator Cuff Tears” [Mesh] OR “Rotator Cuff Tear” [Mesh] OR “Tear, Rotator Cuff” [Mesh] OR “Tears, Rotator Cuff” [Mesh] OR “Rotator Cuff Tendinosis” [Mesh] OR “Rotator Cuff Tendinoses” [Mesh] OR “Tendinoses, Rotator Cuff” [Mesh] OR “Tendinosis, Rotator Cuff” [Mesh] OR “Rotator Cuff Tendinitis” [Mesh] OR “Rotator Cuff Tendinitides” [Mesh] OR “Tendinitis, Rotator Cuff”
	#2	“Exercise” [Mesh] OR “Exercises” [Mesh] OR “Activities, Physical” [Mesh] OR “Activity, Physical” [Mesh] OR “Physical Activities” [Mesh] OR “Exercise, Physical” [Mesh] OR “Exercises, Physical” [Mesh] OR “Physical Exercise” [Mesh] OR “Physical Exercises” [Mesh] OR “Acute Exercise” [Mesh] OR “Acute Exercises” [Mesh] OR “Exercise, Acute” [Mesh] OR “Exercises, Acute” [Mesh] OR “Exercise Training” [Mesh] OR “Exercise Trainings” [Mesh] OR “Training, Exercise” [Mesh] OR “Trainings, Exercise” [Mesh] OR “Eccentric Exercise”
	#3	Combining #1 e #2.
Science Direct	#1	“Rotator Cuff Injuries” [Mesh] OR “Rotator Cuff Injury” [Mesh] OR “Rotator Cuff Tendinosis” [Mesh] AND “Exercise” [Mesh] OR “Exercise Training” [Mesh] OR “Exercises” [Mesh] OR “Physical Exercise” [Mesh] OR “Eccentric Exercise” [Mesh]
PEDro	#1	“Rotator Cuff” AND “Eccentric Exercise”

To determine the eligibility of the identified articles, the collaborators independently selected titles, abstracts and performed the final analysis of the contents of these articles. Differences of opinion among evaluators on the

eligibility of the studies were resolved by discussion and judged by a third evaluator, if necessary.

The risk of bias was assessed using the PEDroscale^[7]. Two independent researchers assessed the risk of bias.

The differences were resolved by discussion and judged, if necessary. The results of the methodological quality of the ECRs included in the review are presented in Table 2.

The collaborators extracted data on the characteristics of the sample, design of the intervention and estimates of the effect of the exercise in each study. The studies were described in terms of the design of the assay (sample size, follow-up period) characteristics of the sample (age, control group, tendinopathy status), intervention components (amount of supervision, exercises adjusted in type or intensity, exercise dose) and program adem. Estimates of the effect of the exercise on the results measurements were extracted from each clinical trial.

The present study dispenses with the approval of the Research Ethics Committee, due to the use of data taken from studies already published in the literature, and there is, therefore, no intervention or direct approach to human

beings, according to resolution 466/12.

III. RESULTS AND DISCUSSION

Based on the searches carried out in the online databases (Medline, Bvs Lilacs, Scielo, and Google Scholar), no articles were found to compare acupuncture and myofascial release techniques in the same study, thus the research was conducted directing the application of each technique.

The crossing of the descriptors and the use of the filters made it possible to obtain a total of 128 references of which 98 werediscarded because they did not fit the inclusion criteria. Thus, the sample of this study had 30 references, according to theinclusion criteria and keywords. The tables below show an overview of the reading of the articles chosen for discussion.

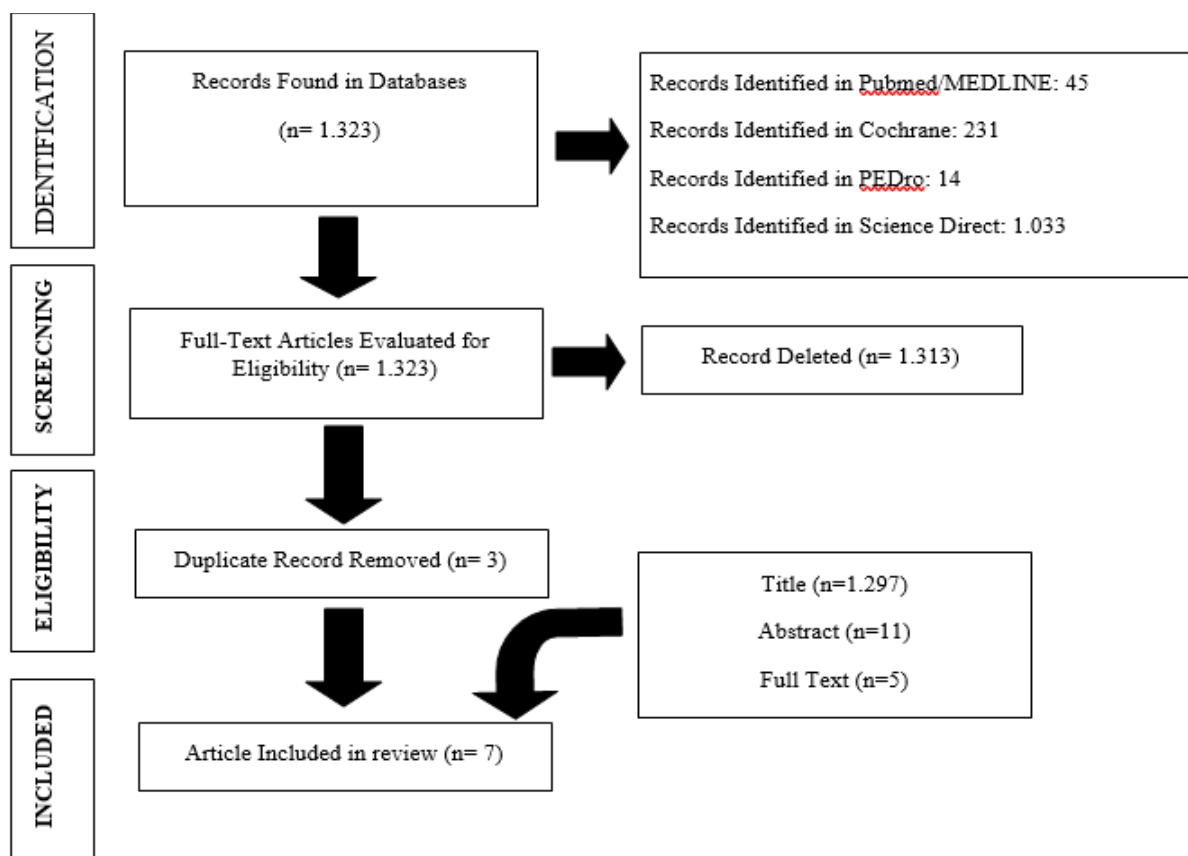


Fig.1 – PRISMA flowchart with the strategy of searching the articles.

Table 2. Characteristics of the studies included in the review.

Author, year	Characteristics of Participants	Intervention Groups	Characteristics of the Exercise Program	Results Measures	Results Obtained	Conclusion
Maenhout et al., 2012 ^[5]	61 patients with subacromial	Traditional RC training	Both groups received one physiotherapy	Abduction isometric force	Isometric strength	Adding eccentric heavy load training

	impact syndrome	group GTT (n=30); Traditional training group + GTTE eccentrics (n=31)	session per week for six weeks. After, one session every two weeks for more weeks, totaling 9 physiotherapy sessions for 12 weeks; Traditional group: 2 resistance exercises for internal and external rotation, 3 x 10 rep 1 x daily, 6 sec per repetition; Traditional + eccentric group: same exercises with addition of an eccentric load lasting 5 sec, 3 x 15 rep. 2 x a day; Load increase of 0.5 kg if painless since the last session;	and internal and external rotation (manual dynamometry); SPADI;	increased significantly in all directions; SPADI score decreased significantly in both groups; GTTE showed an over-the-million-bit gain 15% of abduction force	resulted in a greater gain of strength isometric of abduction, but was not superior to lessen the pain and improving shoulder function
Hallgren et al., 2014 ^[8]	97 patients (36 women and 61 men), age 52 years (30-65) with clinical signs of subacromial pain without complete rupture.	Eccentric Exercise Group (n=51) and nonspecific group (n=46)	Three months of home exercises, with weekly visits from the physiotherapist in the first 2 weeks and after, every 2 weeks; Non-specific group: six exercises for head and shoulder without progression for 10 weeks. Eccentric Group: exercises for RC and a combination of eccentric and concentric exercises for scapular stabilizers with load progression.	Radiographic evaluation; Ultrasound; Constant Murley; Pain (VAS); EuroQol; DASH.	Improvement of Constant-Murley scores in all patients; Rate of patients who underwent surgery in 1 year was 63% in the nonspecific group and 24% in the eccentric group.	Eccentric exercises should be the first line of treatment for subacromial pain.
ne et al., 2015 ^[9]	patients, age 50 years (23-84) with SIS .	Concentric Exercises Group (n=16);	2 x week for four weeks both groups 2 initial weeks idem for	Pain (NPRS); DASH;	No significant difference in any measure of result between the two	Both eccentric and concentric programs resulted in improved

		Eccentric Exercises Group (n=18)	<p>both groups with 3 x 20 rep. each exercise;</p> <p>3rd week - differentiated exercises in each group with 3 x 12 rep each exercise with 70% 1RM;</p> <p>3rd week - differentiated exercises in each group with 2 x 12 rep each exercise with 80% 1RM;</p>	<p>Active range of motion;</p> <p>Abduction muscle strength and external shoulder rotation (dynamometry)</p>	<p>groups;</p> <p>Both groups with significant improvements in all outcome measures from the beginning to the week five (p <0,0125);</p> <p>Significant improvements also from week five to week eight (p < 0.0125) for all result measurements, except adm elevation of the scapular plane.</p>	<p>function, ROM and strength in patients with SIS. No difference was found between the two exercise modes.</p>
co et al., 2016 ^[10]	36 patients with RC tendinopathy	<p>Eccentric Group, 50.2 ± 10.8 years (n=20);</p> <p>Conventional Group, 48.6 ± 12.3 years (n=16);</p>	<p>Daily exercises for 12 weeks;</p> <p>Conventional Group: 8 daily exercises (abduction in the scapular plane up to 90°, external and internal rotation at 0° abduction;</p> <p>Eccentric Group: 2 exercises (external rotators and abduction), 6 to 8 sec per repetition with progressive load increase;</p> <p>Three sets of 8 repetitions for each initial group, increasing to 15 repetitions with increased load;</p>	<p>Constant-Murley score;</p> <p>Pain (VAS);</p> <p>Active ADM;</p> <p>Isometric abduction force;</p>	<p>Both groups showed a significant increase in constant murley's score and decrease in EVA scores;</p> <p>No difference was found between the groups, for any of the outcome measures;</p>	<p>A 12-week isolated eccentric training program is beneficial for shoulder function and pain;</p> <p>However, it is no more beneficial than a conventional exercise program for CR and scapular muscles.</p>

<p>Vallés-Carrascosa et al., 2017^[11]</p>	<p>22 patients with subacromial syndrome, mean age of 59 years.</p>	<p>Non-painful Eccentric Group (GEND); Painful Eccentric Group (GED);</p>	<p>Exercises for RC: 1. Eccentric exercise for RC, 3 x 10 rep; 2. Exercise for external and internal rotation, 3 x 10 rep; Scapular stabilization exercises: 1. Dynamic Hug exercise, 3 x 10 rep; 1. Lower Glide exercise. 3 x 10 rep, each contraction of 5 sec; 2. Upper trapezoid elongation, 3 x 30 sec; groups 5 x week for 4 weeks; Same protocol in both groups, GED with exercise causing pain up to 4 in VAS. GEND without causing pain;</p>	<p>Pain (VAS); ADM; Constant-Murley score;</p>	<p>Both groups improved significantly in all outcome measures (P <0.05); The comparison between the groups did not show significant differences;</p>	<p>Os results suggest that painful exercise does not add benefit in comparison with pain-free exercise.</p>
<p>Chaconas et al., 2017^[12]</p>	<p>48 patients with chronic shoulder pain, mean age of 46.8 ± 17.29 years</p>	<p>Experimental group (EG) (n=25); Control group (CG) (n=23)</p>	<p>EG: eccentric exercises for 6 weeks; 1. Eccentric exercise for external rotators with thera-band, 3 x 15 rep with 3 sec in eccentric phase 1 x daily; 2. Scapular retraction exercise with thera-band, 2 x 10 rep 1 x daily; 1. Progressive increase of load; 1. Capsule stretching posterior shoulder, 3 x 30-45 sec 1 x daily;</p>	<p>Western Ontario Rotator Cuff Index (WORC); Pain (NPRS); Muscle strength of external rotators, internal and abduction; Active ADM; Upper Quarter Y-balance test</p>	<p>Improvement of worc score in eG at three weeks (p=0.003), six weeks (p=0.001) and six months (p=0.007); Pain improvement at six months in EG (p=0.006); Improvement of muscle strength in the EG with six months for external rotator (p <0.001),</p>	<p>An eccentric program aimed at external rotators was superior to a general exercise program for strength, pain and function after six months; The results suggest that eccentric training may be effective in improving function and strength.</p>

			<p>CG: conventional exercises for 6 weeks;</p> <ol style="list-style-type: none"> Active lifting exercise in scapula plane without resistance, 2 x 10 rep 1 x daily; Scapular retraction exercise with thera-band, 2 x 10 rep 1 x daily; Stretching of posterior shoulder capsule, 3 x 30-45 sec 1 x per day. 	<p>(UQYBT);</p> <p>Global Rating of Change (GROC);</p>	<p>internal rotator (p = 0.02) and abductor strength (p <0,001);</p>	
<p>Macías-Hernandez et al., 2020^[13]</p>	<p>26 patients with partial RC rupture</p>	<p>Eccentric Group (EG) (n=12);</p> <p>Control Group (CG) (n=14);</p>	<p>GE:</p> <ul style="list-style-type: none"> Eccentric exercises for deltoid, internal and external rotators, biceps, triceps, pectorals and trapezoids, 3 x 12 rep with eccentric phase of 12 sec duration; 20 sessions, 5 x week, 4 weeks; <p>GC:</p> <ul style="list-style-type: none"> Concentric muscle strengthening for deltoid, internal and external rotators, biceps, triceps, pectorals and trapezoid, 3 x 12 rep.; <ol style="list-style-type: none"> 20 sessions, 5 x week, 4 weeks; 	<p>Pain (VAS);</p> <p>Constant-Murley score;</p> <p>Ultrasound (cross-section area);</p>	<p>Intergroup differences in the Constant scale at 1 and 3 months (p <0.05);</p> <p>Intergroup differences in strength in months 1 and 3 (p <0.05);</p> <p>Structural differences in the tendon (healing) between groups at 3 and 12 months.</p>	<p>Both exercise programs show early improvement in pain, functionality and tendon structure;</p> <p>Eccentric training seems to be more effective than concentric in the early improvement of tendon functionality, strength and healing.</p>

NPRS: numeric pain rating scale; RM: maximum resistance; ADM: range of motion; SIS: subacromial impact syndrome; RC: rotator cuff; rep: repetitions; mon: seconds;

Regarding the intervention protocols, six studies compared the exercise protocol with a control group^[8-11,13,14]. Only one study compared a non-painful exercise program with a group performing painful exercises.^[12]

Most studies used the daily exercise protocol¹⁰ or

five times a week for four weeks^[11,13] and six weeks^[12]. One study performed the interventions twice a week for four weeks^[9]. Another study used one session per week for the first six weeks and then another six weeks with one session every two weeks^[5]. One study does not make clear

the frequency of exercises^[8].

The eccentric training protocol was applied in all studies included in the review, with three sets of 10 to 20 repetitions.^[8-13] Progressive load increase was indicated in four studies.^[8,10,11,13] Scapular activation exercises have been added to the eccentric shoulder program in four studies.^[9,11-13]

Of the seven articles selected in the search, six evaluated pain through the Visual Analog Scale (VAS)^[8,10,11,13] or the Numeric Pain Rating Scale (NPRS)^[9,12]. Four studies evaluated muscle strength through manual dynamometry^[5,9,10,12]. Four studies evaluated range of motion (ROM)^[9-12]. All studies evaluated shoulder function, four of which used the Constant-Murley score^[8,10,11,13], a study used the Shoulder Pain and Disability Index (SPADI)^[5], two used the DASH questionnaire^[8,9] and finally, one study used the EuroQolInstrument (EQ-5D and EQ VAS)^[8] and another the Western Ontario Rotator Cuff Index (WORC)^[12]. Only one study used the objective functional test Upper Quarter Y-Balance Test^[12]. As for image analysis, one study used radiography^[8] and two studies used ultrasound^[8,13].

Regarding the pain outcome, all six studies that analyzed pain demonstrated significant pain improvement with eccentric exercises. However, four of these studies^[9-11,13] reported no significant difference compared to the control protocol. Two studies^[8,12] found significant differences in pain reduction favorable to the eccentric protocol.

Regarding the amplitude of motion outcome, of the four studies that analyzed range of motion, only two

studies^[9,11] demonstrated significant improvement with eccentric exercises, although they did not report significant difference compared to the control protocol. Two studies^[10,12] found no significant differences in the increase in the range of motion favorable to the eccentric protocol.

As for muscle strength outcome, four studies^[5,9,12,13] of the five who analyzed strength showed a significant improvement with eccentric exercises, and of these a study^[9] showed no significant difference compared to the control protocol and another study^[13] presented relevance for the eccentric exercise group when compared to the concentric exercise group. Only 1 study^[10] showed no significant difference in strength increase in any of the groups.

With respect to function outcome, all studies showed a significant improvement after eccentric exercises. Of these, four studies^[5,9-11] found no significant differences compared to the control protocol. Two studies^[12,13] presented a significant improvement superior with eccentric exercises when compared to the control protocol.

The mean PEDro score obtained in the studies was ^[6,8], which demonstrates a moderate quality of the selected studies. Of the studies included, one study did not meet the random distribution criteria (14,28%). Two did not present information on blind allocation criteria (28,56%). Four studies met the criteria for blind evaluation (57,12%), none for blind participants and none for blind intervenors. Regarding the descriptions of losses and exclusions, all studies met this criterion (100%). The results of the bias risk assessment are presented in Table 3.

Table 3. Evaluation of the quality of the articles included in the review

	Maenhout et al., 2013 ^[5]	Hallgren et al., 2014 ^[8]	Blume et al., 2015 ^[9]	Dejaco et al., 2016 ^[10]	Vallés-Carrascosa et al., 2017 ^[11]	Chaconas et al., 2017 ^[12]	Macías-Hernandez et al., 2020 ^[13]
1. Eligibility criteria	S	S	S	S	S	N	S
2. Random distribution	S	S	S	S	S	S	S
3. Blind allocation	N	S	S	S	S	N	S
4. Equality between pre-treatment groups	S	S	S	S	S	S	S
5. Blind participants	N	N	N	N	N	N	N
6. Blind intervenors	N	N	N	N	N	N	N
7. Blind appraisers	N	S	S	N	N	S	S
8. Results in 85% of the sample	S	S	S	S	S	S	S

9. All subjects received the selected treatment	S	N	S	S	S	N	N
10. Statistics	S	S	S	S	S	S	S
11. Measures of accuracy and variability	S	S	S	S	S	S	S
PEDro Score	6/10	7/10	8/10	7/10	7/10	6/10	7/10

Maenhout et al^[5] conducted a study in which the value of adding eccentric heavy load training to conservative treatment in patients with RC tendinopathy was verified. A protocol of resistance exercises of internal and external rotation of the shoulder was introduced, while the experimental group performed the same exercises with the addition of eccentric heavy load exercise. It was demonstrated that both groups presented increased isometric strength, decreased pain and improved function after 12 weeks of treatment, without presenting significant differences between groups.

Blume et al^[9] found similar results, where eccentric exercises were analyzed compared to concentric exercises in 38 participants complaining of CR tendinopathy, randomly distributed in two groups. Both eccentric and concentric programs showed improvement in function, ROM and shoulder strength, without finding relevant differences when compared to the two modes of exercises.

However, Dejaco et al^[10] reported that after 26 weeks of an eccentric versus conventional training program there was improvement in pain and shoulder function, without presenting statistically significant difference when comparing the groups, but did not find any relevant improvement in strength and shoulder ROM in both groups. The eccentric exercise program consisted of eccentric exercises isolated along with stretching, while the other group included scapular stabilization exercises, concentric strengthening exercises of the RC muscles and stretching.

Chaconas et al^[12] the sample was forty-eight individuals with RC tendinopathy, performing an eccentric exercise protocol for external rotators along with scapular retraction and a general protocol of active flexion shoulder exercises, abduction, scapular retraction and stretching of the posterior musculature. It was verified that after the eccentric exercise protocol there was an improvement in pain, function and shoulder strength in both groups and a relevance was evident in the group of eccentric exercises when compared to the general protocol of shoulder exercises.

Second exposed by Macías-Hernández et al^[13], a protocol of eccentric exercises for deltoid, internal and

external rotators, biceps, triceps, pectorals and trapezoid and a protocol of concentric exercises for the same muscle grouping were effective in terms of pain, function and strength in both groups, and the treatment group with eccentric exercises reached a greater statistical significance in all outcome variables, resembling the study of Chaconas et al^[12].

Hallgren et al^[8] investigated whether an eccentric exercise program considered effective after 3 months, maintained the results after one year or if the patients eventually chose to have surgery. The eccentric exercise program consisted of concentric and eccentric exercises of the CR muscles, all with load progression, while the control group performed active movement exercises for the neck and shoulder without any load or progression. One year after inclusion, the number of patients who chose to perform surgery in each group was compared and it was found that in the control group there was a greater number of patients who chose to do the surgery, showing that the short-term positive results of eccentric exercises, pain reduction and improved function, maintained after one year.

Vallés-Carrascosa et al^[11] analyzed 22 patients applying in one group a protocol of painful eccentric exercises, with painful implement that reached up to 4 on the visual analog scale (VAS), and another group that performed eccentric exercises without causing pain. After the application of the protocol, the groups alone improved pain, function and ROM, showing no relevant difference between the groups and showing that painful exercise does not add benefit when compared to pain-free exercise.

IV. Conclusion

It is notorious that eccentric exercises in the treatment of rotator cuff tendinopathy are relevant within the physiotherapeutic approaches. Among the studies analyzed, eccentric exercises were shown to be effective in the treatment of patients with R Ctendinopathy, however, when compared to other modalities of exercises such as resistance, concentric and isometric exercises, it was observed that one did not present relevance over the other, where they also achieved the objectives of physical

therapy rehabilitation on RC tendinopathy, it was observed that one did not present relevance over the other, where they also achieved the objectives of physical therapy rehabilitation on THE tendinopathy of CR, reducing pain, recovering ROM, improving strength capacity and providing an early improvement in shoulder functionality and tendon healing.

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Socioeconomic and Environmental valuation of the Ecosystem Services: A Case Study of from Zoobotanical Park in Belém, Pará, Brazil

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Abstract —The value of ecosystem services produced by the natural ecosystem preserved by the Zoobotanical Park of Belém (ZPB) was estimated based on the population's perception of the existing link between nature and the well-being that is provided to society. The preserved ecosystem provides the population with physical and mental benefits through individual and collective recreation, contemplation of the environment and direct and indirect interaction with animals and plants, as well as knowledge about endangered species and awareness of the need to preserve natural resources in the Amazon. The wood products were estimated by the Net Present Value (NPV), considering a flow of 100 years, as proposed by the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA). Three methods of estimating the NPV were adopted: the value of the carbon stock evolving based on the geometric rate of growth of the diameter of the trees, which resulted in the value of (US\$ 145,216.75); the value of the carbon stock without growth rate, with a value of (US\$ 66,332.21); and the value of the wood volume of (US\$ 34,660.36). The value of ecosystem services was estimated by the Integrated Method of Contingent Valuation and generated the socioeconomic and environmental value for preserving the ZPB of US\$ 1,464,527.41 and the value of replacing it with another activity at US\$ 1,628,657.59. This amount was more than twice the opportunity cost of the park area for the civil construction market.

I. INTRODUCTION

The Zoobotanical Park of Belém (ZPB), in the State of Pará, Brazil, is located in the center of the city of Belém, and has been managed for more than 100 years by the Museu Paraense Emílio Goeldi (MPEG), a research institution linked to the Brazilian Ministry of Science, Technology, Innovation and Communications. The green park houses a physical infrastructure for research and preservation an area of 5.2 ha of Amazon forest, including plants and rare/endangered animal species.

The forest and its interaction with biodiversity and human beings constitutes the natural assets with wood and non-wood products of economic value and a set of ecosystem services, which directly and indirectly influences the social well-being of the population associated with the value of use value for leisure, recreation, cultural and scientific knowledge, regulation of climate and air quality; and the value of non-use for the preservation of rare and endangered species of the Amazon ecosystem. The socioeconomic and environmental value of this natural asset was estimated to guide the MPEG management decisions on how to fund the ZPB management activities in order to avoid the threats to its extinction, arising from the local real estate sector and the federal financial budget restriction. Here, the value of products with market prices was estimated by the cost-benefit method; and the ecosystem services without market price was estimated by the Integrated Method of Contingent Valuation (IMCV), proposed by Santana [1].

The ZPB's natural asset is formed by arboreal vegetation of the Amazon biome, whose species have a market price; and by rare species of flora and fauna with risk of extinction, which have no market price. This asset generates a flow of ecosystem services that includes the regulation of the city's microclimate, mitigates greenhouse gases emitted by vehicles, provides cultural and scientific knowledge to the local population and tourists, provides physical and mental comfort to people through leisure, contemplation and interaction with the forest and animals. The result translates into direct gains in well-being for visitors, and indirect gains for the surrounding population in the city of Belém. These products and services make the economy more viable, through tourism and the value of the surrounding homes; additionally providing the population with amenities and opportunities for leisure and well-being. However, even in the face of the population's perception of its benefits, the socio-economic and environmental value of the ZPB is not yet known. The reversal of this reality of threat to the replacement of the park area by residential condominiums must be changed based on the payment for the preservation of the assets and

the flow of ecosystem services that it produces over time, by contributing to stabilize the financial budget at a sufficient level for its preservation. Therefore, the basic question is: what is the value of this natural asset in the population's perception and its opportunity cost associated with the urban area market for civil construction?

The lack of knowledge of the total economic value of the park's natural assets and its importance for the population's social well-being is an important issue, as the ZPB is in danger of being replaced by residential condominiums, due to its strategic urban location and the lack of guarantee of resources for its maintenance by the public sector. Thus, the estimation of the value of the natural asset constitutes a technical, socioeconomic and environmental parameter to support the preservation of this natural ecosystem, which references the history of Belém and the Amazon.

In this context, the objective of this research was to estimate the socioeconomic and environmental value of the ecosystem products and services produced by the natural asset of the ZPB, as a way of internalizing this value in the price of the urban property and ensuring the right to have and enjoy this green area of vast content of historical knowledge and socioeconomic and environmental benefits for the population of Belém.

Theoretical Reference

Each day there is an increase in the number of people that realizes the importance of products and services produced by ecosystems for the well-being of the population. Due to this growing knowledge, the needs to manage the use of natural resources as a source of raw material for industrial processes, well-being and quality of life for the population are advancing. Thus, according to Costanza et al. [2,3,4,5], the attribution of value to natural assets is a necessary condition to estimate the opportunity cost of their preservation and/or rational use, within the scope of a sustainable management policy for natural resources. The ecosystem services can be classified into four categories [2,3,6,7,41]:

- (1) Provisionservices: includes products such as food and fibers, wood, seeds, resins, roots, genetic resources, biochemical, medicinal, pharmaceuticals, ornamental and water products;
- (2) Environmental regulationservices: includes climate control, pollination, diseases and pests, water and air purification and protection against disasters;
- (3) Cultural services: includes cultural, religious and spiritual values, knowledge, recreation, and educational and landscape values;
- (4) Supportservices: defines the production of other services such as soil formation and retention,

photosynthesis, nutrient cycling, biological soil activity, water cycling and maintenance of habitat dynamics.

Therefore, without these products and services, there is no economic growth or improvement in the population's quality of life [8]. Furthermore, studies on the valuation of ecosystems contribute to the improvement of valuation methodologies for natural assets that have a market price, and those that are not traded, given the rarity, endemism and non-consumption [5,7,9,10,11]. The basis of the valuation is to include the value of natural assets in the property's equity, and with it enabling the development and implementation of environmental policies, regulating the extraction of resources and estimating the effects of ecological footprints and natural phenomena [9,12,13,14,15]. In the specific case of ZPB, it looks to estimate the value of the asset for the population and to ensure a permanent budget to guarantee the management of the park and the preservation of the natural ecosystem by the continuous provision of these services for the benefit of society.

In general, the valuation of natural assets for the purpose of preservation, indemnification or compensation, has as methodological basis applied by several studies, among them: Santana and Khan [16], Turner et al. [17], Carson [18], De Groot et al. [3], Santana [1], Bentes et al. [19], Santana et al. [20], Rosa et al. [21], Santana et al. [7,22], Acharya et al. [23] and Oliveira et al. [11].

From the considered methodologies, only the Contingent Valuation methods allow to capture the value of existence, or that of non-use of natural assets in the estimation of the Total Economic Value (TEV), which is given by (Pearce [24], Bishop and Romano [25], Carson and Mitchell [12], Adams et al. [13], Carson [18], Santana et al. [7], Oh et al. [26], Eq. 1:

$$TEV = \text{Value of Use (VU)} + \text{Option Value (OV)} + \text{Existence Value (EV)} \rightarrow (1)$$

The VU for the products that present a market price is estimated by the economic surplus, which represents the socioeconomic benefits of consumers and producers [2,5,16,17,26,27,28]. For products that have no market price, the value is defined by the willingness to pay for the preservation of natural resources, or the willingness to receive compensation for the use of these resources; which is also based on the consumer surplus or benefit [2,9,18,22,27,29].

The VU can be subdivided into two components: the Direct Value of Use (DVU) and the Indirect Value of Use

(IVU). The DVU refers to the consumption or direct enjoyment of natural resources as a source of raw material, food, medicinal and scientific products, leisure, recreation and satisfaction, which can be obtained by hunting, collecting and/or extracting resources, or by visitation of the natural environment. In the case of ZPB, DVU is represented by wood and services oriented to the leisure of visitors. The IVU, in turn, represents the externalities that the natural asset generates through its functions within ecosystems to maintain biodiversity and ensure the preservation of rare and/or endemic species of flora and fauna, climate regulation, water courses, nutrient cycling, among others. The ZPB shelters species that are important for maintaining the dynamics and balance of ecosystems and that influence the regulation of the local climate.

The OV refers to the value of environmental services produced by natural resources that must be preserved for future use, as a way to ensure new discoveries for the benefit of society. From an economic point of view, it reflects the aversion to the risk that resources, in the future, may have their products and services valued so that decisions of use are delegated to the people, since by conserving species of the Amazon biodiversity, the ZPB fulfills this role. Therefore, it is the attribution of value to the natural asset just for its existence is related to rare plant and animal species, in which irrational use and ignorance increase the risk of threatening their existence and new scientific discoveries that benefit humanity.

The value of direct use of the ZPB is given by utility or benefits that ecosystem products and services generate for visitors, local residents and bystanders, through leisure activities, recreation, thermal comfort and other amenities, environmental education and cultural knowledge, and by allowing people to interact with biodiversity in the urban environment. This fact is based on the studies realized by Bishop and Romano [25], Turner et al. [17] and Elmqvist et al. [30], which allow validating the method of benefit of visitation, by the values of use and non-use of the park's natural assets.

The value of indirect use is the benefit or utility that results from the consumption of biodiversity through the contemplation of plants and animals and the aesthetic quality of the fauna and flora of the Amazon. This value is derived from the ecological functions of the ZPB that materialize with the breeding in captivity of endangered species, and the conservation of the regional fauna and flora. The option value is configured by the conservation activity of the environmental asset to reduce the risk of extinction of species and to raise awareness of visitors to guarantee access to the resource in the future. The existence value is given by the benefit that the ZPB offers

to society for preserving the natural resources. The preservation of rare, endemic species with a high risk of extinction generates existence value. In addition, according to Fuller et al. [31], Elmqvist et al. [30] and Santana et al. [32], the biota of natural ecosystems produces human satisfaction or social well-being from the desire, feeling, pleasure, contemplation and altruism of people for the preservation of nature.

The manifestation of people about the intensity of the benefits that ecosystem services generate for their well-being, through the relationship with the value of use (direct and indirect), option value and value of non-use, can lead to results inconsistent with the reality; given the high difficulty of the population to link ecosystem services to the type of value. To overcome this difficulty, we adopted the direct relation between the service and the benefit perceived by the population, and its consequent attribution of value to continue enjoying the benefit or to replace it with another economic activity. This fact encouraged people to evaluate ZPB even without visiting it, due to them being altruistic towards friends, family, users, future generations, fauna, flora, and because they understand that nature has a right to exist and, therefore, it must be preserved. In effect, the technical relation between the visitor and the natural asset, through knowledge, interaction and contemplation, represents the demand for recreation, which makes the consumer surplus close to the incremental benefit of recreation and/or study visits, which associates environmental services to social well-being.

The method of Net Present Value (NPV) was applied to estimate the economic value of wood products, updated at a discount rate of 4% per year, using as economic variables the volume and stock of carbon stored in the aerial part of the trees, as well as the average growth rate of 157 species and 678 individuals from 20 cm in diameter at breast height.

In the valuation of ecosystem services, socioeconomic and environmental relations were integrated with the Integrated Method of Contingent Valuation to estimate the ecosystem services of the natural assets from the ZPB [1,5,41]. The IMCV was specified by the social (SOCV), economic dimension (ECOND) and environmental dimension (ENVD). These dimensions contain the explanatory variables of the equations of the Willingness to Pay (WTP), for maintaining the benefit of the ZPB, and the Willingness to Accept (WTA) compensation, to obtain benefit elsewhere.

IMCV	WTP = f (SOCV, ECOND, ENVD; α
	WTA = f (SOCV, ECOND, ENVD; β)

Which α and β are the parameters vectors to be estimated.

II. MATERIAL AND METHODS

Valuation of wood products

In the cost-benefit analysis, the net present socioeconomic and environmental value of the asset is estimated through an infinite cash flow for vegetation, updated by a social return rate of 4% per year. This was done by estimating the total volume of arboreal vegetation in the ZPB area, based on a forest inventory of trees with diameter, measured at 1.3 m from the ground (i.e. breast height), equal or greater than 20 cm, the value of each tree species from its known market unit price (US\$/m³), and the value of the carbon stock (carbon stock as t times the price of carbon credit in R\$/t). Thus, the net present value of the natural asset that has a market price was estimated from the wood forest production, according to Santana [33, 41]:

$$NPVNA_i = \sum_{i=0}^{t=100} VCNSA_i \left[\frac{(1+\theta)^i}{(1+r)^i} \right] \rightarrow (2)$$

Where NPVNA is the net present value of the natural asset, assessed based on the value of the carbon stock accumulated in the trees at the price of international carbon rates (R\$/t); VCSNA is the value of the carbon stock of the natural asset in t; θ is the average growth rate of the carbon stock of forest species [34,41]; and r is the discount rate of 4% per year.

This methodology advances in relation to the criteria used, because it includes all arboreal species identified and transformed into a homogeneous product commercialized in general market, which is carbon credit, operated in a competitive market. It also advances because it considers the horizon of continuous time and not just the portion of the forest explored in the cut years proposed by IBAMA. Another methodological contribution refers to the inclusion of the growth rate of the primary forest in the mathematical model to estimate the net present value of the asset, particularly considering the need for empirical studies to obtain the measurements of the diameter at breast height of the species over time.

The data used in the cost-benefit analysis were generated from the forest inventory of 678 individuals of 157 species [35] with WTP (trunk diameter 1.30 cm from the ground) greater than or equal to 20 cm, computing the diameter of the tree, height of the stem and crown, and the wood volume of trees with and without commercial value. Based on these data, the biomass, carbon stock and growth rate for the tree species were estimated [35,36,41].

The net present value of the carbon stock of arboreal vegetation considering only the discount rate of 4% per year in the capital update, and assuming that there is no variation in the carbon stock, is given by:

$$NPVNA_{sc_i} = \sum_{i=0}^{i=100} VCNSA_i \left[\frac{1}{(1+r)^i} \right] \rightarrow (3)$$

Where NPVNA_{sc} is the net present value of the natural asset, without considering the increase rate of the carbon stock over time.

The estimation method using the price of standing wood from a forest for the purpose of indemnification to IBAMA, according to Nogueira and Rodrigues [37], considers a flow of exploitation of the forest area for a period of 100 years, with the cutting of trees with diameter ≥ 45 cm in the years zero, 50 and 100; and those with diameter < 45 cm in the years 25 and 75. In this work, to reproduce the result of this methodology, we considered the value of wood with a diameter equal to or greater than 30 cm (years zero, 50 and 100) and wood with a diameter less than 30 cm (years 25 and 75), as adopted by VALE [38], estimated as follows:

$$NPVWood_i = \sum_{i=0,25,50,75,100} VWood_i \left[\frac{1}{(1+r)^i} \right] \rightarrow (4)$$

The value of wood is given by the market price of standing wood [15,39,40], monetarily adjusted to reflect the opportunity cost of wood (US\$/m³), multiplied by the volume of wood (m³) of each species. The sum of the values (trees with diameter < 30 cm and ≥ 30 cm) was considered and the update was made for the four time points, according to the methodology used by IBAMA for payment for forest suppression.

Valuation of Ecosystem Services

The integration between the functions of ecosystems and the benefits of the population requires decisions to facilitate the combination of natural assets, human capital and manufactured capital in order to maximize economic growth and human well-being [1,2,17,29,41, 42]. Thus, the population's declaration of preference to preserve a natural asset, or to receive compensation for the suppression or loss of that asset, was specified by the equations of willingness to pay and willingness to accept [1].

The value of ecosystem services was estimated using a defined demand curve based on the visitors' declaration of willingness to pay a maximum amount to obtain the benefit of their visits and to ensure that the ZPB remains available for future generations [7,11,21,22]. This technique captures the value of direct and indirect use,

revealed by the satisfaction obtained with the visitation and the benefits provided by the environment; as well as the value of non-use for those who do not visit the ZPB, but who, through altruism, they want to keep it for the benefit of others and are therefore willing to pay for its permanence. The interaction between flora and fauna in the park spaces generates services with value of use and non-use for visitors [2,7,10,18,27,41].

The empirical application of IMCV, as proposed by Santana [5], and applied by Santana et al. [7], Santana et al. [22] and Oliveira et al. [11], considering the equations of the WTP for the benefit of the visit and the WTA compensation for not visiting, allows the integration of knowledge about consumer surplus and social well-being with the premises Ecological Economy on the benefits that natural assets generate for the economy and the population. Thus, the WTP and WTA equations, which represent consumer demands for ecosystem services, were specified as follows:

$$WTP_i = \alpha_0 + \alpha_1 + Age + \alpha_2 Gender_i + \alpha_3 Education_i + \alpha_4 Income_i + \alpha_5 TFamily_i + \alpha_6 FVisits_i + \alpha_7 DEnvironment_i + \alpha_8 VDR_i + v_{1i} \rightarrow (5)$$

$$WTA_i = \beta_0 + \beta_1 + Age + \beta_2 Gender_i + \beta_3 Education_i + \beta_4 Income_i + \beta_5 TFamily_i + \beta_6 FVisits_i + \beta_7 DEnvironment_i + \beta_8 VDR_i + v_{2i} \rightarrow (6)$$

Where WTP and WTA are the willingness to pay for the benefit of the visit and the willingness to accept compensation for the non-visit, incorporating all costs of the interviewee (R\$/visit); interviewee's Age in years; interviewee's Gender; Education level in years of study; average monthly Income of the interviewee who visits the ZPB, in R\$/month; TFamily is the size of the family, given by the number of people; FVisits is the frequency of visits made to the ZPB throughout the year (number of visits/year); DEnvironmental is an indicator constructed based on a set of qualitative variables (regularity of rain and temperature, deforestation, fires, air and water pollution, regulation of the environment by forests, rare and threatened animal and plant species, forest landscape, water springs, etc.); VDR is a dummy variable used to capture the effect of interviewees who are willing to pay a maximum amount for the benefit of each visit equal to or greater than five times the entrance fee currently paid; v_1 and v_2 are the random error terms; α_i and β_i are the vectors of parameters to be estimated by the maximum likelihood method with complete information [43].

The data used to estimate the parameters of the equation were obtained through field research, by applying a specific questionnaire to a representative sample of 548 interviewees from a population of 220,000 visitors per year to the ZPB [1,32].

To configure the environmental dimension, which incorporates the value of all ecosystem services, including the value of existence, an indicator was constructed from nine variables related to the value of direct use, value of indirect use, value of option and value of existence. For this, a factor analysis was applied to build an indicator to represent the average value of the behavior of the variables that define the environmental dimension [32].

III. RESULTS AND DISCUSSIONS

The net present value of wood production will be initially presented, considering the flow of the carbon stock and the volume of wood. Following, the result of the value of ecosystem services of natural assets is shown, based on people's perception of the social benefits obtained through visits to the park.

Value of wood forest product

The biomass of the 678 trees generated the carbon equivalent stock of 847,71273 tons. The average price (R\$/ton) of carbon credit was obtained by multiplying the carbon price, of the order of 4.57 euros/ton, by the average value of the August 2017 exchange rate, equal to (R\$/euro) = 3.5513, generating the value of R\$ 16.23/ton (US\$ 5.16/ton - the average value of the August 2017 exchange rate is US\$/R\$ = 3.1465). Thus, the total value of the wood carbon stock is US\$ 4,513.52.

Considering the discount rate of 4% per year, the growth rate of trees and the time horizon of 100 years, this value would then reach US\$ 145,216.75 (Equation 7).

$$NPVCS_{sci} = \sum_{i=0}^{I=100} 13,757.904_i \left[\frac{(1 + 0.001037705)^i}{(1 + 0.04)^i} \right]$$

$$= R\$456,924.50 = US\$145,216.75 \rightarrow (7)$$

The net present value of the carbon stock, not including the growth rate of the trees, was estimated at US\$ 66,332.21 (Equation 8).

$$NPVCS_{sci} = \sum_{i=0}^{I=100} 13,757.904_i \left[\frac{1}{(1 + 0.04)^i} \right] = R\$208,714.29$$

$$= US\$66,332.21 \rightarrow (8)$$

The methodology adopted by IBAMA for the purpose of

indemnifying the suppressed forest generates the amount of US\$ 34,660.36 (Equation 9).

$$NPVWood_i = \sum_{i=0,25,50,75,100} = 65,658,97_i \left[\frac{1}{(1 + 0.04)^i} \right]$$

$$= R\$109,058.81 = US\$34,660.36 \rightarrow (9)$$

Therefore, the method that uses the value of roundwood tends to underestimate the value of the forest in relation to the carbon stock, with or without taking into account the growth rate of the forest.

Valuation of Ecosystem Services

Description of the Variables

The total number of valid questionnaires was 548, a number 42.7% higher than the minimum sample, which reduced the sampling error from 5% to 4.18%. Of the interviewees, 44.2% are male and 55.8% female.

The interviewee's age varied between 13 and 90 years. Of these, 37.6% were in the range of 13 to less than 25 years of age, 23.4% from 25 to under 35 years, 19.3% from 35 to under 45, 19.7% with at least 45 years, and with a small portion of 2.9% being at least 65 years old. Therefore, 91.8% of the public that attends the ZPB is under the age of 55, and a good part of them are families that take children and young people to the visits and exercise the principles of environmental education.

Regarding the level of education of the interviewees, the most important factor in the perception of the benefits of ecosystem services for well-being [41], 76.9% are among high school and college, and 13.2% have attended graduate school. The remaining 9.9% attended up to high school.

The modal frequency of visits to the ZPB is once a year, effected by 50.2% of the interviewees. A group of 18.6% make visits every six months, 15.9% monthly, 6.2% quarterly, 4.6% quarterly and 4.6% make occasional visits more than one year. The visit time is around three hours, concentrated on the morning period. The origin of visitors is 68.4% from the Metropolitan Region of Belém, 18.4% from other municipalities in Pará, 12.2% from other states in Brazil and 0.9% from other countries.

All interviewees, in addition to agreeing to participate in the survey, revealed that they have sufficient knowledge to answer questions about the environmental and ecological conditions provided by the park and its influence on the well-being of the population. They declared their willingness to pay for the preservation of the natural assets of the ZPB and to receive compensation for

opting to visit another park instead of the ZPB. In this case, the Botanical Garden Grove Rodrigues Alves was the closest replacement, indicated by 54.15%, followed by the Mangal das Garças by 31.06%, Park of Utinga by 4.49% and other different sites by 10.30%. The main choice of the former as the main substitute place was due to the similarity of the ecosystem services offered by the forest area.

The variable per capita income concentrates 63.1% in the stratum that earns up to three minimum wages (MW) per month, 14.4% between three and five MW, 14.2% between 5 and 10 MW and 8.2% between 10 and 40 MW per month. Regarding the concentration structure, 24.6% earn less than one MW and 1.1% earns more than 25 MW per month.

Perception of ZPB Benefits

The ecosystem services produced by the systemic interaction of the natural assets of the ZPB with the fauna and population that were perceived directly and indirectly by the interviewees who visit the environment, contemplate: regulation of the environment (temperature, winds, rain and pollution); visual landscape (trees, wild animals, forest mosaic in urban environment); biodiversity (rare and endangered animals, Amazonian fauna and flora interacting); environmental education (functions of animals and plants in the ecosystem, values to be preserved, knowledge about the Amazonian flora and fauna); social well-being (comfort and mental relaxation, awareness of preservation); and real estate valuation of the site (land, buildings and other buildings).

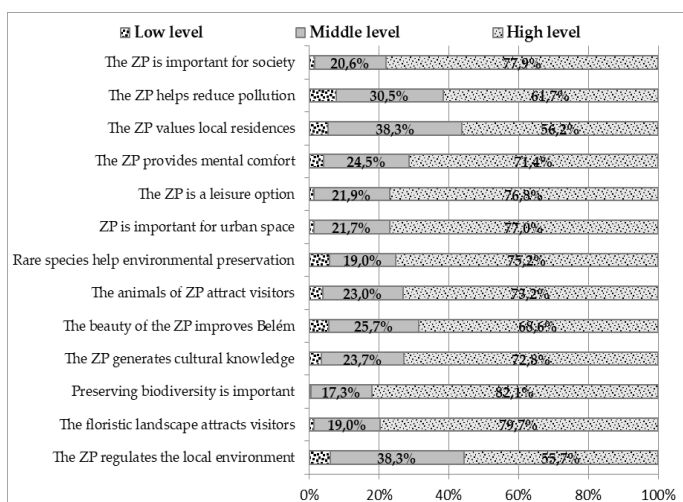


Fig.1. Perception of interviewees on ecosystem services produced by ZPB, Belém, 2017

The importance of ZPB to society was recognized by the interviewees, with 98.5% of them evaluating as medium to high importance. The results presented on the

Figure 1 reveal the level of importance that the interviewed perceived and attributed to the ecosystem services produced by the natural assets. These results were superior to those found by Santana et al. [32] and Oliveira et al. [11], due to the higher degree of formal education and knowledge of the interviewees about the effects of the environment on the well-being of humanity.

The results in Figure 1 allow the four groups of ecosystem services offered by the ZPB to fit into the four components of the TEV. The ecosystem services that define the DVU are consumed by direct interaction with the organs of the senses, and were evaluated by the interviewees as being of high importance for the well-being and improvement of the quality of life of people; to note: leisure option (76.8%), fauna as a visitor attraction (73.2%), mental comfort (71.4%). The IVU refers to the utility obtained by the contemplation of plants and animals such as the attraction of the floristic landscape (79.7%), reduction of pollution (61.7%), the scenic beauty improves the image of the City (68.6%), valuation of local residences (56.2%), and regulation of the local environment (55.7%). The OV, which reflects the interest in conserving the natural asset as a legacy to knowledge and/or future use by society, was captured by the responses attributed to the fact that the ZPB contributes to knowledge (72.8%) and is important for environmental education (77.0%). Finally, the EV reflects the utility or benefit generated by the simple fact of being informed about the functions produced by natural assets, and was captured in the answers about the fact that rare and endangered species contribute to the awareness of the population to preserve (75.2%) and that the preservation of biodiversity is fundamental for the well-being of the global population (82.1%).

Representative indicator of the environmental dimension

The results of the factor analysis to be used in the construction of the environmental indicator are shown in Table 1. The correlation matrix presented determinants different from zero, thus admitting inverse and providing a single solution that best represents the phenomenon [32]. According to the KMO test of 0.82 (higher than the acceptable limit of 0.50) and Bartlett's sphericity test significant at 1%, the sample is suitable for factor analysis [45]. The estimated factor loads showed significance at 1%, confirming the adequacy of the factor model. All communalities are greater than 0.50, validating the participation of variables in the definition of factors [45].

The factor model specified to reflect the behavior of ZPB's environmental dimension was configured by three factors and explained 69.4% of the total data variance

(Table 1). Factor 1 explained 30.1% of the variance and represents the combined strength of four variables that, in the interviewees' perception, reflect the recognition of biodiversity and the contribution of the species to the preservation of natural assets, attraction for tourists and the importance in environmental education. This factor represents the preservation of biodiversity. This dimension is the most important, given that it is the reason for maintaining the flow of ecosystem services and their contribution to the economic activity and well-being of the population.

Factor 2 explained 22% of the data variance and represents the effect of the variables: environmental regulation, knowledge about the Amazon, and offering comfort and mental relaxation to visitors. This factor

represents socio-environmental regulation and is aligned with the effectiveness of generating usefulness for people through leisure, contemplation of natural beauty, and a differentiated climate for visitors, which contributes to the improvement of well-being.

Factor 3 explained 17.3% of the total variance of the data and is related to the variables that produce positive externalities by contributing to the valorization the homes located around the ZPB, and to the reduction of air pollution. This factor can be called positive social-environmental externality. The increase in the value of homes has a direct effect on increasing people's well-being, as it contributes to increasing the value of built capital and, at the same time, improves people's health and quality of life (e.g. by reducing temperature, air pollution).

Table .1: Factorial load matrix of representative model of the environmental dimension of the ZPB

Variables	Common Factors			Commonality
	F1	F2	F3	
Biodiversity Preservation (flora and fauna)	0.809	0.227	0.075	0.711
Rare Species Raise Awareness about the Preservation	0.882	0.071	0.110	0.796
Wild Animals help to Attract visitors	0.756	0.154	0.088	0.603
O ZPB is important to environmental education	0.750	0.255	0.169	0.656
The ZPB contributes to regulating the local environment	0.147	0.818	0.070	0.696
The ZPB contributes to know about the Amazon	0.247	0.789	0.131	0.701
The ZPB provides mental comfort and relaxation	0.155	0.692	0.255	0.569
The ZPB values the homes around it	0.117	0.139	0.860	0.772
The ZPB contributes to reducing air pollution	0.145	0.199	0.822	0.736
Sum of square of the loads	2.708	1.976	1.556	6.240
Percentage of trace (%)	30.10	22.00	17.30	69.40
Factor Weights - θ	0.434	0.317	0.249	1.000
Sample Adequacy:	KMO = 0.820; BARTLETT'S TEST = 1,727.796 (p < 0,01)			

The environmental dimension indicator was constructed from these results, explained by the set of nine variables that describe the effects produced by ecosystem services on well-being, and that were perceived by the interviewees.

$$EDI = 0.434EF_1 + 0.317EF_2 + 0.249EF_3 \rightarrow (10)$$

Where EDI is the environmental dimension indicator, EF1, EF2 and EF3 are the factor scores, normalized to vary between zero and one, following Santana et al. [32]. This is the variable that will explain the behavior of the environmental dimension in the WTP and WTR models.

This indicator was classified by 58.0% of the interviewees as having medium to high impact on the well-being and quality of life of the people, with 25.0% considered it with high importance. Another 40.0% classified the indicator as intermediate, and only 2.0% observed that the environmental effects are of low importance.

Value of the ecosystem services provided by the ZPB

The gender and age variables were excluded in the WTP and WTR equations of the model because they do not present statistical significance. The value of R²-Adjusted for degrees of freedom indicated that the

explanatory variables used in the model explained 76.71% and 76.37%, respectively, of the variations in the value of the willingness to pay for a visit - WTP and in the value of the willingness to receive for replacing a visit - WTA (Table 2). This result, together with the statistical significance of the parameters, indicates that the set of

explanatory variables validated the specification of the system of equations.

Table .2: Results of the parameters estimative of WTP and WTR for visits to the ZPB

Variable	Coefficient	Statistic t	Probability	WTP (R\$/v)
Intercept - a_{10}	-5.839297	-4.996956	0.0000	-5,8393
Income - a_{11}	0.000289	10.81291	0.0000	1,1043
Education - a_{12}	0.695015	5.899461	0.0000	3,7891
Environmental Dimension - a_{13}	19.80190	11.02310	0.0000	13,3346
Dummy Variable - a_{14}	6.479356	13.73160	0.0000	6,4794
Total Economic Value of ZPB's WTP =			R\$ 18,8680/v; US\$ 6.00/v	
TEV of ZPB Ecosystem Services =			R\$ 4.151.211,01; US\$ 1,319,310.67	
Variable	Coefficient	Statistic t	Probability	WTA (R\$/v)
Intercept - b_{20}	-7.820977	-6.024715	0.0000	-7.8210
Income - b_{21}	0.000272	6.066495	0.0000	1.0393
Education - b_{22}	0.966744	7.186549	0.0000	5.2705
Environmental Dimension - b_{23}	24.66451	12.24482	0.0000	16.6091
Dummy Variable - b_{24}	6.117396	12.23450	0.0000	6.1174
Total Economic Value of ZPB's WTA =			R\$ 21,2153/v; US\$ 6.74/v	
TEV of ZPB Ecosystem Services =			R\$ 4.667.646,61; US\$ 1,483,440.84	
R-Square Adjusted: WTP	0.767086	Average of the dependent variable		14.32745
R-Square Adjusted: WTA	0.763735	Average of the dependent variable		16.92931
Statistic F: WTP	451.38 (p < 0.01)	Statistic F: WTA		443.05 (p < 0.01)

The results indicate that the increase of US\$ 1,000.00 on the interviewees' income tends to generate an increase of US\$ 0.29 in WTP for each visit and preserve the park's ecosystem. Likewise, it tends to generate an increase in the average value of the WTA of US\$ 0.27 for each replaced visit. Similar results for WTP were found by: Adams et al. [13], in the work on the preservation of the Brazilian Atlantic Forest; Groot et al. [3], in estimating the global value of ecosystems; Santana et al. [5], in the work on the total economic value of the potential damage to fishermen and family farmers from the hydroelectric dams planned for the Tapajós River basin, state of Pará; Rosa et al. [21], in the valuation study to preserve the mangrove in the Bragantine Region of Pará; Santana et al. [7,22], in the study of valuation of the metallophytic savanna vegetation of the Flora of Carajás for compensation by mining companies; Oliveira et al. [11] estimated the value of

ecosystem services produced by the agroforestry systems of the county of Tomé-Açu, state of Pará.

It was seen that a higher level of education leads to a higher WTP price for the benefit of a visit, as well as a WTA greater compensation for visiting another location instead of the ZPB and maintaining the same level of satisfaction. This is due to the fact that education adds greater knowledge about the natural asset and in recognizing the gains in well-being and quality of life provided by them. For each additional year of study that the person attended, WTP tends to be increased by R\$ 0.70 per visit, while the value of WTR can be increased by R\$ 0.97 for each replaced visit (Table 2). This result corroborates those obtained by Lima and Bastos [43] who obtained a positive correlation between education and the perception of benefits generated by ecosystem services.

Some studies on WTP have obtained significant results for education, among them are: Bentes et al. [19], in the work on the economic and environmental value of the damage caused by the Tucuruí Hydroelectric Power Plant to fishermen downstream from the Tocantins River in the state of Pará; Lera-López et al. [47], in the WTP study for reducing the environmental impacts produced by road transport; Adams et al. [13], in the research on the value of WTP for the preservation of the Atlantic Forest; Rosa et al. [21] and Santana et al. [7], respectively for the preservation of the mangrove and metallophytic savannah of the Flora de Carajás; Oliveira et al. [11], for the conservation of agroforestry systems in the municipality of Tomé-Açu, state of Pará. Regarding studies on WTR, Santana et al. [7,22] and Oliveira et al. [11] obtained positive and significant results for education. On the other hand, in the studies by Baral and Bhattarai [14], Subade and Francisco [48] and Veronesi et al. [49], the variable showed a positive sign but was not statistically significant.

The result of the dummy variable, which captures the effect of the interviewees' distribution of purchasing power, indicates that people who are willing to pay at least five times more than the rate currently charged have a higher purchasing power and level of education. This group of people willing to pay US\$ 2.06 above the average and receive US\$ 1.95 above the average has greater potential to make changes in the environment and influence the preservation or replacement of the ecosystem [22].

The environmental dimension was defined based on the effects of nine variables, associated with the three factors that represent the monetary value of the multifunctionality of ZPB ecosystem services in the perception of the interviewees. Table 2 shows that the increase of one unit in the average value of the environmental dimension tends to generate an increase of US\$ 6.29 per visit in the value of WTP to continue enjoying the benefits of visits, and US\$ 7.84 per visit in the amount of WTA for the replacement of visits to the ZPB. This result supports the fact that more information, clarification and awareness about the benefits to the population that the ecosystem services of urban environmental parks generate, favors the tourism and the hospitality network, making cities more livable, healthy and resilient to adversity; which stimulates public investment in green infrastructure in the urban environment [30].

According to the results in Table 2, the estimated average WTP value for continuing to visit the ZPB was US\$ 6.00/v (with a maximum value of US\$ 7.88/v) and a WTA value for visiting other ZPB substitute locations of US\$ 6.74/v (with a maximum value of US\$ 8.00/v). These

values, considering the visitor population of 220 thousand people per year, have a maximum WTP value of US\$ 1,319,310.67 and a value of the WTA of US\$ 1,483,440.84. Adding the standard deviation to this value, the maximum value of US\$ 1,759,697.60 is obtained.

Participation of the social, economic and environmental dimensions

The participation of the social, economic and environmental dimensions in the total economic value of the ecosystem services produced by the natural assets of the ZPB is shown in Figure 2. The social dimension is defined by the variable level of education, given that it was the only one that presented statistical significance. The economic dimension includes the income variable and the dummy variable that captures the distribution of purchasing power among interviewees. These are the variables that allow to exercise the purchasing power of goods and services, enabling the choice to qualify and diversify the shopping basket that results in maximum utility or benefit.

The environmental dimension represents the influence of ecosystem services on the well-being provided to visitors. The environmental dimension presented the greatest participation, due to the high perception of the population about the socioeconomic and environmental benefits provided by the natural biodiversity of the ZPB of Belém.

The sum of the social and economic components is lower than the value of the environmental component, demonstrating that the natural asset represents the greatest economic value of the park, in the perception of society. This fact justifies the inclusion of environmental capital in the value of the urban property and justifies the investment in the infrastructure of green areas in the city.

These dimensions have an income elasticity of 0.0771, education elasticity of 0.2645 and environmental elasticity of 0.9307 to the WTP. These results indicate that for changes of 10% in income, in years of education and in the environmental dimension, the value of WTP tends to change in the same direction by 0.77%, 2.64% and 9.3%, respectively. Oliveira et al. [11] obtained similar results for the participation of the environmental dimension in relation to the WTP to preserve agroforestry systems in the Amazon. These results justify public and/or private investment in urban environmental spaces for public visitation, considering the importance of natural ecosystems for the improvement of the population's social well-being.

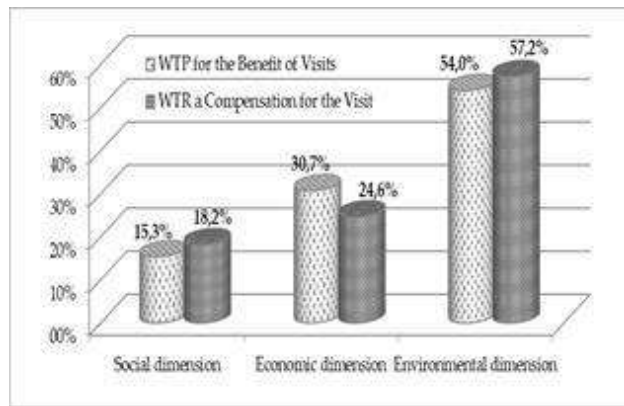


Fig.2 – Participation of the social, economic and environmental dimensions in the value of the natural assets of the ZPB, Belém, 2017.

IV. CONCLUSIONS

The population in the state of Pará elected the ZPB as the foremost public space for leisure, knowledge and well-being of the population; being recognized as such for more than a century.

The WTP revealed a strong recognition of society for the benefits provided by the ecosystem services produced by the natural assets of the ZPB, which justifies the public and/or private investment in the provision of urban natural spaces for leisure, knowledge, interaction with biodiversity and contemplation of the Amazon biome.

The value of the timber forest product was US\$ 145,216.75, about 11.01% of WTP for the preservation of the ecosystem services of the natural asset of the ZPB. The WTA to give up visits to the park and obtain the same level of satisfaction was US\$ 1,483,440.84, which added to the value of the carbon stock resulted in US\$ 1,628,657.59. This value represents the opportunity cost of the area for the civil construction market.

CONFLICTS OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this work

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The Feasibility of Tax Arbitration In The Brazilian Legal System

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Abstract — *The ineffectiveness and slowness of national tax litigation, whether in the judicial or administrative field, is an irrefutable reality. There are several causes of this reality and it is natural that the scant presence of alternative methods of conflict resolution contributes to the perpetuation of this scenario. In this context, the theme under study is tax arbitration in Brazil, with a main cut in the feasibility of the use of arbitration in the resolution of tax disputes. The problem of research is the effective use of arbitration in tax pending. The problem of research is the effective use of arbitration in tax pending. For the development of this work, the deductive method will be used, starting, as can be seen, from the general analysis of arbitration to the specific points that outline the theme. Thus, the study was split into five topics: the status of the taxpayer; Bill No. 4,257/2019; Bill No. 4,468/2020; tax arbitration in Portugal, and finally the feasibility of tax arbitration by the National Tax Code (CTN) and criticism and praise on the part of the doctrine. Thus, the issue of arbitration will be better understood, especially by relating it to the branch of Tax Law, so that the practical implementation of this mechanism can be assessed.*

I. INTRODUCTION

Evidently, a tax reform that seeks to modify the bases of consumption taxation, as is currently being debated, is not enough. It is not enough (and this is not even the agenda) a reform that aims to change the levels of income taxation. It is necessary to reassess the structure of collection and collection of taxes in the Brazilian territory.

Public Administration should be guided by the idea of implementing a tax collection model that consists of imposing the lowest possible cost on the state entity to

collect the highest possible amount, within the legal framework (OLIVEIRA, 2015).

The reality is that, until the recent implementation of the tax transaction, there has been little progress in tax litigation other than the introduction of political sanctions, restricting the regular exercise of taxpayer activities. It is observed that tax litigation has been suffering from the idea anchored in issues such as isonomy, illegality, unavailability of tax credit, as if this made it impossible to use alternative methods that would improve the resolution of tax conflicts.

Certainly, the unavailability of the public interest does not impose the immobilization of the state machine. The starting point must be the thought that collective interests must prevail over the interests of the Public Administration. And the collective interest in the application of alternative methods can be easily ascertained, either from the increase in revenue, or from the promotion of business maintenance.

In this perspective, the focus should be on the public interest involved, which, in the opinion of Celso Antônio Bandeira de Mello, would be the desires arising from the set of interests that the subjects personally hold when considered in their quality as members of society and by the simple fact that they are (BANDEIRA DE MELLO, 2005).

It should be noted that, supporting the reception of alternative measures, the Organization for Economic Cooperation and Development-OECD argues that the current financial crisis must be eradicated by the tax authorities, taking into account the possibility of providing swift legal certainty to taxpayers, with regard to their tax liabilities, in cases where this can free up resources or unlock cash flow (CIAT /IOTA/OECD, 2020).

Fortunately, it is possible to observe, in Brazilian territory, an evolution of the discussion about the adoption of alternative methods of resolving tax disputes. In this wake, the tax transaction institute has been gaining more and more strength. The same is true of tax arbitration. Until recently, the doctrine was still focused on the discussion about the possibility of the tax credit being the subject of arbitration, based on the debate about the availability of the tax credit, as well as whether the arbitration award could be recognized as one of the reasons for extinction of the tax credit, or even what the enforceability of the credit would look like in the course of the arbitration procedure (ESCOBAR, 2017).

The national scenario is not far from that identified in other nations and, notably, this debate needs to exist so that the population is comfortable with having part of the demands that deal with Tax Law resolved outside the jurisdictional path or administrative bodies subordinated to the Executive Power.

In this context, the present work will address several issues concerning arbitration, giving a special bias to arbitration in the sphere of Tax Law, thus, identifying the strategies present in this area, through an approach based on good practices and indicators of quality is relevant.

II. METHODOLOGY

The method used in the present research is the deductive one, starting from the analysis of the Taxpayer Statute, of several doctrinal positions and of legal dispositions to infer a plausible conclusion. Regarding the means, the research is bibliographical and is developed through consultation of doctrine and legislation at the national and international level, especially tax arbitration in Portugal, in order to bring a greater understanding of the phenomenon under study.

2.1. SUSTAINABLE DEVELOPMENT OF AGRIBUSINESS

The search for sustainable development is growing more and more in Brazil, and practices are being adopted that aim at environmental preservation allied to agribusiness. The use of land without sustainable practices can generate irreparable damage to the environment, and economic losses within the activity.

Sustainability consists of the existing natural resources, while without it, far beyond society, biodiversity would also be vulnerable, resulting in serious risks to the global ecosystem (MILARÉ, 2018).

As for natural resources, their definition is very broad, since it covers land, soil and its topography, water, climate, ore, as well as the possibility of fishing, integrating the location and geographical extension of these resources (BURANELLO, 2018). For this reason, the awareness of agricultural entrepreneurs about the protection of the Conservation Units is of extreme importance so that entrepreneurial actions are carried out with special attention to sustainable development.

Antunes (2019) defines Conservation Units as "[...] territorial spaces which, by virtue of an act of public authority, are destined for the study and preservation of specimens of flora and fauna [...]".

According to article 2, item XI, of Law 9.985/2000, sustainable use is about exploring the environment in a way that guarantees the continuity of renewable resources and ecological processes, so that biodiversity is maintained in a fair and economically viable way.

Although the environment presents an abundant ecosystem, sustainability is still difficult to achieve, since the great majority of the population does not recognize the importance of natural resources for agribusiness.

With the transformations that the environment undergoes as a result of exploitation, specifically for agricultural expansion, native flora and fauna are harmed, since burning and deforestation occur, in addition to the high rate of water use and land use in an immoderate

manner. The indiscriminate use of natural resources can cause irreversible damage, involving current and future generations.

"Thus, environmental management in agribusiness must be based on an ecological approach, whose focus implies the integral treatment, before, during and after production, of all relevant environmental issues [...]" (BURANELLO, 2018).

The relevance of the studies and the achievements in favor of the protection of the natural environment of the group of scientists protecting nature, from the 19th century on, under the aspect of valuation and care of forests, fauna and flora, deserves to be reassessed in the light of current legislation. This new evaluation of the natural environment in the XIX century will provide reflections and practices for the maintenance of the vegetation still existing in Brazil, as well as, the regularization (spontaneous or coercive) of rural areas, public and private, that had irregular suppression of vegetation by anthropic actions (CÉSARO; FERREIRA, 2018).

"Sustainability is associated with economic and material development without harming the environment, using natural resources wisely so that they can be conserved in the future, i.e., they aim at the very survival of the planet [...]" (MOREIRA, 2018).

In fact, especially in the Cerrado biome, sustainability becomes a challenge, since society does not understand that fauna and flora, while a diverse set of native vegetation and animals, carry a commercial potential of great value (MOREIRA, 2018).

Thus, it can be observed that from the 19th century on, through research by scientists and scholars who were concerned with nature, the protection of the fauna and flora in Brazil began to be valued, so that the practices of maintenance and conservation of vegetation in rural and urban areas have been gaining focus in the current forest legislation.

2.2. DRAFT LAW 4.257/2019

On August 6, 2019, Bill 4,257 was presented, proposing the modification of the Tax Enforcement Law, to, among other measures, enable the institution of arbitration proceedings in the field of defense of tax enforcement proceedings.

In general terms, the aforementioned Project aims to admit that the defendants, by offering a deposit, surety bond or surety, may opt for the Arbitration Convention for judgment of the motion to be embargoed.

The data mentioned in the project's justification and, several times, published by official bodies, show that tax executions account for a large portion of the stock of

tax cases awaiting resolution. In addition, it is known that this high volume of executions, dealing with the most varied topics, in many cases, prevents magistrates from responding to the parties quickly and effectively.

Therefore, without a shadow of a doubt, the Project clearly presents a great importance in the attempt to solve this issue. However, it is necessary to consider that the arbitration procedure, *a priori*, is intended to deal with the most complex cases, offering the litigants the best possible decision, in view of the specialized knowledge of the arbitrators, with regard to the procedure and substantive law.

Thus, due to the very nature of the arbitration procedure, it does not seem to us that the promotion of arbitration in the proposed manner is an effective measure to promote a significant reduction in tax foreclosures sent to the Judiciary, but it will certainly represent a relevant mechanism for faster resolution of disputes. more complex tax disputes, ensuring a more efficient and specialized analysis of documents, facts and legal issues involved, generating better collection efficiency.

It is important to emphasize that the Economic Affairs Committee issued an opinion on Bill 4,257/2019, with the rapporteurship of Senator Otto Alencar proposing some amendments to the Bill, among them the following:

Art. 41-T. The debtor may opt for the arbitration procedure provided for in arts. 16-A to 16-F case, when filing the action provided for in art. 164 of Law 5,172, of October 25, 1966, or the action for annulment of the debt declaratory act, provided for in art. 38 of this law, guarantee the judgment by cash deposit, bank guarantee or guarantee insurance (SENADO FEDERAL, 2019, p.8).

According to the aforementioned proposal, the tax arbitration procedure in question would also be capable of reaching consignatory and annulment actions, thus, going beyond the debates held in the field of tax foreclosures. The proposal is bold, but very salutary. It is normal that taxpayers, defeated in the administrative sphere or even aware of the impossibility or the tiny chances of success, especially in view of the type of matter, choose not to wait

to receive an executive charge, but rather to file an ordinary action aiming at the annulment of the tax credit.

Discussions in this type of judicial process usually drag on for several years, as they involve highly complex issues that require the participation of experts, especially accounting experts. Thus, it seems to us that arbitration would appear here as an alternative method of considerable value.

2.3. DRAFT LAW 4.468/2020

In the context of the encouraging and evolving arrangement of the State to make use of consensual dispute resolution methods, it is extremely important to point out some considerations about PL n. 4,468/2020, since it was recently filed, on September 3, 2020, at the Federal Senate, and which, despite not dealing with tax transactions, provides for the establishment of a special tax arbitration regime for the resolution of disputes .

As is well known, arbitration reveals itself as an alternative means of conflict resolution, in which a third party is elected to carry out this resolution. However, in this PL, the arbitrator will have his/her performance restricted to factual matters, being prohibited to use this mechanism in situations of tax credits already constituted, debates about the constitutionality of laws and legal norms, or decision contrary to the understanding sedimented by the Judiciary (TOLEDO, 2020).

Arbitration as an alternative mechanism to the judicial route in the resolution of disputes is not new, both nationally and internationally, having been present since the Roman period. In Brazil, the contemporary time frame was the entry into force of Law n° 9.307/1996 (Arbitration Law), which “adopted the *monist system* of arbitration, providing for a single standard of rules for arbitration, whether for those considered to be international arbitrations, or for those considered domestic arbitrations” (FICHTNER, MANNHEIMER, MONTEIRO, 2019. P. 96).

Taking into account the current moment in the country, which is marked by the high incidence of lawsuits that overload the Judiciary, and in view of the debate about the need for a tax reform to simplify the collection of taxes, which the Bill n. . 4,468/2020 was presented under the argument of being able to provide greater speed and efficiency in the recovery of values in the resolution of impasses (SENADO FEDERAL, 2020).

One of the novelties that most attract attention, with regard to this special tax arbitration, refers to the mandatory constitution of an arbitration triad to mediate the conflict. According to the Bill above, one arbitrator must be appointed by the taxpayer, another by the

administrative authority, and the third arbitrator must be elected, by mutual agreement, by both opponents (SENADO FEDERAL, 2020).

As you can have an idea, this third party will have a “tie-breaker” role, which will be in charge of evaluating the documentation of the process and rendering a decision, when there is no unanimity in the arbitration award. Thus, the scope of seeking a more agile solution in disputes will be compromised, as it can make the solution more time-consuming, including generating costs, hitherto non-existent, between the Public Administration and the taxpayer (TOLEDO, 2020).

The explanatory memorandum also highlights its impact on the quantification of credit recognized in court, or on its application in tax consultations. In this wake, the criticism rests on the consultation institute, since it does not have the scope to resolve any impasse, but only to clarify to the taxpayer about the interpretation that the Public Power has about the application of a certain normative provision (TOLEDO, 2020).

In view of the aforementioned considerations, special arbitration, under the terms proposed in PL No. 4,468/2020, seems to be relevant. However, it will still require further evaluation, with the aim of helping to resolve the enormous tax dispute.

2.4. TAX ARBITRATION IN PORTUGAL

Arbitration for the resolution of tax disputes has gained increasing visibility in international law, becoming common practice in the USA, Germany, the Netherlands, Australia, Japan, Canada, France, the United Kingdom, Mexico and, above all, , in Portugal, taking into account that the numbers of lawsuits pending before the receipt of the institute under discussion were also exorbitant (PASINATTO; VALLE, 2017).

The insertion of tax arbitration in the Portuguese regulatory framework represented an innovative mechanism, because Portugal assumed a pioneering role, being one of the first nations to welcome tax arbitration in its domestic legislation (FERNANDES, 2019). Thus, there was some fear regarding its institution, since there was no comparative law at the time for Portugal to be able to evaluate the experiences and analyze the pros and cons, to decide whether or not to implement the mechanism.

It is well known that tax arbitration in Portugal had its spark in 2004, through the reform of administrative litigation, which opened up possibilities for debates in the administrative field, and enabled the establishment of arbitration centers, until then restricted to administrative contracts (FERNANDES, 2019). In this sense, through Law 13/2002, the Statute of Administrative and Tax

Courts (ETAF) was approved, by which, in its articles 12 and 26, b, it recognized that only matters of law would be dealt with (PORTUGAL, 2002).

In addition, Law 15/2002 brought the Code of Procedure in the Administrative Courts-CPTA. With the advent of the CPTA, permission to establish permanent arbitration centers was verified, whose focus would be to allow the evaluation of issues related to contracts, legal relations of public employment, civil liability of the Administration, public systems of social protection and urbanism (PORTUGAL, 2002).

In this context, the legislator had two alternatives: to use the existing Voluntary Arbitration Law (LAV) as a basis and make the necessary adaptations, or to develop a more pragmatic regime, and the latter option was accepted. Thus, an alternative dispute resolution means was created, applying not equity, but the law.

In 2009, the Administrative Arbitration Center (CAAD) was created in Lisbon, used to resolve conflicts between the state entity and the civil servants, and in 2011, through Law 10/2011, Tax Arbitration became effectively implemented, aiming to strengthen the effective protection of the rights and interests of the taxable person, to provide agility in the resolution of disputes and to work on minimizing procedural pending issues, in the tax and administrative courts, leaving a clear need to raise funds.

It should be noted that the use of arbitration was gradual, according to the president of CAAD, Nuno Villa-Lobos, who stated that tax arbitration surpassed even the most positive expectations. Emphasizing the high level of quality of the decisions and the response time linked to the present deontological credibility. In the meantime, it took a while for trust to remain solidified, and the first decisions had to be made so that, gradually, the use of tax arbitration increased (PASINATTO; VALLE, 2017).

In Portugal, Arbitration has the function of resolving conflicts with the same value attributed to the Judiciary, and the purpose is to reduce pending issues, bring revenue to the public coffers and relieve the courts. However, such a reduction has not yet been possible, despite being a trend, taking into account the increasingly expressive increase in the number of cases that the Administrative Arbitration Center judged (CAAD, nd). As pointed out, it all started with a high economic crisis and a high number of active debt inscriptions, requiring that adequate decisions be taken so that the credits were quickly collected.

With regard to the economic crisis, there was an intervention by the Troika, which sought financial support and halted the recession, with the signing of a memorandum of understanding between the Portuguese govern-

ment, the European Commission (EC), the International Monetary Fund (IMF) and the Central Bank. European (ECB). In this wake, the Organization for Economic Cooperation and Development (OECD) expressed itself about the exit from the recession: Portugal is emerging from a deep and long recession, which has resulted in a high unemployment rate (about 15% in March of the year 2014), and a reduction in the income of family entities. Recent economic indicators have pointed to certain positive trends, including the reduction of unemployment and growth in exports (OECD, 2018).

The reform efforts carried out by the competent authorities have paid off ahead of schedule at the start of the joint program of the European Union (EU), the IMF and the ECB. As global conditions improve, the economy should gradually gain strength (OECD, 2018).

The aforementioned president of CAAD, Nuno Villa Lobos, one of the most responsible for the battle for the implementation of Arbitration, pointed out advantages for the institute to be used and pointed out that: there would be a reduction in the costs that the state entity has exhaustively with the judicial demands; dispute resolution would take place more quickly, underlining that taxpayers would save money when discussing their rights; in addition to the entry of revenue (PASINATTO, VALLE, 2017).

Another interesting issue that attracted the attention of taxpayers is that, in the CAAD, in the event that the claim is proven, the amount spent with the arbitration fee would be returned in full. Greater trust was observed in arbitrators, taking into account their technical specialties, and there was a reduction in litigation in the courts, with tax collection occurring more quickly (PASINATTO, VALLE, 2017).

In 2014, the OECD pointed out suggestions for improvements for Portugal, and mentioned improvements in the tax field, with regard to improved litigation and collection; highlighted that the improvements were identified as of 2011 and the aforementioned improvements took place during the arbitration period.

Raising tax revenues, through greater compliance by taxpayers, and reducing tax administration expenditures thanks to improved operational effectiveness are also part of the State's budget consolidation plan. Positive progress was made between 2011 and 2013, including the creation of a new integrated authority for customs and taxes - Autoridade Tributária e Aduaneira (AT) -, however, essential reforms that will have to be evaluated in close by AT servers (OECD, 2018).

Despite the aforementioned suggestion being relevant, it is important to point out that the Tax Arbitration

mechanism was not introduced in Portugal in an isolated way, integrating various measures indispensable to the promotion of the country, and to the exit from the crisis.

A survey carried out by the CAAD, in 2017, indicates that 60% of the cases submitted to the arbitration court had the taxpayers as winners, however, it is curious to note that data listed by the OECD also state that these same 60% are won in the courts, that is, the taxpayers are successful both when they are before arbitrators and judges. In this light, what can be seen as advantageous is the quicker response in the Arbitration Convention.

As already pointed out, the purposes of the Arbitration institution were to reduce pending in the courts and to speed up the demands, reinforcing the protection of the interests of the parties. In this context, it is noted that speed was achieved, the demands obtained arbitration awards, in a short period of time (in approximately four months), and, if the purpose was to guarantee revenue quickly, Arbitration played a crucial role, given that, in the words of the president of the CAAD: a lengthy court decision delays the effective collection of tax revenue by the Public Power or, in case the taxpayer wins the case, may cause the amount of compensation to be paid by the Public Administration to 'shoot up' only in due to interest, plus sponsorship and guarantee charges (PASINATTO, VALLE, 2017).

CAAD data exposed in the work whose coordinators Nuno Barroso and Pedro Marinho Falcão (2015) outlined the socioeconomic profile of the contributors and identified that approximately 75% of the requests for submission to Arbitration were distributed by collective contributors, that is, they are at the center of the Arbitrage the mass issues.

It is noted that there was a reduction in litigation expenses; attraction of the taxpayer by the fact that, in the event of being victorious, he will be entitled to a refund of the fee paid; faster revenue collection; prediction of the arbitration decision time, that is, it helps entrepreneurs to work their provisions, which also attracts more investors; and more quality in the decisions taken – positive aspects.

In general, arbitration is seen in a positive way in the Portuguese scenario, however, the challenges are latent, since the sought success has not yet been reached, that is, it is too early to be sure about a possible success, because, as everything is still relatively recent, there is a lack of quantitative and qualitative data for conclusion purposes.

2.5. FEASIBILITY OF TAX ARBITRATION BY THE CTN AND CRITICISM AND COMPLIMENTS FROM THE DOCTRINE

With regard to the provision for the use of tax arbitration in national legislation, it is important to mention that the effects of the arbitration decision are already duly outlined in the National Tax Code (CTN) as circumstances of extinction and suspension of the tax credit. The simplicity of the argument is also based on its justifications, reiterating the need to distance itself from the systemic reading of the regulations on the matter.

With regard to the provision for the extinction of the credit by the arbitration award, it is imperative to draw attention to the fact that articles 141 and 156, X, of the CTN, provide for the extinction of the tax credit by the "decision passed in *res judicata*". Notably, there is the unmistakable equivalence of the arbitration award to the hypothesis established in art. 156, X of the CTN, since both article 31 of the Brazilian Arbitration Law (LBA) and item VII, art. 515, of the Civil Procedure Code (CPC) equates the arbitration award to the judicial enforcement title, that is, to the final and unappealable judicial decision.

Assuming that the expression "transit in *res judicata*" is a consequence of the legitimacy of the judicial decisions (SOARES, 2010), in the case that the arbitral award is legitimate, it constitutes a judicial enforceable title, or, in the terms of the art. 156, Inc. X of the CTN, that is, it configures a hypothesis of extinction of the tax credit already inserted in complementary legislation, pursuant to art. 146, inc. II, of the constitutional text.

The same logic applies to the provision of suspension of the tax credit by arbitration, pursuant to art. 151, Inc. V, of the CTN, since it adopted the expression: "the granting of an injunction or of injunctive relief, in other types of legal action" (BRASIL, 1966), however, it being certain that, in addition to the application of the same logic already used to the extinction of the tax credit, it should be noted that art. 31 of the LBA determines that "the arbitration award produces, between the parties and their successors, the same effects as the sentence handed down by the Judiciary bodies" (BRASIL, 1996), that is, by affirming the hypothesis of suspension of the tax credit in other modalities of legal action, the CTN considered the arbitration award among the suspension hypotheses, given the provision in ordinary law - CPC and LBA - stating that the arbitration award produces the same effects as the sentence issued by the bodies of the Judiciary (BRASIL, 1966; BRAZIL 1996).

Still with regard to the provision in a complementary law of the effects of the arbitration award in tax matters, it is important to emphasize that inc. V of art. 151 of the CTN was added upon the enactment of LC 104/01, necessarily due to the need to extend the interpretation of the provision established in inc. IV of the

same legal provision that restricted the suspension only when an “ injunction in a writ of mandamus ” was granted.

In the same way, when extending the hypotheses of suspension of the enforceability of the tax credit, the legislator chose to insert a broad provision, admitting the suspension both in the granting of injunctive relief and preliminary injunctions in " other types of legal action ", being wrong to discuss the regarding the practical reiteration of the granting of precautionary or urgent measures in arbitration proceedings, in view of the provision of the sole paragraph of art. 22-B of the LBA, which allows arbitrators even to maintain, amend or revoke the precautionary or urgent measure granted by the Jurisdictional Power.

Although the effects of the arbitration award are already duly outlined in the CTN with clear hypotheses of extinction and suspension of the tax credit , it is natural that tax experts instinctively react by seeking the express insertion of a provision for tax arbitration, in the text of the CTN, and not only in its reflexes.

However, this initial desire is also not supported, by paths already trodden by previous discussions, since arbitration is a matter related to Civil Law and Civil Procedure (ESCOBAR, 2017) and having been fully conveyed by ordinary legislation - LBA - has fulfilled its normative role in a harmonious way, relegating to the CTN only predicting the effects of arbitral awards, without such a conclusion imposing any sort of affront to the provision in inc. II of art. 146 of the Magna Carta.

This conclusion follows from the provision listed in art. 22, Inc. I of the constitutional text, which restricts the Union to privately legislate on the process. Once again, the matter does not present anything new, since it has already been discussed in the doctrinal field, and, in the opinion of Carlos Alberto Carmona (2009), it might be plausible that - similarly to France and Italy - the discipline of arbitration was inserted within the CPC , however, further ponders that, taking into account the specificity of the institute and the fact that the law contains rules that cannot be considered only procedural, the legislator chose to outline the rules in a separate diploma (CARMONA, 2009).).

In turn, Cândido Rangel Dinamarco (2013) is more incisive in defending that arbitration would constitute a specialized expression of a more extensive science, that is, the general theory of the process .

The position of the doctrine reflects an old judgment of the Supreme Court of November 14, 1973 in the emblematic Lage Case - AI 52.181/Guanabara - which crystallized the understanding that arbitration is not a

matter of Administrative Law, but of the Civil and Law field. Civil Procedure (STF, 1973).

In other words, as arbitration is also a matter of Civil Procedural Law, it is up to the Union to legislate privately, as it did, to institute arbitration through the LBA, as well as to provide for the rules of the current civil procedural law, being in both situations , edited through ordinary legislation.

Considering the reason why the LBA should, as it was edited by ordinary legislation, there is no need to talk about the institution of authorization, through an express provision of arbitration in the middle of the CTN, for the simple fact that the aforementioned Codex also does not admit in its articles the use of the civil procedure, but it deals only with the effects of the decisions rendered in the civil procedure, as suspension and extinction of the tax credit.

As in the example of the lack of provision allowing the use of the civil procedure in the CTN, the mere argument of the indispensability of a complementary law to provide for arbitration in tax matters is also not plausible, since the LBA, as ordinary legislation, fulfills its function normative to submit all administered and federated entities to the same content agenda, and the Supreme Court has also discussed the issue a lot, pointing out that “general rules” do not mean “generic rules, since the term “general” refers to the normative predisposition to submit all administered and federated entities to the same conduct agenda, as a mechanism for stabilizing and harmonizing expectations of the legal certainty pact (STF, 2010) .

Thus, the CTN still prohibits, in its art. 110, that the law modifies “the definition, content and scope of institutes, concepts and forms of private law”, thus being prohibited to the tax law any attempt that aims to bring new concepts or redefine arbitration (BRASIL, 1966) .

According to Ribeiro e Castro (nd), within the scope of the private sector, it appears that the arbitration institute is totally valid, given that the composition of conflicts can be much more advantageous than having to resort to the judicial process to this end, since the Judiciary still imposes a series of formalities that, many times, intimidate the litigants. On the other hand, with regard to tax arbitration, these scholars state that there are still doubts as to whether this represents a legitimate way to resolve impasses, since there is already a prevailing party in the relationship over the other, that is, the entity state-owned. Thus, there could be intimidation of opponents of the State, as it is considered sovereign and supreme.

With regard to external tax arbitration, it was found that it is already present in some nations, and, in the

case of Europe, the European Constitution brings this possibility, including the establishment of arbitration tax courts, which operate under the prism of the Administrative Arbitration Center (RIBEIRO; CASTRO, nd).

In the opinion of Escobar (2018), the alleged technical infeasibility of submitting tax matters to arbitration leads us to the hasty and erroneous understanding that it would be a strictly academic discussion, without major impacts on the factual sphere, as it depends, in theory, on the specific law edition. The imprecision of this limiting view stems from the fact that the overwhelming majority of tax experts do not actually act in arbitrations, in the same way that a tiny portion of arbitrators are specialists in tax matters. Under the empirical prism of both segments - taxation and arbitration -, added to a systematic interpretation, through a holistic panorama of the national system, however, a new perspective arises, free from barriers and prejudices, in theory, insurmountable.

With regard to the application of arbitration in the tax field, the importation of ideas from the Portuguese experience must be preceded by a necessary adaptation and by an intense debate. The national reality with all its social, economic and political nuances requires quick solutions that need to be followed by a new model of tax process.

The differences between the Brazilian and Portuguese tax administrative processes would not be able to prevent the creation of an arbitration court in the CAAD standard in Brazil. The national tax administration does not express any practical interest in adopting the tax arbitration institute, despite the fact that the Ministry of Finance encourages alternative methods of conflict resolution.

In the country, a CAAD could also be created, which would function as a Public-Private Partnership (PPP), with intense supervision by the Public Power, to ensure the smoothness of the procedure, as seen in Portugal. Furthermore, the cases of tax arbitration must be attentive to the specificities that justify it and that consider the peculiarities of the tax credit as an arbitration object. Certainly such a mechanism does not have the power to work as a magic formula in this field, however, if adopted by the Public Power, it could contribute positively to the stir that arose during the course of this study.

Concluding the issue of not including the provision of tax arbitration in the CTN, it is important to remember that authorization for its use, including by the Public Power, is properly affirmed in art. 1st of the LBA. In this wake, it is imperative to certify the availability of

the tax credit, a condition also established in art. 1st of the LBA.

2.6. (IN) AVAILABILITY OF TAX CREDIT

With regard to the availability of the tax credit, an essential presupposition for its arbitration, pursuant to art. 1 of the LBA, we also did not observe major obstacles to overcome this barrier (BRASIL, 1996). From the CTN, it appears that the tax credit is formed by the administrative procedure tending to verify the generating event constituting the tax credit, called release, and that can be changed, including the effects and extent (BRASIL, 1966).

Especially with regard to the hypothesis of altering the assessment, the CTN is also clear in providing that it can be modified by the taxpayer's resistance exercised through the tax administrative procedure (BRASIL, 1966). Thus, in practice, what happens is the improvement of the entry, through the tax administrative procedure, until, through it, it is perfected and the tax credit is constituted. Improvement is the act that begins with the inspection, results in an eventual tax assessment, and may be object of challenge and target of appeal by taxpayers; These resistances will be assessed in the first and second administrative instances, which may maintain the infraction notice, reduce it or even proceed with its cancellation (BRASIL, 1966).

Now, if in the process of improving the assessment there is no need to talk about a tax credit actually constituted, but simply in expectation on the part of the Public Power embodied in a tax work that will be subject to review by the competent administrative authorities, one cannot speak of unavailability, since it is not even before something that has already been implemented, but in the process of calculation, evolution, improvement.

The tax assessment notice, which only reflects the beginning of the assessment process, which is perfected during the tax administrative procedure, only reflects an expectation on the part of the Public Power, since the tax work is subject to failures, imperfections or excesses.

Once the availability of the "tax credit" has been appreciated until the conclusion of its release, the next question would be whether this availability would also be present after the registration of the credit in active debt (arts. 201 to 204 of the CTN) (BRASIL, 1966). Without long delay, as they are unnecessary, the question referred to in the figure of the so-called special installments, such as the Tax Recovery Program (REFIS), implemented by Law 9,964/2000 (BRASIL, 2000) is returned; the Special Installment Payment (PAES), established by Law 10,684/2003 (BRASIL, 2003); the Tax Regularization Program (PERT or Novo REFIS) - established in Law

13,496/2017 (BRASIL, 2017), among others, including at municipal and state levels, that is, even after the effective constitution of the tax credit, the Power itself The Public has the credit, in the examples of the installments mentioned above, whenever it issues a specific legal diploma, since, before its constitution, there is also a clear example of the disposition of a substantial portion of the taxes by the Public Power, when implementing SIMPLES, which considerably reduces the tax burden, encompassing several taxes with substantial reduction in rates.

A new element was recently inserted in this debate, when Law 13.988/20 was published, which, by providing for the transaction of tax disputes, removed any debate about the availability of tax credit, since, if subject to transaction, it may also be subject to of arbitration, the tax transaction being a gateway to tax arbitration, since it becomes indisputable that, when transacting any tax, the state entity will have a portion of it (BRASIL, 2020).

Even so that the lack of indication of the competent authority is not considered, it is important to remember that the sole paragraph of art. 171 of the CTN already established, when it was enacted, that the legal system would indicate the competent authority to approve the transaction, given that this gap has been remedied, since 2015, by the inclusion of § 2 of art. 1 of the LBA, stating that “the authority or competent body of the direct public administration for the execution of an arbitration agreement is the same for the execution of agreements or transactions” (BRASIL, 2015). In the meantime, law 13.988/20 (tax transaction law), five years after the amendment of the LBA indicated herein, addressed the alleged gap of the competent authority in its art. 13 (BRASIL, 2020).

III. CONCLUSION

Undoubtedly, the Brazilian tax system is extremely complex, in addition to the high tax burden that falls on taxpayers, especially legal entities, representing causes of stimulus to litigation. This context, in parallel with the continental dimension of the national territory, generates a worrying level of ineffectiveness in conflict resolution, both in the judicial and administrative spheres. Despite this, the discussion on alternative dispute resolution methods in the tax field, which would have the bias of improving this reality, is still incipient.

It should be noted that the approval of these bills will not represent the biggest obstacle to the establishment of arbitration in the tax area, the biggest challenge will be to change the culture rooted in the Public Tax Administration of judicializing all tax debt collections. An example of this is that, in 2015, federal law authorized

arbitration within the scope of the Public Power and to date the vast majority of state entities do not adopt this alternative dispute resolution mechanism.

The differences between the Brazilian and Portuguese tax administrative processes would not be able to prevent the creation of an arbitration court in the pattern of the Administrative Arbitration Center (CAAD) in Brazil, which would function as a Public Private Partnership (PPP), with intense supervision by the Federal Government. Public, to ensure the smoothness of the procedure, as seen in Portugal. The national tax administration does not express any practical interest in adopting the tax arbitration institute, despite the fact that the Ministry of Finance encourages alternative methods of conflict resolution. In other words, the main change must occur in the cultural field.

Furthermore, the cases of tax arbitration must be attentive to the specificities that justify it and that consider the peculiarities of the tax credit as an arbitration object. Certainly, such a mechanism does not have the power to work as a magic formula in this field, however, if adopted by the Public Power, it could contribute positively to the stir that arose in the present study.

For all the above, it appears that Brazil is still far from being able to use tax arbitration, such as the Lusitanian experience, and it is important to note that not even in this nation is the adoption of arbitration for the resolution of conflicts of order unanimous. tributaries.

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Defense Mechanism of the Immune System Against Hepatitis C Infection

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Keywords— Genetic, Hepatitis C, Immune system.

Abstract— Hepatitis C is an inflammatory process caused by a virus of the genus Hepacivirus. It can be triggered acutely or chronically, the latter being predominant. Chronic hepatitis C (CHC) has a worldwide prevalence in about 1% of the population. Hepatitis C virus infection (HCV) has a diverse genetic variety, which makes its elimination difficult. The present work emerges as a need to understand the mechanisms of defense action against HCV in the human body. The study was based on a literature review, based on research in articles from the SciELO and PubMed platforms, using the descriptors hepatitis C, genetics and immune system associated through the Boolean operators OR and AND. In the end, 15 articles were selected that guided the research of the work. In research, it was found that the virus infection can present in the acute phase or in the chronic phase, in which most cases tend to progress from an acute infection barely detectable by the immune system to a persistent chronic infection. In addition, it was observed that T cells during the chronic phase have their ability to resolve reduced, because, in the acute phase, because of the virus, a large variability does not allow T cells to create neutralizing antibodies or memory cells, therefore, when they present the chronic stage, it causes these defense cells to collapse. Much progress has been made in understanding the immune mechanisms that HCV stimulates, however there are still many gaps that need to be closed.

I. INTRODUCTION

Hepatitis C is an inflammatory process caused by a virus of the Hepacivirus genus, of the Flaviviridae family.

Its morphological structure is based on a single-stranded RNA with positive polarity, being enveloped and measuring approximately 50 to 70 nm in diameter [1]. In this sense, hepatitis C can be triggered acutely or

chronically, the latter being predominant. "Chronic hepatitis C (HCC) has a worldwide prevalence in about 1% of the population (~71 million infected). It is considered one of the biggest causes of liver disease and the seventh most frequent cause of death in the world" [2].

From this perspective, it is known that this pathology has a silent character, affecting the liver through an inflammatory process [3]. The transmission takes place through the sharing of objects, such as syringes contaminated with the infected person's blood, in the use of injecting drugs [4]. It also occurs through failures of health professionals, when reusing materials that can promote the spread of contamination, in addition to the absence of sterilization of manicure materials in salons, corroborate the transmissibility [5]. Furthermore, despite being less common and frequent compared to hepatitis B, unprotected sexual contact can be a way of contamination with HCV, however, the spread of the virus is inefficient in this form of exposure [1].

Parallel to this, the human organism, with its physiological processes, seeks to eliminate foreign bodies that infect them [6]. However, the HCV virus (Hepatitis C virus) has a diverse genetic variety. It has six genotypes and several subtypes. Due to this great viral diversity, the production of the vaccine has not yet been made possible, which ends up triggering the persistence of the virus in the human body. In Brazil, the predominant Hepatitis C virus is genotype 1 [3].

Regarding the defense mechanisms of the immune response, it is known that the pathogen receptors, after the virus enters the body, seek and recognize the viral products, resulting in the production of pro-inflammatory cytokines, such as the Tumor Necrosis Factor (TNF) and Interleukin 6 (IL-6), as well as type I interferons [2]. From this, there is the initiation of the immune response with the induction of antiviral products and the participation of NK Cells and T Lymphocytes, whose goal is to defend the organism in response to the attack of these pathogens [7].

Therefore, the present work arises as a need to understand the mechanisms of defense action against the Hepatitis C virus in the human body, given the various means that the pathogen develops to continue replicating, thus presenting the objective of this research.

II. METHOD

The study was based on a literature review, based on research in articles from the SciELO and PubMed platforms. To develop the work, some steps were followed, the first being the delimitation of the theme, then conducting research with specific descriptors, choosing

inclusion and exclusion criteria, analyzing the articles and developing the writing.

The following article had the theme delimited in defense mechanism of the immune system, hepatitis C clinic and infection treatment. Thus, to carry out the search for the matter, the descriptors hepatitis C, revision, virus and immune system associated were used through the Boolean operators OR and AND. With the use of these descriptors, 152 references were initially found, with these 2 studies from scielo and 149 studies from pubmed, including scientific articles and scientific summaries of analyzes and systematic reviews. Thus, studies written and made available in Portuguese, Spanish and English were sought. Having as inclusion criteria used in the research, analysis and systematic review articles published from the year 2016, addressing the content of the given topic and excluding all articles that were not of the cited type, other than between the years of 2016 and 2021 and which does not refer to the subject outlined.

Finally, it was necessary to analyze each of the studies in order to select those that were related to the problem of the proposed theme and that corresponded with the determined inclusion criteria. In the end, 15 articles were selected that guided the research of the work.

III. RESULTS

According to the data obtained from reading the 15 selected articles, it was possible to verify that HCV has some interactions with the host organism that are not fully understood at the moment [8]. Besides the wide genotypic variability and interference on the immune system function, the viral infection can present in acute or chronic phase, which most cases tend to progress from an barely detectable acute infection by the immune system, to an persistent chronic infection [9].

The life cycle of HCV is directly associated with hepatic lipid metabolism and contributes for the viral persistence, in addition to interfering with the host's homeostasis of lipids, lipoproteins and cholesterol, which can cause, for example, hepatic steatosis, for example, an histological characteristic of the liver of patients infected with HCV [5].

Throughout this study, it was observed that there are component cells of the immune system that act as a line of defense related to the infection of the virus existing in the human organism, but these responses likely to vary according to the stage in which the disease is found on the host [3]. Among the immune system cells that act in response to viral infection, we can mention: interferons type I (IFN α and IFN β), type II (IFN γ) and type III (IFN λ),

Natural Killers cells (NK), Neutralizing antibodies and TCD4 + and TCD8 + cells [4].

Another correlation that the texts refer to, is that NK cells and IFN γ . NK cells during the acute phase release the production of IFN γ , an important viral control factor that allows most precise elimination of viral load, through the inhibition of HCV replication [10]. However, in the chronic phase this cell decreases its capacity of liberate IFN γ and increases the production of cytotoxicity that takes to liver damage [3].

Furthermore, based on the encountered studies, identified that the high rate of virus replication when progressing to chronicity causes a low production of T CD4 + cells, leading to a low efficacy of T CD8 + cells and, therefore, targeting these TCD cells into a collapse stage, and consequently an faulty immune defense [11].

IV. DISCUSSION

In view of the studies read and proposed, it is understood that hepatitis C is a pathology which tends to chronicity in most cases, as the acute phase is mostly diagnosed as subclinical [5]. Thus, HCV is a highly complex pathogen. When analyzing its chronic phase, the attitude of the virus to decompensate the immune system causes an immunological failure in the elimination of the HCV infection [12]. So, the inefficiency of the immune system leads to persistent inflammation in the liver, cirrhosis, liver failure or the development of hepatocellular carcinoma [7].

Its replicative capacity together with countless genetic errors end up causing its high genetic variability, a fact that contributes to the exhaustion of T cells when trying to identify and kill the HCV virus. Furthermore, this pathogen has an escape mechanism which is still not fully understood, making its permanence in the host for a longer time causing its chronic phase of the disease [13].

HCV needs to be in hepatocytes to carry out its replication process [6]. Some studies indicate that the virus binds to very low-density lipoproteins (VLDL), allowing it to “camouflage” during this period and thus making it difficult for defense cells to identify [7]. In addition, there is an interference in lipid homeostasis that leads to disorders such as hepatic steatosis, which is a diagnosis present in patients with HCV infection [8].

Another important aspect is the NK cells that act during the acute and chronic phases, but have different effects in each of these stages. During the acute phase, NK cells produce the IFN γ that are sorely needed for the elimination of HCV infection. However, when chronicity persists, there is a decrease in IFN γ and an increase in

cytotoxicity leading to serious liver damage [14]. Although interferon is highly resolving, it has a deleterious effect as the sustained production of type I IFNs can hamper the induction of virus-specific T cell responses [4].

It is also worth noting that T cells during the chronic phase have their resolving capacity reduced since, in the acute phase, because of the virus, a wide variability does not allow T cells to create neutralizing antibodies or memory cells, thus, when they have the chronic stage causes these defense cells to collapse [15]. By mechanisms not yet understood, CD4 + T cells that are seen in the acute phase lose their effectiveness in the persistence of the infection [10]. In addition to, it causes CD8 + T cells to lose their effectiveness against HCV and causes the exhaustion of CD8 + T cells, which occurs through a multi-step process in which antigen-specific cells progressively lose their effector functions and reduce their expression of cytokine receptors necessary for homeostatic proliferation of memory CD8 + T cells [11].

V. CONCLUSION

Much progress has been made in recent years in the knowledge of the immune mechanisms that HCV stimulates, however there are still many gaps that need to be closed. However, as far as is known, the diagnosis in the acute phase is still very underreported due to nonspecific signs and symptoms, having a better parameter when it has reached chronicity and organ damage. The tendency to chronicity and genetic variability of the virus causes the depletion of the immune system and the immune failure to eliminate the pathogen, in addition to preventing it from having an effective vaccine for the pathology. For these patients to have a better prognosis, further studies are needed to close these gaps, especially in the mechanisms that lead to reduced T cell efficacy in the acute phase.

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Article Modelase by Fajate – Direct Sale and manufacture products directly from industry to consumer

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**Keyword— Fajate, business model,
catalogs, direct sales.**

Abstract— This article works the direct sales market focusing on the Modelase by Fajate project, a form of marketing promoted by companies such as Jequiti, Natura and Avon, which sell and manufacture products directly from industry to consumer. In the current phase of the economy and with the productive reformulation of capital and labor relations, in which the expanded reproduction of capital is sought, the configuration of the globalized economy has led to a new order between the upper and lower circuit. The recent dynamics of the Brazilian economy have influenced the expansion of the two circuits of the urban economy in large Brazilian cities. This business strategy allows the insertion of a wide range of workers, usually urban, integrating into the dominant production model, from a commercial contract. In the understanding of this process, the analysis was imposed in which the accumulation of capital is enhanced in the form of exploitation of the labor force. This articulation, which explains the combined and concomitant existence of different technological stages within the same set of productive processes, makes it indisputable that the criterion of "modern" and "backward" are faces in the same way of capitalist social reproduction. If in the past the direct selling business model was adopted by a few companies, today it is adopted by large and small. In this sense, being extremely important the understanding of the transformations of large companies, which are part of the superior circuit of the economy, with the lower circuit, in their search for expanded reproduction of capital through primitive accumulation, present in many forms of contemporary work. The companies with the direct sales business model that distribute their products through catalogs (Avon and Natura) were presented, demonstrating the peculiarity of each activity in its differentiations within the direct sales system. Adopting the Fajate project to this world of renewing and expanding, in the period of globalization.

I. INTRODUCTION

To think and approach the direct sales business model and its implications in contemporary society, we take up Milton Santos' theoretical conception, the Theory of Economic Circuits, formulated in the 1970s, which analyzes the urban economy of underdeveloped countries. The theme of the circuits of the urban economy is of special importance at this moment when the consequences of the neoliberal project of the 1990s in the relations of urban production become visible, with the increase of the vulnerability of the population, the precariousness of work

and the production of new forms of impoverishment. For Maria Laura Silveira (2004a), poverty has been, in some way, an obstacle to the full expansion of the economy, and at the same time has allowed the development and implementation for some companies that bet on their product distribution network in the lower circuit. It is a correlation of forces, in which the great industry enters with capital and the inferior circuit with precarious work (SANTOS, 2008, p.131-2).

As Silveira (2007b) analyzes, due to the power of large corporations and the increase in the contemporary

economy, a solidity of the upper circuit and a weakness of the lower circuit, whose dependence increased considerably. The increasing internationalization of the Brazilian economy and the consequent increase in the presence of hegemonic agents, characteristic of the current period, have been producing a rearrangement in the dynamics of the circuits of the urban economy.

The arrival of hierarchical happening (Santos, 1996, p.166), implies the change in the interactions and intentions of the two circuits. In this context, we believe that direct selling can be related as a mercantile modality that presupposes a logic involving new socioeconomic and spatial rationalities, which has been delineated since the twentieth century in Brazil.

II. DESIGN DESIGN BY FAJATE

Modelase by Fajate is a company that will represent Fajate in Brazil, with compression straps for post-surgical treatments and to improve posture, and can be used after plastic surgery, bariatric or simply aesthetic.

The Fajate project started in Colombia in 2001, being a family business. The following year being chosen by the experts as a reference, in 2006 the brand began to be marketed in the United States becoming recognized by customers and forming the new and succinct slogan that remained to this day: "Fajate, tu segunda piel".

In 2009 the brand received iso 9001 2008 certification following the franchises in Ecuador.

Over the years the brand has grown and opened new fans within the sports and swimwear business. With social networks the visualization increased generating many profits and opportunities for new partnerships, operating today in more than 30 countries. Contando with invima and OAS (Authorized Economic Operators) certification.

2.1 Business Model

Direct selling is a business and product distribution model in which the marketing of goods is carried out through an autonomous reseller. It began in Brazil from the 1950s, being considered as a traditional form of retail held "outside the stores", also known as "home sales" or "door-to-door selling", although this system has changed in recent years. Until these decades, the direct sale practiced by Avon and Watkins Company was carried out in the old system, in which the company mapped in detail the area of operation of each dealer, house by house. Each dealer could operate in an area, which, in the case of Avon in Brazil, had something around 200 houses, and could not resell in another neighborhood, city or state that was not assigned to him. In Brazil, this door-to-door system of Avon was

adopted until the 1960s/70s, in the first two states where the company established itself - São Paulo and Rio de Janeiro.

From 1970, Avon was abandoning this system for two reasons: the entry of the other companies generated an overlap of records and information, making it impossible to control house by house. In any case, for almost 15 years the system had worked satisfactorily (ALMEIDA, 2007, p.22).

Today, the direct sale carried out door to door has resurfaced with the entry of Nestlé and other companies. A combination of material factors influenced, from the beginning, direct selling and its current contours in the urban economy. More recently, such organizations have grown because of their ability to provide the solution of two problems: it allowed capitalist entrepreneurs access to a broad base of workers without employment, maintenance and substantial costs, allowing this group an opportunity for income and work. Being a form of work performed by women, who want a financial income to meet the material needs of their daily lives.

From the case of the study of direct sales, we can consider that the relations between capital and labor adapt to the new historical and temporal circumstances, in which the competitive logic directs companies through differentiated strategies to meet the needs of capital, through the innovation of the forms of commercialization of their products, and in meeting consumption patterns. In this sense, innovation is subordinated to both the rationalization of work and commercial imperatives.

2.2 Direct Selling

For Silveira (2007a), in the ideology of globalization, the new is synonymous with modern, authorizing us to speak, in this way, in a geography of modernity. Direct selling is now considered modern from the interest of large foreign companies that are present in Brazil, in which the large industry appropriates flexible worker mobility for the accumulation of capital based on technological and financial components and carried out by a modern discursive practice. According to the leaders of direct selling companies: "In a country marked by social exclusion, direct sales create sit-in-service opportunities and complementary income for a large group of people in all regions of our immense Brazil" (ALMEIDA, 2007, p.75).

In this regard, Silveira (2007a) had already analyzed that the rescue of old forms of commerce, and here we include the case of direct selling, remodels and perfumes itself in something attractive and brings with it the aura of modern, in the current period and that is resumed by companies through the discourse of social inclusion. The discursive practices of the direct selling

leaders promote a correlation between the sector's increase in the labor market: "Through the official discourse, these companies are presented as saviors of the places and are appointed as creditors of recognition for their contributions of employment and modernity" (SANTOS, 2001, p.68).

In Rodolfo Gutilla's view: "It seems that our sector is immune to the moods of the economy" (GARRIDO, 2007, p.17). As it is not dependent on credit, direct selling has passed off the recent economic crises (MENDES, July 21, 2009, s.p.). For the leaders of direct selling companies, it is considered worldwide as a sector that provides microcredit, because the autonomous reseller can make payment to the industry with the payment of its customers.

They also assess that this sales model works both for a strong and a weak economy, in which, in markets with large fluctuations and uncertainties, such as the Brazilian, in times of crisis, tend to attract more and more women to the direct selling business, as a way to obtain income and even as a way of insertion in the labor market. Thus, "if the economy is strong and stable, direct selling grows, because consumers tend to buy more, if the economy is weak, the sale grows because direct selling has the power to attract more resellers" (KLEPACKI, 2005, p.148). One of the factors that contribute to this stability of direct selling is that it develops through personal relationships that, even in times of crisis, always exist.

Direct selling can be considered a more sophisticated form of subordination of labor to capital, in which large capital is used to reduce its costs. Today, there is a more subtle and refined subordination, which, at the same time, individualizes the work relationship, increases the worker's exposure to the risks of the market and of the social existence itself, as Castel (1995) rightly put it, dispersing and weakening workers, by interchanging difficulties and new challenges to their collective organization. In this sense, it will be necessary to qualify the worker in direct sale beyond a mere insum of the productive process, as well as its insertion as a social subject and as a participant in the logic of the reproduction of capital. Direct selling is a case of informal work, considering that there is no employment relationship, in which catalogs, carts and other means are used to carry out sales. The relationship occurs through a commercial contract for the purchase and sale of products, which is established between the industry and the autonomous reseller. This relationship, according to Tavares (2004), is an unproductive work.

However, even in certain cases, in which even information on how to perform the activity is made through catalogs, phone calls or e-mails, the people involved in this activity

perform a function similar to that of the merchant, with much greater responsibilities, due to the distance that, objectively and subjectively, there is between the seller and the capitalist trader. [...] This supplementary activity, however, does not end the discussion about the sellers, who we believe are unproductive workers (TAVARES, 2004, p.162,).

2.3 Direct Selling Features

- Personal approach: A striking feature of direct selling is the personal approach to sales and personalized service. Weitz (1994) clarifies that different formats adapt to certain types of products and consumers. In the same way that there may be consumers interested in a kind of mass selling approach. Another aspect weitz recalls is that the direct sales system is more fit for some cultures.
- Control of the steps involved in the distribution channel: The control exercised by the manufacturer over all the steps developed in the channel is another characteristic of the direct sales system. The steps begin in the stock of finished products, as soon as the merchandise is produced, until the delivery of the product to the final consumer. The direct selling system therefore discards the figure of the intermediary.
- Practicality for the consumer: Andrade (1994) states that household sales are absolutely practical from the buyer's point of view, since he chooses when and what products he wants to have in his home. In addition, any failures or reasons for dissatisfaction are identified much more quickly, reducing the possibility of lasting heartening.
- Direct sales system sales team: Resellers, in direct sales, are generally people who do not maintain employment ties with the manufacturers. The sales force has some unique characteristics such as turnover. For Araújo (1995), the people involved in direct sales (resellers) have some basic motivations that drive them towards the practice of this activity.
- Direct Sales Perspectives: Technological development and the use of new technologies have helped to make the sales force more efficient. Satellite conferences can also be used for training and product demonstrations. One aspect worthy of mention, as a possible trend of the direct sales system, is the incorporation of new formats for sales. It is not ruled out the opening of stores in strategic locations in order to improve the demonstration of products. Many direct marketing tools can be incorporated, such as direct mail, home shopping tv,

the extent of the use of catalogs and others.

III. MARKETING CONCEPTS

"Marketing is so basic that it cannot be considered as an isolated function... It's the whole business seen from the point of view of the end result, that's the customer." (KOTLER, 2000 apud DRUCKER, 2002)

3.1 Direct Marketing

Direct Marketing is a specialization of Marketing, which involves the use of advertising and sales techniques that allow to reach the market - target in a much more targeted way and get direct and measurable answers, for this reason, even it is said that Direct Marketing is a Relationship Marketing. Exploring the database concept helps explain the dynamic strength that direct marketing makes a fairly effective way to direct sell: your goal is to collect meaningful information about prospects or customers for a long-term marketing relationship with your business.

3.2 Case Study

The analysis of direct selling is still based on the search for understanding of the recent articulations that have been established between the upper and lower circuit in the urban economy. These are differentiated forms of business management in which industrial capital expands its sphere of activity, directly involving itself in the disassignment of its production, eliminating the figure of the middleman and creating its own productive circuit. The distribution, as a strategic focus of large corporations in order to increase their space of operation, can be understood as a expansion of the industrial world: industrial capital merges as commercial capital in such a way that there must be a merger of these two capitals. The analysis of direct selling, as a form of conducting business in which eliminates the figure of the wholesaler, suggests that the two spatial circuits of the urban economy of underdeveloped countries. The direct selling system can be executed in several ways and therefore receiving other nomenclatures, such as catalog selling, door-to-door sale by carts and sale by network marketing:

- Companies that sell products through catalogs: Avon (the best known and traditional in the direct sales sector in Brazil, producing and marketing cosmetic, hygiene and perfume products); Natura, for its innovative profile and exponential growth in Brazil, also in the beauty and personal care sector.
- Companies that sell products through carts in door-to-door visits: Nestlé entered the direct sales sector in 2006, marketing food products through the

establishment of small business units called microdistributors, and Yakult, for its representativeness in the cart sales trade, operating since the 1960s.

- Forever Living Products, a company of North American origin, which imports its products through its Brazilian subsidiaries, marketing products through network marketing, a business model in direct sales differentiated by the form of remuneration.

Target audience

The target audience of Modelase by Fajate are women from 18 years of age, mainly A/B classes, who value their beauty and the health of their skin and body. The company had to follow the evolution of women, who today is an active, participating and ambitious model of women whose main opponent is the clock. They are women who prefer the ease and convenience of being able to buy the products without leaving home.

Goods

Modelase by Fajate products are developed by Matriz in Colombia. There is a constant search for innovation and improvement of products, following the latest worldwide trends in the market of belts, fabrics, raw material and continuous improvement. Modelase by Fajate's product line includes more than 20 high-quality models and state-of-the-art technology that seek to meet the varied needs of its consumers.

Distribution (Sales Force)

All marketing of Modelase by Fajate products will be focused exclusively through direct sales by resellers (Consultants), who will not have employment ties with the company. Beauty Consultants will be the basis of Modelase by Fajate's business.

IV. SWOT ANALYSIS

- Strengths: Good identification with the public, market leader in Latin America, working in more than 20 countries, better post-surgical performance, durability, loyalty of consultants.
- Weakness (Weaknesses): Little known in Brazil, communication failures in Brazil (Image), does not have clear positioning in Brazil, lower market share in direct sales.
- Opportunities: Market growth, optimism and changes in brazilian consumers' habits, post-surgical negotiations, the rise of women in the labor market, a trend towards greater appreciation of social marketing, the use of the Internet as a strategic tool.

- Threats: A fall in the purchasing power of Brazilians, increased exports, political problems with Colombia, growth of products with lower prices.

4.1 Strategies

- Consultants
 - Increase the number of active consultants when the brand is operating in Brazil.
 - Increase the individual profitability of each Consultant, ensuring a significant increase in the profitability of the company.
- Final Consumer
 - Launch the brand for greater public knowledge.
 - Focus efforts on solving brand problems.
 - Create a Mailing from the clients' portfolio of the Consultants, which guarantees future direct marketing actions and closer to the company to the target.

4.2 Shares

Consultants:

- Training on products, sales strategies, customer approach: "Marathon team sales".
- Incentive actions. The incentive actions are the events, award system and recognition

Final Consumer:

- Develop actions demonstrating the products and brand in strategic locations frequented by the target audience: Stands for Brand Presentation and Product Demonstration.
- Participate in philanthropic parades, presenting the brand in a positive scenario, and associating its image with social issues: Parades with Social Causes.
- Encourage the promotion of the brand, influencing the spread of the campaign through "word-of-mouth": Word-of-mouth Propaganda - "Start New Consultants"

V. FINAL CONSIDERATIONS

I can conclude that for the elaboration of this business model within the company as a result of modernization, we seek to understand, through the study of direct sales that the territory has increasingly assumed a corporate space, in which we need to have an increasingly organic relationship by the horizontal relationships of social networks established by the autonomous resellers. Once the

company is installed, we can build bases for its performance and market expansion for production and consumption generating a chain among the saleswomen, thus creating more contacts and increasing our field of operation. Being an activity that provides a business and income opportunity. This business strategy allows a wide range of workers having the understanding of this process in which the accumulation of capital is enhanced in the form of exploitation of the workforce. With the focus on promotional actions for Direct Marketing developed in this work, it is possible to make the Brand Modelase by Fajate better known in the Brazilian market. Thus, a certain union of some ideals of the company with direct marketing solutions and promotional actions that will bring results is made. That is, betting on "word-of-mouth propaganda". For this, actions were developed for Direct Selling, with great social appeal and focusing mainly on Consultants and Final Consumers, taking into account the entire history of the company, as well as its philosophy, so that the target audience of the actions is effectively reached.

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Prevalence of Physical Inactivity and Associated Factors: A study with military policemen from Macapá-AP/Brazil

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**Keywords—Physical Inactivity. Military
Police. Associated Factors.**

Abstract— The present study aimed to estimate the general prevalence of physical inactivity and identify associated factors. Participants were 162 military police officers from Macapá-AP/Brazil, of both sexes and aged between 23 and 54 years, 25.9% female. The assessment of the level of physical activity was obtained using the International Physical Activity Questionnaire (IPAQ) short version 8. The identification of association factors were obtained by the Socioeconomic Classification Questionnaire of the Brazilian Association of Research Companies (ABEP) version 2018, and by the Body Mass Index (BMI). Descriptive statistics were used to obtain the relative frequency in percentage with a confidence interval of 95%. The association between inactivity and associated factors was performed using the chi-square independence test and Spearman's correlation coefficient with a significance level of $p < 0.05$. It was identified that 27.8% of the studied sample is physically inactive and is associated with a lower economic class and with the perception of "poor/regular" health. Therefore, approximately three out of ten military police officers in the city of Macapá-AP/Brazil were classified as physically inactive and these rates are associated with socioeconomic and sociodemographic factors.

I. INTRODUCTION

In a study carried out in 168 countries with 1.9 million participants, it was pointed out that 32% of women and about 23% of men do not reach sufficient levels of physical activity to maintain a healthy life, which corresponds to 150 minutes of moderate-intensity physical activity or 75 minutes of vigorous-intensity physical activity per week [1].

The reduction in physical activity levels and the increase in time spent in sedentary behavior have contributed to the occurrence of chronic non-communicable diseases (NCDs), such as cardiovascular diseases, diabetes, some types of cancer, obesity and depression and anxiety, among other morbidities. High

blood pressure, diabetes, cancer and obesity can affect longevity, quality of life and social costs arising from this scenario [2, 3].

On the other hand, the understanding related to physical activity refers to the recognition of its importance in improving the health of the population. To this end, the World Health Organization (WHO) recommends the regular practice of physical activity in different areas (commuting, free time (leisure), work or study, and/or household chores) indicated in its guides [4, 5]. However, the Brazilian reality, supported by epidemiological surveys, shows that the prevalence of physical inactivity in people over 18 is 32.1% for men and 47.5% for women [6]. In this context, the military police officer, by working

actively in public security, is subject to a high stress load that forces him to work more ostensibly to protect the population. According to Barbosa et al. [7], some factors such as diet, physical and mental health, environment and genetics influence the health of this group of workers.

It is important to emphasize that the nature of daily activities, overload, rigid hierarchy and military discipline, insecurity, fear of dying, among others, make these professionals more exposed to risks for NCDs [8, 9]. As a result, this population group is more vulnerable, in addition to other chronic diseases, to the progressive growth of inactivity. Therefore, it can be considered that the decrease in physical inactivity would have a great impact on the costs of health services and on the improvement of the health of this population group.

Thus, it is of fundamental importance for health, quality of life and the exercise of police activities, the relevance of knowledge of scientific production directed in order to enable a greater understanding of the risk factors associated with levels of physical inactivity in military police officers. Because there is still a shortage on the aforementioned topic related to this professional category, which will allow for a deeper understanding of the epidemiological pattern of this practice and monitoring its prevalence in population subgroups.

Therefore, the present study aims to estimate the general prevalence of physical inactivity and identify associated factors in military police officers of both sexes in Macapá-AP/Brazil.

II. METHODOLOGY

This is a study with quantitative, descriptive, cross-sectional and epidemiological designs carried out with military police officers from the city of Macapá-AP/Brazil, in 2021. Macapá is the capital of the state of Amapá, located in the Southeast of the state to the extreme North of the Brazil.

Data were collected from an estimated target population of 2,965 military police officers distributed in seven Battalions. For this study, police officers belonging to three main Battalions in the city of Macapá-AP/Brazil were selected, being the 1st, 2nd and 6th, which totaled an initial population for the study of 279 military police officers.

Through the calculation formula proposed by Agranonik and Hirakata [10] in which $n = N \cdot Z^2 \cdot p \cdot (1-p) / Z^2 \cdot p \cdot (1-p) + e^2 \cdot N - 1$ (n : calculated sample, N : population, Z : normal variable, p : real probability of the event, and: sampling error), we arrived at the value of $n = 162$ military police officers.

All military police officers of both sexes were considered eligible for this study; aged between 23 and 54 years; active; active in the Military Police Battalion in Macapá; be working in the end activity or in the middle activity. Exclusion criteria for participation in this study were police officers who were on sick leave; vacation; special license; those in the capacity of attaché and; those who did not present a duly signed Free and Informed Consent Term (ICF).

Data collection consisted of the following variables and instruments: 1) Assessment of physical activity level by the International Physical Activity Questionnaire (IPAQ), short version 8; 2) Assessment of socioeconomic and sociodemographic indicators by the Socioeconomic Classification Questionnaire of the Brazilian Association of Research Companies (ABEP), version 2018 and; 3) Anthropometric measurements of body weight (kg) and height (m).

The 2018 version of the ABEP questionnaire contains questions that encompass the characteristics of family socioeconomic indicators, consisting of 15 questions referring to household characteristics, housing conditions and educational status (education level). Each question receives a score that can vary between 0 and 14 depending on the answer, according to the points table predetermined by the study instrument itself. The economic classification was divided into a social stratification resulting from the final score, with the following social classes A (45-100 points), B1 (38-44 points), B2 (29-37 points), C1 (23-28 points), C2 (17-22 points) and D-E (0-16 points).

The IPAQ was proposed by the World Health Organization (WHO) [11], with the aim of validating the characteristics of physical activity in a single instrument. The short version covers items on walking, physical activities of moderate and vigorous intensity, as well as physical activity in the domains of light, moderate and vigorous intensity, and sedentary behavior [12]. The sum of frequency, duration of activities and self-report of intensities performed allows to quantify the level of physical activity/inactivity of individuals.

Currently, the WHO [5] recommends that adults engage in moderate physical activity of 150 to 300 minutes or 75 to 150 minutes of intense physical activity per week. The IPAQ in short form, version 8, classifies the levels of physical activity of those evaluated considering the relationship between time and intensity of physical activity. In this study, according to the IPAQ, physical inactivity was considered as an outcome, defined as practicing physical activities of vigorous and/or moderate intensity inside or outside the work environment, in a

structured or unstructured way, for less than 150 minutes per day. week.

Anthropometric measurements of body weight (kg) and height (m) were obtained based on self-reported values by study participants. Anthropometric status was assessed using the Body Mass Index (BMI), according to the formula $BMI = \text{weight (Kg)}/\text{height}^2(\text{m})$, for sex and age. As for the classification, the proposal of the World Health Organization [13] was used, which establishes the following indicators: obese BMI values $\geq 30 \text{ Kg/m}^2$, and those with excess weight with BMI values $\geq 25 \text{ Kg/m}$.

Statistical analysis was performed using the IBM SPSS program, version 26 for Windows. The variables were characterized through absolute and relative frequencies (in %).

To study the association of physical inactivity level (ordinal variable) with sociodemographic and socioeconomic factors, the Chi-square test of independence (study of association with nominal qualitative variables) and Spearman's Correlation Coefficient (association with ordinal variables) were used. and quantitative). For the conclusions of the results of the statistical tests, associations were considered statistically significant when the significance value was less than 0.05 ($p < 0.05$) and respective intervals with 95% confidence (95% CI).

This study complied with the ethical aspects according to the Human Research Protocol established by the National Health Council (CNS), Resolution No. 510, of 04/07/2016 and was approved by the Ethics Committee of the Federal University of Amapá/Brazil (UNIFAP) under protocol, number: 28291019.3.0000.0003.

III. RESULTS AND DISCUSSION

The studied sample consisted of 162 military police officers, 42 female and 120 male. Figure 1 shows the distribution of the prevalence of physical inactivity according to the sex of the military police.

According to the results of the present study, it was identified that the general prevalence of physical inactivity in the studied sample was 27.8%. These results corroborate those of Jesus and Jesus [14], indicating that 37% of those studied did not reach the international recommendations regarding the regular practice of physical activity.

Despite the need for police officers to maintain sufficient levels of physical activity in addition to maintaining health and for the good performance of their professional functions, the studies by Sassen et al. [15] also pointed out that 48.2% of the participating police officers reported being physically inactive, and 37.7%, in

addition to being inactive, still had a low intention to start practicing physical activities. As in the study conducted by Minayo, Assis and Oliveira [16] with a sample of military police officers in the city of Rio de Janeiro (Brazil), it was identified that almost 25% of the military police officers interviewed reported not doing any type of physical activity.

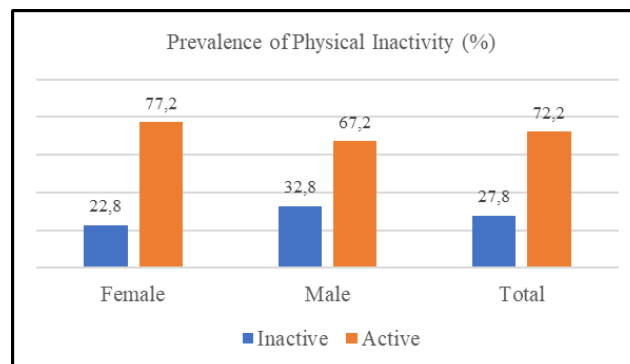


Fig.1. Distribution of the prevalence of physical inactivity according to the sex of military police officers (n = 162), Macapá-AP/Brazil, 2021.

Source: Study authors, 2021.

Therefore, these findings lead to the reflection that intervention strategies must be directed to this population group of both sexes. The increase in physical inactivity levels has contributed to the occurrence of chronic non-communicable diseases (NCDs) such as hypertension, diabetes, cancer and obesity, which have important repercussions on longevity, quality of life and social costs arising from this scenario [2, 3].

Table 1 presents the results of the study of the statistical association of sociodemographic and socioeconomic factors with physical inactivity.

Table 1. Association of sociodemographic and socioeconomic factors with levels of physical inactivity of military police officers (n = 162), Macapá-AP/Brazil, 2021.

Variables	Physical Activity Level		p
	Active	Inactive	
Social class			
C (n = 43)	14 (32,6%)	29 (67,4%)	0,011 ⁽¹⁾
B (n = 105)	29 (27,6%)	66 (72,4%)	
A (n = 14)	2 (14,2%)	12 (85,7)	
<i>Spearman Correlation</i>	R = 0,270		0,001 ⁽²⁾

<i>Coefficient</i>			
Health condition			
Bad/regular (n = 26)	9 (34,6%)	17 (65,4%)	< 0,001⁽¹⁾
Good (n = 70)	25 (35,7%)	45 (64,3%)	
Very good/excellent (n = 66)	13 (16,6%)	55 (83,3%)	
<i>Spearman Correlation Coefficient</i>	R = 0,331		< 0,001⁽²⁾

⁽¹⁾ significance value of the chi-square test; ⁽²⁾ significance value of the Spearman Correlation Coefficient.

Source: Study authors, 2021.

In the present study, in both sexes, a significant statistical association was identified between insufficient levels of physical activity and variables related to health status and social classification. Regarding health status, it was observed that the more active the study participants are, the better their perception of health. However, it is important to highlight that although the concept of health is quite broad, the results obtained in the present study indicated that 62.1% self-declared with a perception of good/excellent health, 33.3% overweight and 42.2% are obese.

These are risk factors for NCDs, and this perspective can be confirmed by studies such as those by Strating et al. [17] who applied a field test that assesses competence for the development of police activity, verifying that police officers, both men and women, with higher BMI had a lower performance and that the BMI and the test result were significantly related to the hours of work. physical activities performed by the police.

In a study conducted by Minayo, Assis and Oliveira [16], when investigating the impact of professional activities on the physical and mental health of civil and military police officers in the state of Rio de Janeiro, it was found that in both corporations there is a 60% or more of police officers with overweight, with obesity being observed more frequently in military police.

Considering that physical activity is an important aspect of human health, the association between insufficient levels of physical activity, excess body weight and negative perception of health in different population groups seems to indicate the urgent need for intervention programs to increase activity levels. physics.

Regarding social classification, it was observed in the present study that the sample has a socioeconomic profile of greater concentration between social classes A and B, totaling 73.4%, regardless of gender. These data allow us to identify, in a general way, concentration in the classes with greater social stratification. In a study conducted with military police officers in the state of Pernambuco, it was observed that police officers with high school education had two or more unhealthy lifestyle habits, such as smoking, insufficient level of physical activity, abusive consumption of alcoholic beverages, among others [18].

Data from a study by Ribeiro and Barata [19] indicate that physical activity levels and of physical inactivity and levels are impacted by several factors that make up social stratification such as housing location, neighborhood safety and vehicular mobility affect these results, with physical activity for groups of higher economic level is divided between work and leisure. These data corroborate those of Santos, Leão and Silva [20], who identified that more physically active individuals, in general, have a higher level of education. Another cross-sectional study, conducted by Nunes et al. [21], concluded that females with lower levels of physical activity have less schooling.

However, the study by Andrade, Hech-Dominski and Liz [22] conducted with 120 civil and military police officers from the state of Santa Catarina (Brazil), aged between 21 and 58 years, found that most belong to the socioeconomic class B2 (40.9%) and is sufficiently active. These results can be justified by the fact that there is no consensus regarding the techniques of social stratification in Brazil, as highlighted by França [23]. Another aspect to highlight is the fact that Andrade, Hech-Dominski and Liz [22] focus on military and civil police, which differs from the study in question, which only addressed military police officers.

Therefore, although studies reinforce that individuals with higher socioeconomic status have greater access to the means of action to positively change their quality of life, belonging to a lower socioeconomic class does not mean having levels of physical inactivity, as it is important to highlight that there are ways to improve their quality of life. different ways of measuring social class and level of physical inactivity.

It is important to highlight that the other variables of the present study such as sex; age; schooling; daily working hours and; nutritional status were not statistically associated with physical inactivity.

Finally, it is possible to understand that the dynamics of society can create mechanisms in the explanation of behavior and lifestyle related to physical activity. The expanded understanding of physical activity refers to the

recognition of its importance related to human development, as a social right and from the perspective of the right to the city [24].

Some limitations of the present study must be considered, such as the use of an instrument that assesses physical activity in a global way and that considers at least 150 minutes per week as a criterion for classification as active, makes it difficult to identify shorter periods, as well as variations in type and intensity of physical activity performed. The fact that the data collection survey related to associated factors that could be linked to levels of physical inactivity did not have a consensus regarding the techniques of social stratification in Brazil. And finally, the sample included only military police officers from three battalions in the city of Macapá-AP/Brazil, which does not allow the generalization of the results for the other military police officers.

IV. CONCLUSIONS

Based on the findings of the present study, it can be inferred that approximately three out of ten military police officers were classified as physically inactive, being more pronounced in male police officers. The prevalence of physical inactivity was associated with military police officers of both sexes who self-declared with a “poor/regular” health perception. Although these rates are similar among police officers of both sexes, the magnitude was not the same, being higher in males than in females. And military police officers of both sexes from lower socioeconomic strata also had higher rates of physical inactivity.

Therefore, this information can help guide the objectives and actions of programs to promote physical activity among military police, suggesting that it is important to encourage these professionals to increase their level of physical activity both through regular practices in the work environment and in tasks of daily life, daily activities such as walking, so that healthy habits are established.

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Uptake, distribution and biofortification of selenium in *Acmella Oleracea* (L.) R. K. Jansen

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Keywords— *Multivariate analysis, dose/response, nutrients deficiency, food insecurity, bad nutrition.*

Abstract —*Nutritional biofortification of foods is a promising alternative to reduce Selenium deficiency in the diet of populations. This study evaluated the biofortification capacity of jambu with Se. The experiment was completely randomized with six treatments and five repetitions, in hydroponics. Five doses of Se in the form of sodium selenate (1, 2, 3, 4 and 5 mg.L⁻¹) and the control dose were used. Biometric, macro and micronutrient analyzes were performed, as well as the Se content in the plant parts. The indices of translocation (TrI), tolerance (tI) and Nutrient Use Efficiency (Nue) were estimated. The results were submitted to ANOVA and principal components analysis for the construction of multivariate indicators, in order to specify the regression models. The plant obtained higher agronomic performance when submitted to a dose of 3mg.L⁻¹, with Se translocation above 70%. The tI and Nue indices indicated that jambu reached optimal growth with the dose of 3 mg.L⁻¹ of Se. The results obtained from the regression equation of the multivariate indicators of growth, mass and nutrition indicated that the ideal concentrations of Se varied between 2.77 and 3.36 mg.L⁻¹. The general indicator that captured the entire plant behavior showed that the optimal concentration for biofortification is 2.98 mg.L⁻¹ of Se. The daily consumption of 100 g of biofortified jambu at the indicated dose provides a daily content of 50.13µg of Se for the population, a sufficient amount of Se for a balanced diet.*

I. INTRODUCTION

The supply and consumption of sustenance is the main theme in reaching the objectives of sustainable development in the schedule 2030. Objectives such as “zero hunger”, “good health and well-being” and “life upon earth” are related to the form we produce, access and consume food [1].

The problem of bad nutrition continues to be a challenge to be beaten in the world, increased with social-economic inequality among the majority population of the world, mainly in underdeveloped regions. According to FAO [2], although Africa is the region where the levels of food insecurity are elevated, it can be observed that in Latin America and Caribbean this insecurity has been

increasing since 2014, putting nearly one-third of the region's inhabitants unable to obtain food or reduce its nutritional quantity and quality [3];[1].

The problem of food insecurity and desnutrition tends to be greater with the increase of world's population and the Covid-19 pandemic. This brings consequences in the world's desnutrition, making the objectives related to production and consumption of food up to 2030 established by ONU couldn't be reached [1].

As a nutritional alternative, the unconventional vegetables bring the possibility of biofortification with many chemical elements essential to life such as iron, zinc and selenium [4]. These are the elements that respond to nutritional deficiency of the population in developing countries [5];[2] and the ones that have low soil concentration.

According to Kabata-Pendias [6], the medium iron content in soil varies by 3 to 5%; the zinc content of 60 to 89 mg/kg and the Se content 0,44 mg/kg. Notably, among the elements that possess low soil disponibility, the Se is the principal, even being a essential element to humans, because its make selenoproteins that physiological processes such as the reduction in the activity of reactive oxygen species, modulation of the immune system, reduction of trace elements in the human body as well as reducing the risk of cancer [7];[8].

Nascimento [9] points that a diet with deficiency of this mineral results in higher susceptibility to many diseases, and according to Agência Nacional de Vigilância Sanitária (ANVISA), of the Health Ministerium [10], the daily recommendation of Se to adult population is of 8.25 at the very least and 319.75 $\mu\text{g}\cdot\text{day}^{-1}$ at most.

The Se is incorporated into human nutrition via agricultural products, however it can be found many types of food poor in this micronutrient due to its low content in soil, especially in Brazil [11];[12];[13]. It can be highlighted the agronomic biofortification as a technique relatively inexpensive and efficient to the increase of nutrition quality in food with minerals through differentiated cultural treatments [14];[15].

Bouis and Saltzman [16] evidences that the biofortification is possible without putting the crop productivity at risk, just as Puccinelli et al. [17] shows that the biofortification of edible crops with Se can represent a alternative system to provide the element in human's diet via mineral nutrition of plants, keeping in mind that around one billion of people presents this mineral deficiency [18].

In this perspective, jambu (*Acmella oleracea* (L.) R. K. Jansen), an unconventional vegetable, arises as a

promising alternative to biofortification strategies in Brazil, such as in countries such as Peru, India, Nepal, China, Mexico and other regions of Africa [19]. Because it's present chemical and nutritional characteristics adequated with presence of proteins, carbohydrates, fibers, aminoacids and other bioactive composts [20].

Specifically in Amazon, jambu is consumed along the year, being part of the traditional cuisine of the region. The vegetable is part of typical dishes in Amazon's gastronomy, mainly Paraense, as pato-no-tucupi and tacacá [21]. According to Gusmão and Gusmão [22] the average of consume in a traditional dish as tacacá is 30g of jambu, and in other traditional dishes known as "arroz paraense", the consumption of the vegetable can reach 600g. Therefore, the biofortification of this vegetable could help to minimize the desnutritional and hunger impacts, mainly in the teenager population of Amazon region, which presents higher levels of food insecurity [23].

Thus, this research aims to show the adequate agronomic conditions to jambu biofortification with Se, mainly in relation of dose/response of the plant to the element, it's potential of translocation and adequate daily consumption of biofortification jambu.

II. MATERIAL AND METHODS

The experimental phase was made with the vegetable *Acmella oleracea* (L.) R. K. Jansen, known as jambu, yellow-flower variety, between february and march of 2020. The experiment was installed in greenhouse at Federal Rural University of the Amazon (UFRA), soil departament, city of Belém-Brazil, predominant weather is equatorial hot humid, according to Af category of Koopen [24].

The seeds of jambu were collected from the UFRA germplasm bank, placed in 128-cell polystyrene trays filled with coconut fiber. After germination, the seedlings were treated with Hoagland and Arnon nutrient solution [25], with 25% ionic strength, composed of 1 mL.L⁻¹ of NH₄NO₃, 4 mL.L⁻¹ of KNO₃, 5 mL.L⁻¹ of Ca(NO₃)₂, 2 mL.L⁻¹ of MgSO₄, 1 mL.L⁻¹ of Fe-EDDHA and 1 mL.L⁻¹ of Micronutrient solution.

To obtain better seedlings growth, it were thinning after 7 days of germination, keeping one seedling per cell. After 21 days, the four leaf seedlings were transplanted to vases with 2 L with milled silica, nutritive solution with 50% of ionic force. After 7 days of acclimatization, the seedlings were submitted to Se doses.

The experimental design was casualized, with six treatments and five repetitions, 30 plants in total. It used

five doses of selenium (1, 2, 3, 4 and 5 mg.L⁻¹), applied in sodium selenate form (Na₂SeO₄) and control [17].

To keep the oxygenation of nutritive solution in the vases, it was drained in the afternoon end and replaced in the morning beginning. This procedure was daily until the experiment ended. Aiming to preserve the nutritive solution concentration, it was monitored the pH in each vase with phmeter GroLine model - HI98118, HANNA mark. Weekly, the solutions were renewed and the water loss by evaporation daily renewed. 50 days after the germination, it was performed the harvest of all plants.

Biometric Analysis

After the harvest, were measured the following variables: i) plant height (PH) - using pachymeter, measuring from the collector to the apex; ii) stem diameter (SD) - using pachymeter, measuring the stem 0.5 cm from the substrate and iii) inflorescence number (IN) - counting of total inflorescence emitted by the plant.

To determine the variables leaf dry mass (LDM), stem dry mass (SDM), inflorescence dry mass (IDM) and root dry mass (RDM), the plants were cleaned with deionized water and droughts in open air during 24 hours. Posteriorly, the plant parts were separated, placed in paper bags and taken to the greenhouse at 65° for 48 hours, until the plants reached constant weights. After 48 hours, the plant parts were removed and weighed on a precision scale [26].

Chemical analysis

The samples of leaf, stem, inflorescence and root of the jambu, after the drought, were milled in a porcelain bowl. Subsequently, a part of 0,25 g was removed of each part of the plant and placed in a teflon tube and added 4,0 ml of concentrated HNO₃, 2 ml of H₂O₂ (30% v/v) and 2 ml of ultrapure water. The solution stay in rest for one hour [26].

After the rest, the samples were placed to complete digestion in a microwave CEM model. The digestion occurs in three steps: temperature elevation from 0 to 180° C in 10 minutes in 800w, 180° temperature constant for 30 minutes and ventilation for 55 minutes. After the digestion the samples were filtered and swollen to 50 ml with deionized water [26].

The determination of macro and micro nutrients of jambu was performed through absorption atomic spectrometry of flame (Agilent Technology, model AA-200) equipped with deuterium lamps (to correction of background radiation) and lamps with hollow cathode to determination of K (766.5 nm), Mg (285.2 nm), Ca (422.7 nm), Fe (248.3 nm), Zn (213.9 nm), Mn (279.5 nm) and Cu (324.8 nm). It was used air-acetylene flame with output of 10 L/h of air and 2.0 L/h of acetylene [27]. The

quantification was made through calibration curves with five points (external padronization). The curves of calibration showed R² to 0.99 and vary from 5 to 40 mg.L⁻¹ for K, 0.5 to 3 mg.L⁻¹ for Mg, 0.5 to 6 mg.L⁻¹ for Ca, 0.25 to 3 mg.L⁻¹ for Fe, 0.5 to 6 mg.L⁻¹ for Zn and 0.1 to 2 mg.L⁻¹ for Mn.

The selenium content in the plant was determined by spectrophotometry of atomic absorption with Varian AA 240 Z graphite furnace with tube atomizer graphite GTA 120 and background broker Zeeman [28]. was used a hollow cathode lamp for the determination of Se at a wavelength of 196 nm, with palladium solution as modifier matrix. The carrier gas was argon 5.0 analytical, with pyrolysis temperature of 120°C, atomization of 1000°C and cleanup of 2600°C. All analyzes were performed in the Water Quality Laboratory of Amazon at the State University of the Pará.

Translocation index, tolerance and efficient use of nutrients

To quantify the ability of growth of the *Acmella oleracea* in Se presence, were determined the Translocation Index (*TrI*), Tolerance (*tI*) and Nutrient Use Efficient (*Nue*), according methodologies proposed by Siddiqui and Glass [29] and Swiader et al. [30], with the following equations:

$$TrI = Aci/AcI * 100 \rightarrow (1)$$

Where Aci is the accumulation of Se in the plant parts (leaf, stem, inflorescence and root) and AcI is the accumulation of Se in root [31].

$$tI = Mi/cM \rightarrow (2)$$

Where Mi is the dry mass in the interest dose and cM is the control mass [32].

$$Nue = (TDM)^2/TCSe \rightarrow (3)$$

Where TDM is the total dry mass produced and TCSe is the total content of selenium in the plant.

Multivariate indicators

With objective of a better comprehension in jambu behavior due to Se presence, it were created multivariate indicators according with the methodology proposed by Santana and Santana [33], Oliveira [34] and Oliveira et al. [26], which utilize the technique of Principal Component Analysis to extract the components according with it's descriptive importance to the data variance.

The indicators were constructed to represent the dimensions which compose the plant development, grouping the variables of each dimension: growth indicator – **gI** (group the variables plant height, stem diameter – and inflorescence number), plant mass accumulation – **mI** (leaf dry mass, stem dry mass, inflorescence dry mass and root dry mass), Nutrient Content – **nI** (content of K, Ca, Mg, Fe, Zn and Mn) and general (**gnI**) of the research, grouping the total set of explanatory variables, all the components were considered to be reach 100% of total mass variation of the data [33], [26].

The indicators creation followed the sequence proposed by Oliveira et al. [26]: *i*) it was estimated the vector with relative participation of the values $\lambda(\lambda_{kj}/\sum \lambda_k)$; *ii*) it was estimated the coefficients of the matrix of absolute values (α_{kj}) of eigenvectors of each transformed component; *iii*) it was estimated the relative coefficients of the eigenvectors matrix $(\alpha_{kj}/\sum \alpha_k)$, and; *iv*) the linear combination of the descriptor variables and matrix multiplication was performed to estimate the weights as in equations 4 and 5.

$$\theta_{j(kx1)} = (a_{kj}/\sum a_k)_{(kxk)} \cdot (\lambda_{kj}/\sum \lambda_k)_{(kx1)} \rightarrow (4)$$

Com

$$\theta_1 + \theta_2 + \dots + \theta_p = 1 (j = gI, mI, nI, gnI) \rightarrow (5)$$

Therefore, it was formed the mathematical model used to estimate the weights associated with the descriptive variables of plant behavior, as reference the related dimensions: growth, mass accumulation, nutrient content and general behavior.

Lastly, each indicator was obtained by the weights vector multiplication θ by the values of explanatory variables related to the content aspects, growth, mass accumulation and general **gI**, **mI**, **nI** and **gnI**. Equations (6 – 9): [26].

$$gI = \theta_{PH} \cdot PH + \theta_{SD} \cdot SD + \theta_{IN} \cdot IN \rightarrow (6)$$

$$mI = \theta_{LDM} \cdot LDM + \theta_{SDM} \cdot SDM + \theta_{IDM} \cdot IDM + \theta_{RDM} \cdot RDM \rightarrow (7)$$

$$nI = \theta_k \cdot K + \theta_{Mg} \cdot Mg + \theta_{Ca} \cdot Ca + \theta_{Fe} \cdot Fe + \theta_{Zn} \cdot Zn + \theta_{Mn} \cdot Mn \rightarrow (8)$$

$$gnI = \theta_{PH} \cdot PH + \theta_{SD} \cdot SD + \theta_{IN} \cdot IN + \theta_{LDM} \cdot LDM + \theta_{SDM} \cdot SDM + \theta_{IDM} \cdot IDM + \theta_{RDM} \cdot RDM + \theta_k \cdot K + \theta_{Mg} \cdot Mg + \theta_{Ca} \cdot Ca + \theta_{Fe} \cdot Fe + \theta_{Zn} \cdot Zn + \theta_{Mn} \cdot Mn \rightarrow (9)$$

Regression analysis

The specification of the multiple regression system used to represent the phenomenon studied, contemplating the effects of selenium doses on growth, mass accumulation, nutrient content in jambu plants, and general behavior of the vegetable, was defined by equations (10 – 13):

$$gI = b_{10} + b_{11}D_s + b_{12}D_s^2 + v_1 \rightarrow (10)$$

$$mI = b_{20} + b_{21}D_s + b_{22}D_s^2 + v_2 \rightarrow (11)$$

$$nI = b_{30} + b_{31}D_s + b_{32}D_s^2 + v_3 \rightarrow (12)$$

$$gnI = b_{40} + b_{41}D_s + b_{42}D_s^2 + v_4 \rightarrow (13)$$

Which: **gI** is the growth indicator of the plant; **mI** is the plant mass indicator; **nI** is the plant nutrient content and **gnI** is the plant general indicator; D represents the selenium doses with linear response; D² the selenium doses with quadratic response (control, 1mg.L⁻¹, 2mg.L⁻¹, 3 mg.L⁻¹, 4 mg.L⁻¹ and 5 mg.L⁻¹); *b* are the equations interceptors (*i*= 1, 2, 3, 4); *b* are the parameters associated with the equations variables; *v* are the random error terms of the equations.

The data of Se content (leaf, stem, inflorescence, root and aerial part), translocation, tolerance, nutrient use efficient, growth, mass and nutrient content (leaf, stem, inflorescence and root), were submitted to variance analysis (ANOVA) and the averages were compared by the Skott-Knott (SK) test, *p*<0.05. The data of the indicators were submitted to regression analysis to the estimation of maximum response of Se in the plant. The analysis were performed through the R software, version 3.5.2 [35].

III. RESULTS

Se Content

The results showed that the concentration increase of Se in nutritive solution results in the bigger uptake of the element in all plant parts. The higher values of the element were found in leaves when submitted to 5 mg.L⁻¹ concentration of Se. The inflorescence also presented high content of the element in dose 5 mg.L⁻¹. Stem and root differ statistically of leaf and inflorescence, absorbing minor content of Se in all doses (Table 1).

The Se content in the aerial part of the plant is the basic element to the calculations of element quantity that will be consumed by population, considering that leaf, stem and inflorescence are the edible parts of jambu. The Se content in the aerial part grows with the doses increase (Table 1). However, doesn't have significant difference between the doses of 3 and 4 mg.L⁻¹. The 5 mg.L⁻¹ dose of Se, in

solution, allowed the higher uptake of the element in the aerial part in relation to the other doses and control.

Table 1 - Medium Se content in jambu plants in hydroponics

Se doses in mg.L ⁻¹	Se content in plant parts in µg.kg ⁻¹				
	Leaf	Stem	Inflorescence	Root	Aerial part
1	166.40±15.63dA	29.22±5.75cB	34.66±7.86dB	15.79±2.11dC	230.28±17.40 d
2	258.05±28.13cA	35.03±2.51cC	63.97±14.00cB	23.78±1.84cC	350.05±23.76 c
3	338.35±22.10bA	41.67±4.14bC	124.40±18.45bB	35.48±4.17bC	504.73±35.90 b
4	329.29±48.75bA	54.56±7.66aC	127.68±11.80bB	55.32±6.95aC	511.55±51.45 b
5	400.74±35.50aA	63.05±10.85aC	177.94±5.84aB	61.41±7.21aC	641.74±24.02 a

The lowercase letters points the significant differences between the Se doses; the uppercase letters points the significant differences between the plant parts, according with Scott-Knott ($p < 0.05$) test.

Translocation Index (*TrI*)

The Se translocation was higher in 1, 2 and 3 mg.L⁻¹ doses, with more than 75% of the element translocated to the leaf (Table 2). In doses with 4 and 5 mg.L⁻¹, the translocation was also high, with that more than 70% of Se moved from the root to the leaf. The stem was the jambu part, beyond the leaf, which more translocated Se, with

15.16% of translocation in 4 mg.L⁻¹ dose. The inflorescence showed higher capacity of translocation in 3, 4 and 5 mg.L⁻¹ doses. Doesn't have differences in the capacity of translocation in root (Table 2).

The results shows the potential of mobility of the element in jambu, and also stimulate the growth and accumulation of biomass by the plant.

Table 2. Translocation index in jambu plants supplemented with increasing Se doses

Se Doses in mg.L ⁻¹	Translocation index (%)			
	Leaf	Stem	Inflorescence	Root
1	75.84±2.49 aA	14.41±3.47 aB	4.83±1.86 bC	4.90±0.69 aC
2	77.09±3.72 aA	12.05±2.02 bB	6.26±2.09 bC	4.57±0.67 aC
3	75.03±1.30 aA	11.62±1.10 bB	7.86±1.10 aC	5.46±0.81 aC
4	70.75±3.80 bA	15.16±2.30 aB	7.82±1.00 aC	6.25±1.32 aC
5	73.29±3.90 bA	13.64±2.05 aB	7.52±1.13 aC	5.52±1.14 aC

The lowercase letters points the significant differences between the Se doses; the uppercase letters points the significant differences between the plant parts according to the Scott-Knott ($p < 0.05$) test.

Tolerance index (*tI*) and Nutrient Use Efficiency (*Nue*)

The results showed a significant increase in the tolerance index of jambu to the Se until the 3 mg.L⁻¹ dose, demonstrating that the element promoted increase in the dry mass production in relation to the control. However, the plant begins to show a decrease in dry mass production in 4mg.L⁻¹ dose, with a significant difference

to the 3 mg.L⁻¹ dose. In 5 mg.L⁻¹ dose, the *tI* had a significant decrease, however, higher than the control dose, indicating that in 5 mg.L⁻¹ concentration, the plant answered with more efficiency in mass production than the plants without the element (Figure 1A).

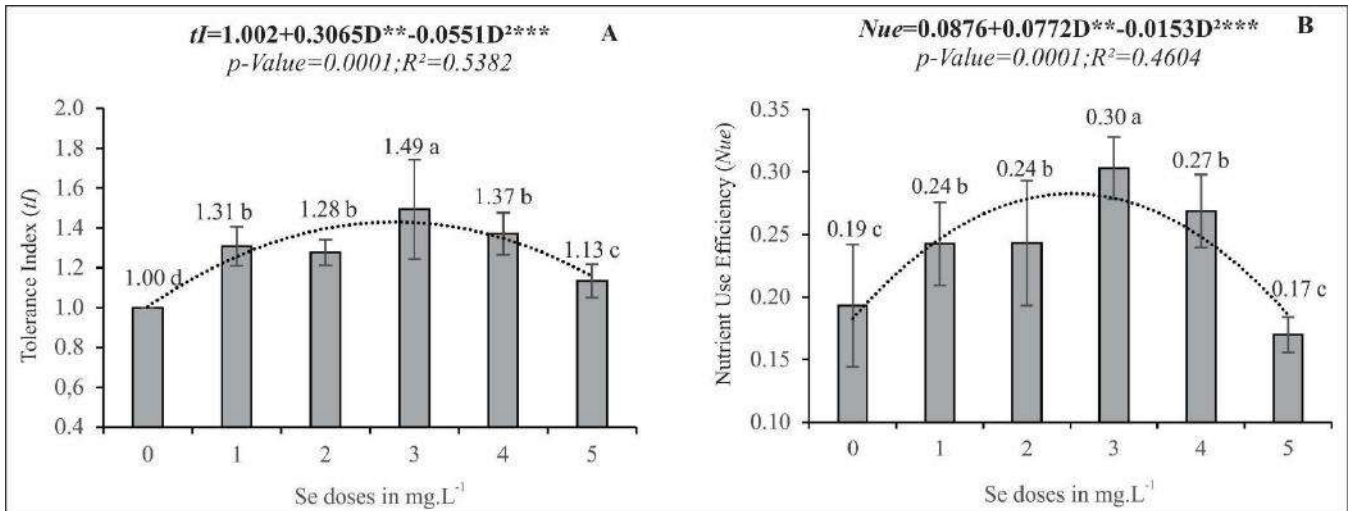


Fig.1. Tolerance index (A) and Nutrient Use Efficiency in $\mu\text{g.planta}^{-1}$ (B), in jambu plants submitted to increasing doses of Se. The bars are the standard deviation; the lowercase letters points the significant differences between the Se doses according to the Scott-Knott ($p < 0.05$) test. **significant to 1% of probability; *significant to 5% of probability (test F); D=dose; D²=square dose.

In the analysis of nutrient use efficient (Nue), it is related the total dry mass produced by the plant with the total nutrient content. Thus, it can be observed in the figure 1B that occurs a higher uptake of nutrient by the plant in doses 1, 2, 3 and 4 mg.L⁻¹, however without presenting statistical differences between the doses to influence de Nue. On the other hand, in 5 mg.L⁻¹ dose, the Nue value was minor than in other doses, indicating that in this concentration the plant begins to reduce its uptake of nutrients in a way to harm the biomass production.

Jambu mass and growth

In table 3, the values of the individual variables and mass are presented. The doses 2, 3 and 4 mg.L⁻¹ of Se influence the jambu growth (PH). In 5 mg.L⁻¹ dose, the PH begins to reduce its growth. In relation to SD, there is no difference between the element doses, presenting differences only in

Table 3. Effect of Se concentrations on growth variables and mass gain of jambu plants grown in nutrient solution.

Se Doses in mg.L ⁻¹	Growth and mass variables						
	PH	SD	IN	LDM	SDM	IDM	RDM
Control	20.4±1.28b	5.24±0.34b	14.00±1.41a	1.60±0.19b	1.57±0.36c	0.39±0.05b	1.01±0.15c
1	22.34±2.14a	6.10±0.65a	16.80±4.26a	1.96±0.24a	2.09±0.17b	0.57±0.07a	1.32±0.10a
2	22.54±1.35a	6.10±0.34a	18.00±1.58a	1.88±0.22a	2.15±0.29b	0.59±0.06a	1.20±.10b
3	23.81±1.19a	6.654±0.51a	16.20±1.92a	2.084±0.16a	2.62±0.29a	0.59±0.07a	1.44±0.10a
4	23.86±1.75a	6.04±0.11a	16.80±3.27a	2.022±0.13a	2.60±0.25a	0.57±0.08a	1.05±0.14c
5	21.53±0.33b	5.87±0.43a	19.20±1.18a	1.77±0.11b	2.11±0.27b	0.40±0.04b	0.86±0.06d

Subtitle: PH - Plant Height (cm); SD - Stem Diameter (mm); IN - Inflorescence Number; LDM - Leaf Dry Mass (g.plant⁻¹); SDM - Stem Dry Mass (g.plant⁻¹); IDM - Inflorescence Dry Mass (g.plant⁻¹); RDM - Root Dry Mass (g.plant⁻¹). The lowercase letters points the significant differences between treatments, according to Scott-Knott ($p < 0.05$) test.

relation to control. The variable IN does not doesn't present Se influence.

To the variables which determine the plant mass gain, it can be observed that with the doses 1, 2, 3 and 4 mg.L⁻¹ promoted higher leaf biomass (LDM), with significant

difference to the control plants and the plants with 5 mg.L⁻¹ (Table 3). In the stem, the doses of 3 and 4 mg.L⁻¹ were the ones which promoted higher mass accumulation as indicated in SDM.

The inflorescence, through the IDM variable, presented similar behavior with the leaves, with more mass gain in 1, 2, 3 and 4 mg.L⁻¹ doses, statistically differing of the 5 mg.L⁻¹ and control dose.

The Se in root promoted more mass gain (RDM) with 3 mg.L⁻¹ dose differing from other doses. It can be noticed that the 5 mg.L⁻¹ dose affected in a negative way

the biomass gain of the jambu root, indicating toxicity signs.

Nutrient Content

The Se had an influence on the content of macronutrients K, Mg and Ca in jambu. with the increase in the concentration of the element up to the dose of 3 mg.L⁻¹, there was greater uptake of macronutrients, with a significant difference for the control plants. The plant's ability to capture K, Mg and Ca begins to be harmed from a dose of 4 mg.L⁻¹, reaching the maximum dose reduction at 5 mg.L⁻¹ (Table 4).

Table 4 – Total content of nutrients absorbed by jambu exposed to increasing doses of Se.

Se doses in mg.L ⁻¹	Macronutrient content in g.kg ⁻¹			Micronutrient content in mg.kg ⁻¹		
	K	Mg	Ca	Fe	Zn	Mn
Control	78.54±2.26 e	19.90±1.38 e	4.14±0.17 c	1.76±0.15 c	3.28±0.09 e	0.25±0.01 b
1	99.06±4.17 c	25.25±0.66 c	9.25±0.26 b	2.02±0.12 b	3.46±0.15 d	0.26±0.03 b
2	103.77±1.91 b	26.25±0.54 b	9.16±0.25 b	2.11±0.06 b	3.80±0.13 b	0.24±0.01 b
3	108.67±1.91 a	32.46±0.59 a	9.89±0.66 a	2.10±0.07 b	4.27±0.14 a	0.30±0.02 a
4	102.48±2.64 b	26.70±0.47 b	9.17±0.52 b	2.38±0.08 a	3.60±0.08 c	0.25±0.03 b
5	93.70±3.91 d	24.14±0.80 d	8.76±0.29 b	2.06±0.06 b	3.62±0.09 d	0.24±0.01 b

The lowercase letters points the significant differences between treatments according to the Scott-Knott ($p < 0.05$) test

The micronutrient Fe, despite having the same absorption tendency of K, Mg and Ca, had its highest content in jambu with 4 mg.L⁻¹ of Se in solution, with a reduction in Fe content with an increase in the dose of Se. Zn showed a higher absorption capacity up to the dose of 3 mg.L⁻¹, when it starts a significant reduction in subsequent doses.

The highest Mn content was notably induced by the dose with 3 mg.L⁻¹ of Se, and the other doses of Se did not interfere with the absorption of the micronutrient.

Multivariate Indicators

The jambu plants when submitted to substances presence, being nutrients, beneficial elements or toxic, tend to answer according to the exposure level and assimilation form to these substances. Many variables can be used to point to the beneficial effect or harm effect of substances in plants, which can be pointed biometric variables, physiologic, biochemical, chemical and others. However, most studies isolate these variables to individualize the effects in each plan condition. In this work, in addition to this traditional analysis, the global behavior of jambu in response to selenium was evaluated. And, based on this new knowledge, the optimal dose of

the element in nutrient solution was estimated, considering the indicators generated from the multivariate analysis.

Growth Indicator (*gI*) and Mass (*mI*)

This dimension includes the results of the growth indicator (*gI*), composed by the variables plant height (PH), stem diameter (SD) and inflorescence number (IN) and mass (*mI*) composed by the variables leaf dry mass (LDM), stem dry mass (SDM), inflorescence dry mass (IDM) and root dry mass (RDM), and the individual results of the variables.

Although some variables shows differences between the Se doses, the growth indicator, which allowed the analysis of the total plant behavior, does not reveal significant differences statistically between Se doses, however, it shows a positive difference of the control plants. From the regression specified for the *gI*, the dose of 3.36 mg.L⁻¹ of Se was estimated, which generated the maximum growth of jambu and that can provide more than 17% growth in relation to non-biofortified plants.

The mass gain indicator (*mI*) has information about the variables leaf dry mass, stem, inflorescence and root.

It can be observed that the dose with 3 mg.L⁻¹ promoted higher biomass gain in jambu, differentiating itself from other doses and control.

The dose of 5 mg.L⁻¹ showed lower mass gain in relation to the other doses, but still stood out in relation to the control plants. The behavior of the indicator shows that there was an increase in jambu mass gain with increasing Se doses up to 3 mg.L⁻¹. Subsequently, a

decrease occurs as the concentration of Se in the nutrient solution increases.

The regression model for the *mI* allowed to estimate the concentration levels 2.77 mg.L⁻¹ which results in maximum production of biomass, with an increase of 47% in relation to the plant non-supplemented.

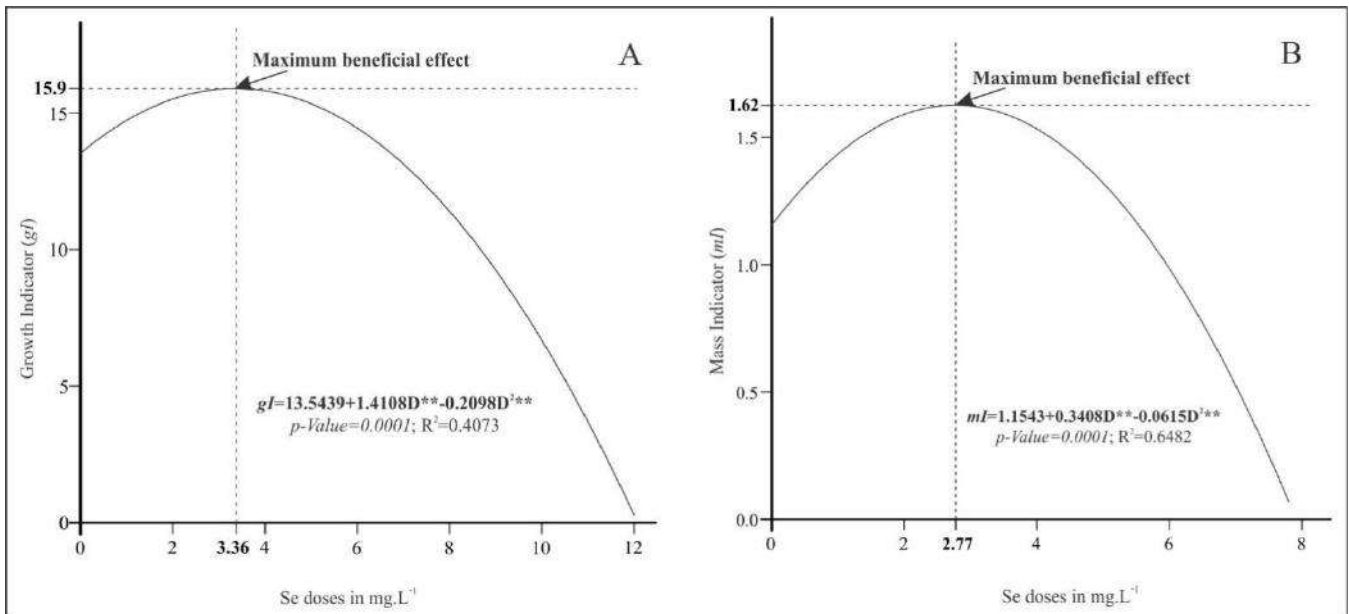


Fig.2. Growth Indicator (A) and Mass Indicator (B) of jambu plants submitted to increasing doses of Se. The bars are the standard deviation; the lowercase letters points the significant differences between the Se doses according to the Scott-Knott ($p < 0.05$) test. **significant to 1% of probability; *significant to 5% of probability (test F); D=dose; D²=square dose.

To the integrated analysis in nutrients uptake by jambu, it was constructed the nutritional indicator (*nI*) which make possible to observe the plant behavior when exposed to Se (Figure 3A). It can be noticed that the *nI* answer presented higher capacity to demonstrate how occurs the nutrients uptake, evidencing a absorption model in quadratic form, with the higher value in the dose 3 mg.L⁻¹ and significant decrease up to 4 mg.L⁻¹ dose. This response corroborates with the individual analysis of each nutrient (Table 4). According to the regression of indicator *nI*, it was estimated that the dose promote the maximum nutrient absorption by jambu, 2.92 mg.L⁻¹ of Se, in nutritive solution with increase of uptake capacity of nutrients in 45%. It is noteworthy that the value of the indicator in the dose with 5 mg.L⁻¹ was significantly higher than the control, showing that although the plant

reduces the concentration of nutrients in its tissues, this dose generates a greater value in the indicator and, therefore, , higher content of absorbed nutrients than plants not supplemented with Se (Figure 3A).

The general behavior of jambu when biofortified with Se, captured by the general indicator (*gnI*), showed the highest efficiency of the plant at the dose with 3mg.L⁻¹, the *gnI* evidences the significant difference of the set of all explanatory variables stimulated by the element and makes the adequate model for the analysis of the biofortification of this vegetable (Figure 3B).

In all models, the data fit the 2° degree polynomial. In this aspect, the *gnI* translates the grouped behavior of all the explanatory variables analyzed of the biofortified jambu.

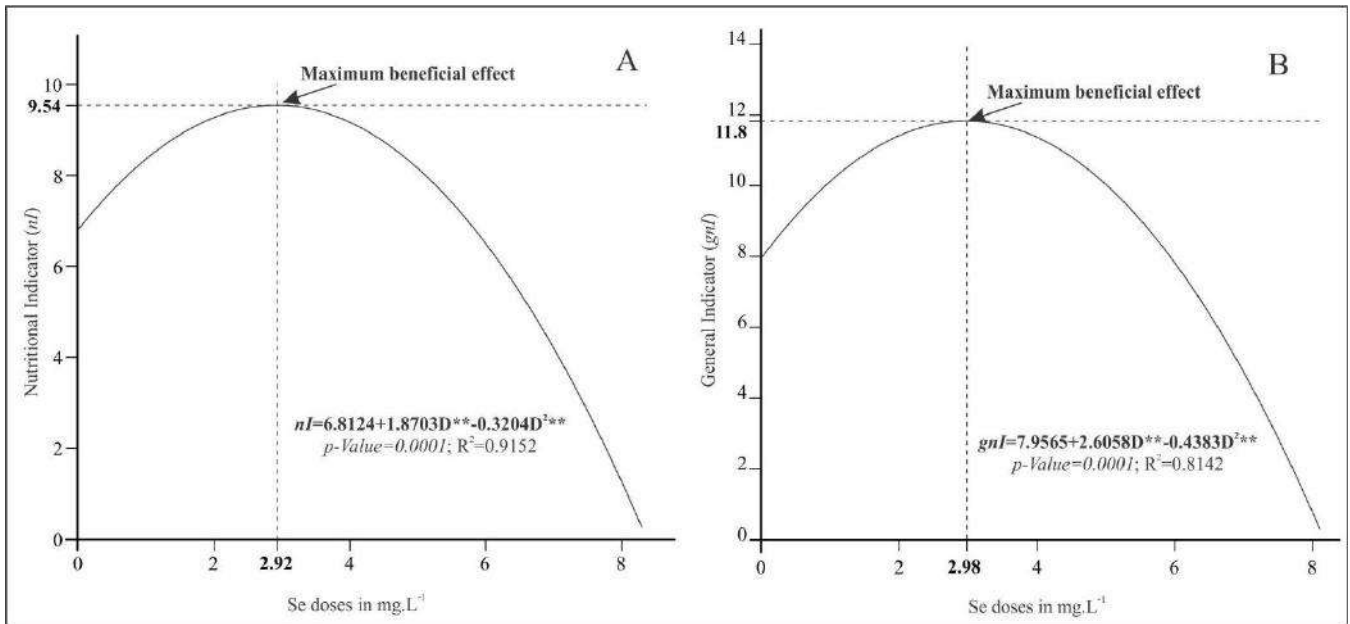


Fig.3. Nutrient Indicator (A) and General Indicator (B) of jambu plants submitted to increasing doses of Se. The bars are the standard deviation; the lowercase letters points the significant differences between the Se doses according to the Scott-Knott ($p < 0.05$) test. **significant to 1% of probability; *significant to 5% of probability (test F); D=dose; D²=square dose.

According to the mathematical model of **gI** (Figure 3B), the plant has its development optimized in the concentration with 2.98 mg.L⁻¹ and the possibility of development is 54% higher than jambu plants not biofortified with Se.

IV. DISCUSSION

The results showed that the Se content in the plant, especially in the leaf, inflorescence and stem (aerial part) was higher as the doses of the nutrient solution were increased, indicating similarity with the results obtained by Ramos, et al. [36] for lettuce cultivars subjected to Se in the form of selenate, by Puccinelli et al. [17] for basil plants, Sindelárova et al. [37] and Silva et al. [38] for broccoli and radish.

The translocation index (**TrI**) showed great efficiency to evaluate the uptake and partition of the Se element in jambu, with the leaves storing more than 70% in the first doses applied. At higher doses, **TrI** showed a reduction in the translocation potential. According to White [18], Se and sulfur (S) have great chemical similarity, competing for absorption routes. At low concentrations, Se acts positively on oxido-reductase enzymes with glutathione peroxidase, catalase, superoxide dismutase and ascorbate peroxidase, reducing the activities of reactive oxygen species [39].

The presence of Se at doses above the carrying capacity, especially in species that do not accumulate the

metal, causes nutritional imbalance, affecting growth and production. This behavior was detected in this study through the tolerance index (**tI**), demonstrating that jambu tolerates up to 5 mg.L⁻¹ of Se in the nutrient solution. From this dose, there is a reduction in the Nutrient Use Efficiency (**Nue**). Therefore, the results show that jambu achieves greater nutritional efficiency with **Nue** in the order of 0.29 ± 0.03 g.plant⁻¹ and an **tI** in the order of 1.49 ± 0.24 g.plant⁻¹ with 3 mg.L⁻¹ of Se in solution.

This reduction of **tI** and **Nue** may occur due to competition for absorption routes between Se and S in the nutrient solution. The higher concentration of Se causes a lower absorption of S, replacing it in sulfur amino acids, glutathione and other compounds of the sulfhydryl group. This reduced dry biomass production and plant growth. This behavior was described by White et al. [39] in *Arabidopsis thaliana*, and shows the reduction in translocation capacity in some plants with increasing Se concentration in the medium.

The performance of jambu against Se is more evident in the multivariate indicators. The behavior of the growth indicator (**gI**) showed that the presence of Se induced an improvement of 17 % in the variables that compose it, showing a curve of maximum growth reached at the estimated dose of 3.36 mg.L⁻¹ of Se in the nutritive solution. Therefore, the growth of jambu reaches the technical optimum with this dose.

The mass indicator (*mI*) shows a gain of 47%, with the maximum efficiency estimated at 2.77 mg.L⁻¹ of Se. This indicator also presents quadratic behavior, indicating that as the maximum efficiency dose is exceeded, there will be a reduction in mass gain.

As seen in the *Nue* index, doses close to 3 mg.L⁻¹ of Se produce greater absorption of nutrients, a fact corroborated by the nutritional indicator (*nI*) that shows a value of 2.90 mg.L⁻¹ as the ideal dose for the highest nutrient concentration with a 45% increase in the plant's ability to uptake nutrients. Also similar to the *Nue* and *tI* indices, as well as the growth and mass indicators, *nI* presents a polynomial behavior, with a reduction in the nutrient absorption capacity as the doses of Se are increased.

Regarding the evaluation of indicators, the general indicator (*gnI*) presents similar behavior to the other indicators and indices and shows that the ideal dose for the best development of jambu in response to selenium is 2.98 mg.L⁻¹. Values above this level can cause the plant to reduce its development potential.

Mostofa et al. [40], Reis et al. [41] and Silva et al. [42], show that concentrations of up to 100 mg.L⁻¹ of Se in nutrient solution caused a drastic reduction of chlorophyll, carotenoids and dry biomass in rice seedlings and a 90% reduction in the concentration of chlorophyll and carotenoids in beans caupi, a fact that may be related to the incorporation of Se into proteins and amino acids, resulting in selenoproteins in higher concentration than sulfur proteins and amino acids [43];[44]. In this work, the Translocation, Tolerance, Nutrients Use Efficiency, as well as the multivariate indicators showed that the optimal range of biofortification for jambu ranges from 2.77 mg.L⁻¹ to 3.36 mg.L⁻¹, with maximum value of Se supplementation in the order of 2.98 mg.L⁻¹ in nutrient solution.

Se is an essential element in human metabolism and the consumption of fortified foods can play a role in mitigating the effects of heavy metal intoxication, in addition to acting to prevent cancer and cardiovascular diseases [44];[45]. In addition, the biofortification of a plant such as jambu, which already brings with it antioxidant compounds, dietary fibers, proteins, carbohydrates, among other bioactive compounds, is an excellent alternative to reach populations in nutritional fragility around the world and especially in the Amazon due to its high consumption in the region.

What should be observed regarding biofortification with Se are the daily intake limits of the element. For the diet of the adult population, ANVISA recommends at least 8.25µg.day⁻¹ and up to 319.75µg.day⁻¹ can be

ingested. Values below 8.25µg.day⁻¹ are considered deficient and above 319.75µg.day⁻¹ can cause toxicity [46];[47].

The daily consumption of 100 g of jambu biofortified with 2.98 mg.L⁻¹ will provide 50.13 µg.day⁻¹ of Se, above the minimum recommended by ANVISA, thus guaranteeing easy access for populations that are food insecure. to a product, which in addition to being biofortified, is a source of proteins, carbohydrates, among other compounds.

V. CONCLUSIONS

The results indicated that jambu can be biofortified with small doses of Se in nutrient solution by increasing dry biomass production, nutrient assimilation and plant growth. The construction of multivariate indicators proved to be adequate to understand the behavior of the plant in the face of exposure to Se. above all in terms of the general indicator, the ideal dose of Se in a nutrient solution is 2.98 mg.L⁻¹, which should be used as a beacon to produce a biofortified vegetable that is safe for human consumption.

The daily consumption of 100 g of jambu biofortified with 2.98 mg.L⁻¹ of Se provides a daily dose of 50.13 µg of Se, being an excellent nutritional alternative for several countries where it is grown, especially those that suffer from scourge of malnutrition, assisting in government policies to achieve the goals of “zero hunger”, good health and well-being”, of the sustainable development of the 2030 Agenda, especially after the COVID-19 pandemic.

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The relation between the Environment and Pandemics

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Abstract—In late 2019, one of the biggest pandemics of our time, with the power to completely shut down cities, was revealed. This is Sars-cov-2, which spreads very quickly and is transmitted through the air. The Coronavirus is nothing new to the world and warnings about the risk of pandemics have existed for many years, such as that of the 2013 epidemic, made by the WHO (World Health Organization) at a time when there was already alarm about the potential of this virus to cause outbreaks. Pandemics are nothing new to humanity. They were present at different times in history, and this paper aims to present the link between pandemics and disturbances of the natural environment, with emphasis on zoonoses. Some pandemics and their consequences will be briefly exposed, pointing out parallels between them. The study was carried out through the analysis of scientific articles within the specified topic in journals with a high level of reliability, seeking to understand this phenomenon and how to face them. This paper was written while the world was going through the Sars-cov-19 pandemic and was evolving together with the discoveries made day by day by the scientific world. Goals were defined for this paper, such as studying zoonoses and their forms of transmission, analyzing the human factor and how it impacts the environment, and pointing out solutions to solve these problems. This literature review concludes that when humans invade the natural environment and destroy existing relationships in this place, diseases transmitted from animals or from the environment itself can arise, which may or may not cause new pandemics through zoonoses.

I. INTRODUCTION

Emerging infectious diseases have socioeconomic, environmental, and ecological factors as a tripod, in addition to the risk of starting in countries in the south of the globe, in tropical areas, where studies and prevention resources are very low, and warnings are usually ignored. Several of them that now plague humanity began with

deforestation, such as the Black Death, Chagas Disease, Toxoplasmosis, Leprosy, Rabies, AIDS, Malaria, Ebola, among many others that have not even been named or studied (Souza, 2020).

In the 1980s there was a large spread of the HIV virus, an example of zoonoses that pass from animals to humans.

It should be noted that about 70% of infectious diseases came from wild animals (JONES et al, 2008).

Everything has become very accessible and continuous, causing the virus to spread very fast across the planet. Cheng et al (2007) warned of the great risk of the coronavirus, which has come to become today's major health problem. According to Ma (2020), the first Case of SARS-CoV-2 occurred on November 17, 2019. Prior to that, China's health authorities pointed to December 8. The author also reports on the possibility of there being cases prior to this date, not knowing exactly who patient 0 (zero) was. For the approach of this paper, we used the bibliometric methodology that, according to Treinta et al (2014), aims to gather the knowledge produced by the scientific community on this subject and thus seek solutions to point out ways to avoid greater damage as a result of new pandemics.

Therefore, the search for answers to this question becomes essential for the establishment of prudence mechanisms. In this sense, by carrying out this study, we sought to point out the ways in which future pandemics can be prevented through knowledge about their origins.

II. ENVIRONMENT

Initially, the environment is commonly linked to natural environments such as forests and what's inside them; but Primavesi (1997) also refers to buildings, cars, cities, and everything else. The author emphasizes that the environment is not just the space in which we live, but the space of which we are all part.

For Meyer-Abich (1993), the thought of the isolated human being does not match reality, it also belongs to a series of interconnections with the environment. In other words, a species is dependent on a certain number of elements from nature and relationships are indispensable for life to exist. Morin (1988) contributes to this thought by showing that nature is not an inert shell, but a complex network of multiple dependencies of which man is a part.

Primavesi (1997) comments on the human view of nature, how it is often seen only as a resource; this view places the blameless human being for destroying various connections and extinguishing species of fauna and flora.

Nowadays, with the current circumstances in which we find ourselves, it is increasingly imperative to acquire knowledge about the natural environment (Keys, 2021) because, according to Freitas (2003), environmental problems are also health problems.

Porto (1998) states that one of the main points of the environmental issue lies in the attempt to understand, through interdisciplinary and transdisciplinary approaches,

the environmental problems and their possible consequences.

In this sense, Jacobi (2003) reports that the knowledge produced should aim to appreciate all the relationships between the natural and the social environment, including analyzing this phenomenon in order to have sustainable development as an alternative, respecting each node of this complex tangled web that defines the environment.

Pandemics

The issues of pandemics are always associated with a disturbance in the ecosystem caused by the arrival of a species that is not part of that environment, or the destruction of natural environments, initially for the settlement of human societies, and, later in history, the destruction of resources for the development of society (Aufderheide et al, 1998).

Aufderheide et al. (1998) continues the reasoning by describing a trip to the past, speaking of the Plague of the Philistines in 1320 B.C. which, in some ways, somewhat resembles the bubonic plague. Little (2007), on the other hand, discusses the similarity between diseases such as smallpox, typhoid, and measles that could inflate the total number of deaths in the Middle Ages.

Most of the named pandemics in history happen due to a zoonosis that, in turn, occurs through an environmental disturbance, such as the Justinian plague that originated due to the total lack of hygiene in the largest city in the world at the time, the city of Constantinople (WADE, 2010). The bubonic plague, as described by O'Neill (1993), spread through infected rats that arrived in Europe via ships and carriages transporting food, weapons, and clothing.

About the Spanish flu of 1918, there are several speculations about its origin, but the most likely would be the hospital camp in the UK. Honigsbaum (2018) reports that 100,000 soldiers from that camp passed through the hospital every day seeking treatment due to chemical attacks and injuries; in this way, they could have spread the flu throughout the UK. The site was also a pigsty to which nearby villages brought birds for supplies. Shanks (2016) points out that there is evidence that the virus was already circulating in the European army months before and probably, years before 1918.

According to Mandell (2010), acquired immunodeficiency syndrome (AIDS) was first discovered in clinical form in 1981 in the United States. The first cases were drug users and homosexuals, who were already suffering from low immunity, and there is no clear reason. According to Gottlieb (2006), the patients had pneumonia caused by the *Pneumocystis carinii* fungus, which was an opportunistic infection. Hymes (1981) reports that in the year 1981, many homosexuals developed a rare skin cancer

called Kaposi's Sarcoma, and when the Centers for Disease Control and Prevention (CDC) was contacted, the cases had already spread to many places. Initially, the CDC did not yet have a name for this disease, but only referred to it by way of clinical conditions in which patients had, for example, lymphadenopathy. Barré-Sinoussi (1983) named the disease "persistent generalized lymphadenopathy." Other names widely used early on were "Kaposi's Sarcoma" and "opportunistic infections."

According to Sharp (2011), HIV-1 and HIV-2 originate in West African primates, a Transmission took place at the beginning of the 20th century. Thus, Gao (1999) discusses HIV-1 coming from southern Cameroon and would be a virus that evolved from SIV, Simian Immunodeficiency Virus, which infects wild chimpanzees. As for HIV-2, for Reeves (2002), the virus would have its origin in southern Senegal and would still have as its closest relative the "Cercopithecoidea" virus, which is from a race of primates known as Old World monkeys, which are resistant to HIV-1. Sharp (2001) explains that, probably, the virus has mutated at least on 3 occasions, giving rise to groups (M, N, and O). Acquired immunodeficiency syndrome, better known by the acronym AIDS, is a disease of the human immune system caused by the human immunodeficiency virus, HIV (Weiss, 2002).

Recently, due to a major historical moment being experienced in 2019-2020, Sars-Cov-2 has been the subject of several conspiracy theories that permeate to the date of editing this dissertation. Theories that this virus was a Chinese weapon for global domination have been spread by heads of states and internet groups (Morel, 2021).

Describing the recent history concerning Covid-19, Li (2020) reports that in December 2019, cases of pneumonia began to appear that were related, epidemiologically, to probable exposure to the live, free-range animal market in Wuhan. Chinese health authorities issued an alert about this problem to the World Health Organization. Later, according to the WHO (2020), it was revealed that cases of pneumonia were caused by a type of coronavirus. Gorbalenya (2020) and Wu (2020) named this new variant of coronavirus as Sars-Cov-2.

According to Khalil & Khalil (2020), coronaviruses belong to the family Coronaviridae, which comprises 2 subfamilies, 5 genera, 26 subgenera, and 46 virus species. SARS-CoV-2 belongs to the genus. Beta coronavirus, subgenus Sarbecovirus, species severe acute respiratory syndrome-related coronavirus, and is related to the acute respiratory syndrome. Its classification was performed by the International Committee on Taxonomy of Viruses (ICTV), taking into consideration mainly its molecular and phylogenetic characteristics, and not the disease it causes.

The WHO (2020) points out that the subgenus Sarbecovirus caused an outbreak between 2002 and 2003, an epidemic that reached a few 8,000 infected people. In early March 2020, the WHO declares the coronavirus to be a pandemic.

In further studies, a similarity of approximately 96% was found with the coronavirus of a bat species *Rhinolophus sinicus* (horseshoe bat) and it was possible to state that the origin would have been from such an animal. Furthermore, a competing theory to this, pointed out by Lan (2020), Xiao (2020), and Liu (2020), would be that of pangolins, an intermediate species to transmission to humans.

Unlike other viruses that have struck humanity in recent decades, coronavirus is highly recombinogenic, as Forni (2017) points out.

This thought is widely accepted in the scientific community, as Maciej et al (2020) state in their study, which sought the origin of the virus in question. The study points out that this may have several possible sources of origin. For their research, the team used 3 different bioinformatics approaches in order to model and remove the parts that recombine in the Sars-Cov-2 genome. The researchers' next step was to reconstruct the phylogenetic history by comparing the mismatched regions and showing which viruses were already involved in past events.

Even with the ease of access to information due to social media, Sars-Cov-2 had and still has a great enemy called "denialism." The denialists, at first, led several people not to believe in the disease; in the second moment, they delegated remedies that had no proven efficacy (Morel, 2021).

Due to the coronavirus, the modeling system for an immunizer has changed and many countries have come together to create an effective remedy against this virus. The first tested and approved vaccines date only 10 months after the causative agent became public. Thus, according to Cognys (2021), the pharmaceutical company Pfizer has developed an immunizer called BNT1262, made of messenger RNA that simulates the genetic material of the virus and creates antibodies for the disease in question. This immunizer reached 95% efficacy in its test phase.

Even with the immunizer already produced, in many countries' vaccination is slow or almost non-existent. Riou (2020) states that each infected person can transmit to 4 more people, leading to a lack of control of the virus, which can cause mutations, to which immunizers lose, in part, their effectiveness.

Yamamoto et al (2020) report that although covid-19 is a respiratory disease, it also affects the brain and other

organs, such as the heart, livers, and kidneys. The author also discusses neuropsychiatric manifestations that are common in viral pandemics and do not usually receive recommended attention. Also, new evidence shows how the virus causes hemorrhagic and immune responses that affect every organ in the human body.

Finally, Yamamoto et al (2020) point out how SARS-CoV-2 affects the mental health of patients, families, and society in general.

The world is in a state of crisis in relation to nature. Entire ecosystems are being destroyed in order to increase the financial power of countries that already have high capital.

Even with the warning of scientists, in several articles, this has had no effect. For Ripple et al (2019), scientists have a moral obligation to warn humanity about any catastrophic threat. Furthermore, according to Ripple et al (2019), with the support of more than 11,000 scientists around the world, all of them claim that the planet is experiencing a climate emergency.

In 1979, the First World Climate Conference took place in Geneva, at which an agreement was reached that climate change should have urgent action. After that, at the Rio Summit in 1992, the Kyoto Protocol in 1997, and the Paris Agreement in 2015, scientists warned of the same directions the world was taking. However, as of the publication date of Ripple et al (2019), all the data indicated that greenhouse gas emissions were still increasing in an uncontrolled manner.

Briggs et al (2015) argue that just using global surface temperature indicators is ineffective, and it is necessary to look at human activities that cause global warming. The researcher and his team warn about the need for governments and society to have access to various indicators of activities that have an impact on greenhouse gas emissions and their consequences on the climate and environment.

According to Ripple et al (2019), the climate crisis is totally linked to the rampant lifestyle consumption of the planet's affluent population. The countries that have the largest gross domestic products (GDP) in the world are also the ones that emit the most greenhouse gases.

In Brazil, public policies around the government have run contrary to the warnings of the scientific community following the 2018 election.

Thus, with the current situation of the Amazon being exploited and destroyed, the point of connection between the disturbance of the natural world and most of the pandemics present in human history is reached. Therefore, zoonoses, which are diseases transmitted from animals to

humans, usually manifest themselves exactly at this time of disturbance between the environment and humans. Johnson et al (2015) state that most human infectious diseases, especially recent emerging pathogens, originate from diseases in wild or domestic animals. A risk to global health. Considering the above, in 2015, the author predicted an emerging risk in a possible zoonosis.

Johnson et al (2015) declare that the world is dominated by viruses and bacteria, most of which do not cause any harm to human beings; however, some can be very dangerous. In the last 80 years, 60% of the diseases that have ravaged humans have originated from animals, of which 70% came from wild animals and the other 60% from domestic animals. When these diseases cross the animal barriers and pass on to humans, physical contact with other beings facilitates the transmission of this disease. Considering the number of people clustered in a city and their displacement globally, the virus receives all the necessary conditions to cause a pandemic.

During the Covid-19 pandemic, scientists needed to produce articles disproving theories that Covid-19 was produced in a laboratory. Andersen (p. 452, 2020), in his work, states that "Our analyses clearly show that SARS-CoV-2 is not a laboratory construct or a purposefully manipulated virus."

Although the ingestion of exotic animals is very common in Chinese culture, what is most considered for more production of these foods is, as Li (2020) cites, the so-called neophiliac gastronomic tourism, where the population of rich countries, people with high purchasing power, go to countries like China to consume these types of animals. This peculiar culture, combined with the way we treat the planet, leads to the disturbance of the environment and, in turn, causes wild animals to frequent the same place as humans, and such a cycle leads to new mutations.

Khalil (2016) points out that in an environment with high biodiversity, the few animals that carry a lot of diseases get diluted with animals that convey no danger to humans and the name of this event is "dilution effect." By destroying the fauna, the first animals that disappear are the ones that do not transmit risks, because, in a way, they are more fragile and dependent on the place where they live; and those that carry more parasites, multiply and become more present throughout the territory.

Also, according to Khalil (2016), with a larger population of animals having more parasites, there is a greater exchange of viruses between them, and they recombine until they can transmit to humans. Thus, the human way of life, especially in rich countries, is leading to the emergence of new diseases at an ever-increasing rate.

Meanwhile, the Brazilian Society of Tropical Medicine (2020) reports that scientists have been warning about zoonotic pandemics for decades, without getting answers from governments. Some of these infections could become catastrophic events even more intense than Covid-19, as more and more forest greenery is lost and biodiversity decreases, making pandemics far more common for the world.

III. METHODS

The present study has as its objective the knowledge about the health disaster situation brought about by a virus that "stopped the world," leading it to adapt to a new reality.

In order to achieve the purposes of this paper, the main published researches on the topic of pandemics and the environment were searched in the literature (in the world-renowned main scientific journals). The main pandemics prior to Sars-Cov-2 were also taken into consideration in order to equate and identify their origins.

To this end, we used literature review literature research defined by Gil (2010) as a type of research that includes printed and digital scientific materials such as books, journals, and periodicals, to respect all safety procedures due to the pandemic.

The data contained in this paper were taken from scientific research published in articles and books that address the topics contained and agglutinated so that we could find measures to combat and prevent the prospect of new pandemics.

Taken into account in this composition were the hypotheses of how pandemics occur: "Would it be due to a disturbance in the environment, because of unaware exploitation and destruction of natural means, or a naturally occurring one?"

Such questions were put on the agenda as well as grounded in science, and indicators were sought for the analysis of such answers.

Materials

The research was carried out in the databases of PubMed, Scopus, Google Scholar, Nature, Science, The Lancet, and Scielo databases, the Journal of the American Medical Association, Center For Disease Control, Cambridge University Press; The New England Journal of Medicine; World Health Organization, and New York: Oxford University Press, with a focus on obtaining and analyzing published journals.

Methods

This is an exploratory and narrative study on the relationship between the environment and pandemics, as a

literature review. The method of consulting scientific articles on the subject had 3 main points:

- The first refers to articles considered historical, where they pointed out the pandemics in their beginning. As an example, we have articles related to the attempt to understand AIDS and how it would have become a pandemic. These articles, then, refer to the dates on which each case or subsequent studies were investigated, which pointed to the causes and consequences of each disease;
- The second refers to data that show the human impacts on nature that, in this way, culminated in pandemics. Such articles alone need to have their dates of study taken into consideration, since nature is increasingly attacked and, because of this, as Steffen et al (2011) argue, we live in a new phase of the earth called the Anthropocene, where all modifications made by man in nature result in irreversible consequences. Also taken into account in this follow-up were articles from electronic scientific journals with credibility on an academic level and after research, looking for the data that prove what is being said in such media.
- The third group of articles researched is related to Sars-Cov-2 and is divided into two subclasses. Those launched at the beginning of the pandemic, which aimed to find out what this new disease was all about. The second subclass is dated from the last 8 months and focuses on pointing out where the virus comes from, how it spreads, and possible vaccines. Materials were obtained between January 6 and May 28, 2021. Original and review studies were obtained and analyzed, in which their titles, abstracts, and topics were aligned with the terms of interest of the referred proposal. The contents of interest were described according to their relevance in contributing to the objective of this paper.

Data Collection

The data obtained in the present work are from articles that describe pandemics, published in scientific journals. Such scientific journals were accessed through portals such as Scielo and Google Scholar, and their sources were verified, taking care to collect the information from the original articles.

Therefore, the search bases for these data were PubMed, Scopus, Nature, Science. In terms of information, The

Lancet, Journal of the American Medical Association, Center for Disease Control, Cambridge University Press; The New England Journal of Medicine; World Health Organization and New York: Oxford University.

Data Analysis

The analysis of the various articles that make up the present paper has as key points the data of the articles that describe a disease or the projects published in the period in which the most recent pandemics were discovered. In the case of the most remote diseases, such as the Plague of Justinian and other pandemics, articles were also searched that dealt with them in a historical way.

Once each of the pandemics was described, journals were searched for detailing the disease and its causes. In some cases materials were obtained to describe how it was fought, making a parallel described in greater detail in the conclusion.

Therefore, the date of each article responds to a part of the investigation, for example: when we mention AIDS, we went through articles published in the period when the disease appeared in the United States and, after that, it became the pandemic that until today it makes victims, with updates until reaching the name we know today as Acquired Immunodeficiency Syndrome.

In the case of the description of the environment, we sought to understand how this term is understood and what exactly this means is. Consequently, old records of researchers were investigated with a clear definition of the term. Then there was an understanding of what an aggression to the environment that humans are part of is, and what the human influence is on pandemics and zoonoses.

When it comes to the reason for this paper, SARS-CoV-2, one should keep in mind the speed with which new articles have been obtained and new evidence of the disease. Papers generated in the very early 2020s, therefore, have the informational weight of how the virus came to be transmissible to humans and where it might have started. Throughout the year 2020 and into the first quarter of 2021, clarification was obtained about the disease (clinical picture and correlated mechanisms) and how to deal with the pandemic that is currently ravaging us.

IV. RESULTS

It can be defined as a sum of the articles presented that the disturbance in the natural environment and the coexistence with wild animals, as Capra (1996) argues, treats nature as an interconnected web of relationships, so that when one end of this web is broken, these relationships collapse.

Porto (1998) states that, with the destruction of the natural environment of one animal or several, the global ecological risks increase, especially in urban-industrial environments that have as one of their characteristics the great concentration of pollution. In this sense, there would be a stampede of animals considered more fragile, leaving only those animals that have a greater risk of transmitting zoonoses to humans—because they are more resistant since they have adapted—who start living with humans or being hunted by them. Meanwhile, the virus contained in them undergoes mutations and, consequently, by these means, ends up reaching humans.

Freitas (2003) contributes to this theme by establishing the correlation that environmental problems are also health problems, arguing that human society is in fact affected in several segments when a disturbance occurs in the natural environment.

The way to fight or, in cases like the present one, to contain a zoonosis is only with the respectful work between man and the natural environment. According to Keyes (2021), it is increasingly imperative to acquire knowledge about the natural environment, and Barreto (1998) completes talking about how we can bring man closer to nature and, in doing so, we will know all the benefits and risks that we find in the environment. through a biological view of the phenomenon between environment and disease.

This way of looking at the environment, in itself, already leads us to the duty and the right to preserve it, since we depend on it and every species, independent of the human race, also needs its natural environment and its confections.

Still, on this topic, we cannot fall into anthropocentrism in its classical sense, which has its construction within Greek philosophy, in which man and nature were completely separated, but which prevails in most of today's environmental policies. There is a concern with the elements that only guarantee the survival of the human species, as if the whole world were just their means of extracting everything for their own benefit, forgetting all the other interconnections that the environment produces.

Unfortunately, for many, there is still the differentiation of human beings and all the rest of biodiversity and natural environments, with a view of superiority and that all the environment and animals are here for man's delight and enjoyment. When in fact, human beings are part of this environment and are not more important than the rest. The human being alone has an intellect developed enough to dominate and modify the environment (PRIMAVESI, 1997). The author also talks about the only way out, which would be science and environmental studies in an appropriate way.

When we look at past pandemics, as Wade (2010) talks about Justinian's Plague, and O'Neill (1993), the Black Death, we have cities with many people without basic hygiene and the destruction of natural means to shelter that population, which later brought disease and death. Years later, Kolata (1999) talks about the Spanish Flu, in which one of its possible causes would be a hospital whose place served as a pigsty, in which the daily coexistence of animals, wounded and dead soldiers may have facilitated the mutation of the virus, thus bringing a large contingent of deaths.

It is also known that the AIDS virus was spread in the human population from living with monkeys.

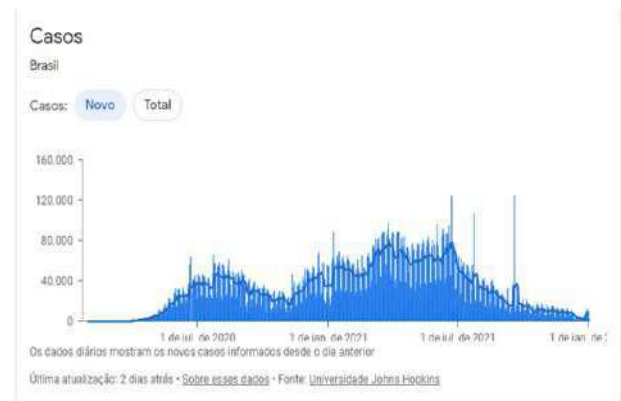
One of the possible origins of the Sars-Cov-2 virus would be bats, which in turn had a secondary host, pangolins. Soon, in recent history dating back to Covid-19, according to Li (2020), in December 2019, cases of pneumonia began to appear, the connection of which was the passage of these patients through the live animal market kept outdoors in Wuhan.

With all these data gathered, the result is the lack of control of the natural environment, which is modified by man, as the main source of zoonotic pandemics and that the solution may be in the place itself (where today is deforested and destroyed), through research and conservation measures. Today, there are several forms of sustainable management that do not harm nature to the point of great disturbance. Zoonoses are diseases transmitted from animals to humans, as discussed in the present study, as well as in the case of Sars-Cov-2. The most accepted hypothesis is that it originated in the animal market in Wuhan, due to the inadequate habits of keeping them in these places.

Brazil is being severely punished by Covid-19. According to reports by Castro (2019), Brazil is the only country with a population of over 100 million that has a free and comprehensive healthcare system throughout its territory. However, it is a victim of misinformation due to the neglect of scientific warnings.

Looking at chart 1 of Covid-19, in the first days of 2022 we can see the difference in cases that occurred after the vaccines started, where there were peaks on March 25 with 98,261 new cases, and on June 22 we got 124,248 new cases of SARS-CoV-2.

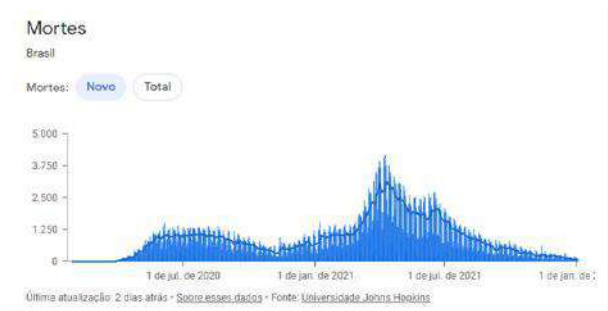
Chart 1 - Cases of SARS-CoV-2 in Brazil.



Source::Covid map, Jan 3rd, 2022, available at: <https://news.google.com/covid19/map?hl=pt-BR&gl=BR&ceid=BR%3Apt-419&state=1&mid=%2Fm%2F015fr>

We can also look at the deaths occurring in the years 2020 and 2021, pointed out by chart 2, where we had the peak of deaths above 1000 reached in May 2020 until the end of August, subsequently with a second wave of deaths above 1000 people, starting in December and going until July 2021, with a major peak of 4,000 deaths in the month of April.

Chart 2– Graph of Deaths by Sars-CoV-2.



Source: Covid map, Jan 3rd, 2022, available at: <https://news.google.com/covid19/map?hl=pt-BR&gl=BR&ceid=BR%3Apt-419&state=1&mid=%2Fm%2F015fr>

Chart 3- Vaccines administrated in Brazil.



Source: Covid map, Jan 3rd, 2022, available at: <https://news.google.com/covid19/map?hl=pt-BR&gl=BR&ceid=BR%3Apt-419&state=5&mid=%2Fm%2F015fr>

When looking at chart 3, which refers to the number of vaccines taken and comparing it with the number of deaths from Covid-19, we can see the impact that the vaccine has had on the decrease in the total number of deaths in Brazil. Which is pertinent, since there has been much controversy in this regard, both in the country and around the world, concerning the efficiency of the vaccine and even the use of drugs unproven by the scientific world, which led to the creation of a Parliamentary Inquiry Commission (CPI) for the Pandemic.

The CPI, which sought to understand the role of Brazilian rulers in seeking the treatment of Brazilians, concluded with a report, according to Siqueira (2021), of a total of 1179 pages. The document, which was divided into 16 chapters, includes investigated and evidences, and indicts 66 people and two companies related to some crime.

The discussion is about the disorders that can be generated due to an environmental disturbance. The disregard for science and the fabrication of fragile news and studies, identified as science, which can result in an exacerbated number of deaths. Even though we have one of the best tools in the world, which is the Unified Health System (SUS), we cannot use them properly, as the presence of conspiracy theories gets in the way.

Furthermore, Berkman et al (2005) point out how all emergencies were developed during the HIV/AIDS pandemic and how the SUS dealt with it, in addition to mitigating the crisis. Being a program widely known in the world, the program to combat HIV/AIDS was a reference worldwide, in the way the pandemic was treated in Brazil.

Berkman et al (2005) say that in 1990 the World Bank predicted that in 10 years the Brazilian population with HIV would be 1.2 million people. However, 14 years later, according to the author, these data were still not materialized and, contrary to what was pointed out, it is estimated that 600,000 people in Brazil have contracted

HIV, in addition to 362,364 who have developed AIDS. Thus, the incidence of HIV is much lower than projected by the institution of the World Bank.

What led Brazil to contain the advance of this pandemic was “citizenship” and “solidarity.” The Brazilian people and the State, through democratic institutions, gave citizenship to the infected, and solidarity was shown through respect for human rights. Several advertisements and lectures on the disease were linked to the entire population, even the neediest, making Brazil successful and keeping the pandemic under control (BERKMAN et al 2005).

As Massuda et al (2018) point out, the system had a very significant budget cut, but it was still expected that the Unified Health System would leave Brazil in a comfortable position in relation to this crisis experienced in the pandemic. However, what was seen was the country being for a long time the second in numbers of cases and deaths, coming to lead the list, in this regard, between March and July 2021 (FIOCRUZ, 2021).

Barberia and Gómez (2020) point to a combination of inaction and irregularities, such as the promotion of chloroquine, among other treatments, even though they have already been proven, several times, to be ineffective against Sars-Cov-2. Without a national direction, the states had to make different decisions from one another, not aligned with science but with political ideologies. This fact has been harming the population, as well as increasing the total number of cases and deaths (PETHERICK et al, 2020).

According to Buss et al (2021), the transmission rate is constantly high and the most vulnerable are among the most affected, especially, as Ahmed et al (2020) points out, those with less financial conditions to isolate themselves or even to pay for private hospitals, further burdening the SUS. In this sense, once the clinical disorder is detected, it is necessary to deal with it in a pragmatic and scientific way, adopting all the procedures that are studied and analyzed by researchers, making it a central role of the rulers to indicate the proven and most correct way to act in each situation.

This paper aimed to study, analyze the phenomenon of pandemics and how they are linked to human beings. During this study, definitions of what nature would be where humans, as well as animals, are, were extracted from the literature. Articles dealing with other pandemics were analyzed, and links were found between the devastation of the natural environment of some animals that forced them to live with humans. From this contact, the transmission of zoonoses, either through feeding based on these animals, kept inappropriately, or by their creation very close and without special care.

However, what has been seen leads us to understand that the more humans perfected their machines, the more severe the changes in natural environments and the larger the cities with nonexistent quality of life and sanitation. Soon plagues appeared that, almost always, derived from a zoonosis.

It was seen that, even with the years passed and basic sanitation/health techniques in big cities, the human being seeks more and more to extract resources from nature, with advances without analysis of the resulting impacts and preservation, the sights of profit, among other quick benefits, without thinking about the future generations of living beings that make up the complexity of life on the planet.

Another important factor to consider is the belief in man as being superior to all the other animals and resources that the planet possesses, without thinking about biodiversity and what can be generated from so much destruction of the natural environment. Aligning all this to a thought of denial of science in all areas, whether when talking about risks of pandemics, even global climate risks. With fauna and flora being lost and water contaminated with the manufacture of technological products, humanity becomes increasingly sensitive to pandemics.

It is known that the announcement of a pandemic caused by some coronavirus was already old, as there are several other diseases with a chance of becoming a new pandemic. In view of this, anti-scientific thinking, which is verified in various parts of the globe, needs to be fought in an educational way.

The advent of communication technologies has facilitated access to unparalleled knowledge, but, on the other hand, it has also given rise to false news and information that are difficult to combat in time, as the speed of propagation of false information needs to be clarified and, clarification is often complex and difficult for ordinary citizens to understand.

V. CONCLUSION

The conclusion of the present paper is given in the assessment that there is a need to find ways to sensitize and educate the population as a whole. This needs to be done in a scientific way and that this same knowledge is easy to understand or in conjunction with the improvement in educational and public health systems worldwide.

Rulers need to take into account the impacts of their speeches and fairly propagate scientific and proven information on all topics brought to public attention. All this together with the protection of the environment, in order to convey the notion that we are also part of the environment and not an isolated fragment or masters of everything that

surrounds us. In addition, environmental awareness and communion with the environment in which we live are necessary.

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An integrated BSC-AHP approach to support the strategic management of small technology companies

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Keywords— *Balanced Scorecard, Strategic mapping, Analytic Hierarchy Process, Technology management, Performance evaluation.*

Abstract— *As monitoring and strategic management issues become increasingly important in the daily lives of small technology companies, a broadening of the understandings that motivate these changes is extremely useful due to the globalized market they are in. To support these understandings, the Balanced Scorecard (BSC) can be used as a tool that helps strategic management. Within this context, possibilities arise that measurements can be balanced between measures of results and measures that drive future performance. This work presents a hybrid approach that uses KPI (Key Performance Indicator) grouped in the BSC perspectives and which are selected through the AHP multi-criteria method, thus composing a strategic map. The results allowed us to understand that although the proposed approach synthesizes evaluation indices extracted from the literature, it can be parameterized and adapted to different realities and, from that, the relative weights of these indices are calculated using the AHP. This work provides guidance on strategies that can help improve organizational performance beyond the financial perspective.*

I. INTRODUCTION

Market relations and their developments in the 21st century are constantly expanding, so, to accompany this expansion, the margin for mistakes in the strategic management of companies also becomes more limited. This is an important reason that drives the need to define strategic plans and practices that constantly align the company with the market.

In the opinion of Kaplan and Norton (1996), the context of cyclical and, at times, occasional changes motivates the need to go beyond the use of strategic

indicators. Corroborating this opinion, Alnoukari and Hanano (2017) highlight that opinion currently needs to be preceded by a broad discussion among peers involved in the planning, management and strategic operations of companies. Durmuşoğlu (2018) also considers the idea of going beyond the use of indicators and, with this, employing multiple criteria in strategic management discussions as a resource for expanding voices.

In the context of small companies, Demuner et al. (2020) emphasize that organizational strategy can be seen as a complex issue, as it is a phenomenon composed of

multiple criteria and sub-criteria, with components that have different priorities and forms of management. For Moraes and Lima (2019) and, Moraes Silva et al. (2020) in Brazil, the diversified scenario in which small technology companies requires them to be prepared for continuous changes and short-term strategic adaptations.

Considering this context and also an approach to acting in an increasingly globalized market, Chong et al. (2019) point to the use of the Balanced Scorecard (BSC) as an important and efficient strategic management tool that, in general, offers adequate conditions for benchmarking and assistance in market positioning decision-making for small companies in various sectors. Complementing this thought Álvarez Jaramillo et al. (2019) emphasize the vision of associating the need to consider multiple perceptions and consolidate opinions.

Corroborating this view, Sorooshian et al. (2020) emphasize that performance measurement systems should be seen as part of the strategic management model, as they are part of the success and failure of organizations; especially in small and medium-sized enterprises. For this reason, these authors recommend the use of multi-criteria methods in order to homogenize opinions, and thereby expand horizons and paths. According to Demuner et al. (2020) the use of techniques, tools and methods of planning and strategic management in organizations are changing. In the past, according to Prashar and Sunder (2020), only graphical tools such as the SWOT matrix (Strengths, Weaknesses, Opportunities, and Threats) were popular in the business environment, which purely presented the organization's strengths and weaknesses, threats and opportunities. of the environment and, as a result, provided managers with a general vision and solutions. However, according to Alnoukari and Hanano (2017) and Moraes Silva et al. (2020) due to the complexity of the environment and the conditions of competition that are currently established and, if they change, managers began to need more efficient tools that can be used hybridly, such as the BSC and the Analytic Hierarchy Process (AHP) method.

Although studies have emphasized financial and non-financial performance indicators for use in the BSC, the way in which they were selected is not clear, and also, the performance measurement systems proposed in the literature are focused on the classification of indicators (Chandra & Kumar, 2019, Chowdhury & Paul, 2020, Cvetkoska & Eftimov, 2021). And, within this context, a vast majority of researchers did not properly address how to select, prioritize and integrate performance indicators through an overall score that gathers opinions. This limitation denotes research biases on dynamic methodological approaches that can be replicated and, at

the same time, contribute to the strategic decision-making process.

More research is needed to broaden discussions on a systematic approach that can consolidate Key Performance Indicator (KPI) into an overall performance score that is replicable and adaptable to different scenarios. For these reasons, this work had the objective of presenting an analysis of classification of KPI grouped in the perspectives of the BSC, being these proposed in a hybrid form based on the AHP multicriteria method and, later elaboration of a strategic map. To assist in the operationalization of the KPI selection, a survey was used with managers and small technology companies.

II. BSC TO ASSIST STRATEGIC MANAGEMENT

The need for the daily use of performance evaluation and monitoring systems at different levels of decision-making is not something new in the different organizational market realities (Rosa et al., 2021).

For Demuner et al. (2020) these different organizational marketing realities give rise to methods, techniques and tools that are adaptable to strategic planning and different business scenarios.

When reflecting on the choice and use of the BSC in an organization, Pedro (2004) highlights that these are mainly due to the assertiveness and technical boldness in the steps that relate to the establishment of strategic objectives and measurement of goals and results. Furthermore, this author emphasizes that the main target of the BSC is based on the rule: "what is measured is managed", thus expanding control beyond financial indicators, and differentiating it from other traditional management systems. From this perspective, the methodology is structured in two main aspects: (i) a measurement framework that translates the strategy into measures, goals and initiatives and (ii) a management system that creates focus, alignment and leadership (Russel, 2015, Hasan & Chyi, 2017).

Among its advantages, the BSC is recognized for providing a systemic view of the business strategy, enabling the compatibility of variables, indicators and goals for the monitoring and quantitative analysis of activities that are part of the organization's strategic plan (Hasan & Chyi, 2017). Furthermore, Alvarez et al. (2019) assess that this methodology allows the consolidation of an important theoretical framework that contributes to decision making and mapping of initiatives that should be prioritized by management members.

The implementation of the BSC is outlined by a set of steps that must be carefully evaluated in order to ensure the performance of the considered management project.

Among these steps, there are: definition of the theoretical objectives of the perspectives most used by the organization; analysis of the vision and organizational model; development of a strategic map; identification of critical points; definition of relevant indicators for monitoring objectives in a quantitative manner; setting goals; assessment of participants' perceptions of the client; measurement of internal capacity and financial perspectives; evaluation of institutional performance and employee productivity (Alvarez et al., 2019).

In this context, Gębczyńska and Brajer-Marczak (2020) mention that the performance measurement model emerges as a comprehensive business management tool, while allowing the prospection and analysis of empirical evidence (performance indicators) related to the creation of value for the different groups of stakeholders (internal and external). Thus, these authors conclude that the BSC has a broad potential, and is therefore applied on a large scale in companies of different natures, such as: educational institutions, hospitals, hotel chains, public administration bodies (government) and non-profit organizations. to profit.

Finally, the literature (Mehralian et al., 2018) shows that the BSC can be used in conjunction with other systems, enabling the measurement and evaluation of a range of financial and non-financial indicators, such as the 3Es models (Economy, efficiency and effectiveness) and "IOO" [input, output and outcome]. Therefore, despite the strengths and limitations of each model, the joint use of these methodologies contribute to the optimization of results, enabling the continuous improvement and progress of management activities and processes.

The financial prospects of a BSC system are outlined by four basic assumptions: revenue growth, lower unit costs, profitability and shareholder value (Kaplan, 2005). For government and non-profit organizations, Russell (2015) points out that the financial perspective is replaced by a "mission perspective", which is responsible for identifying the main objectives of stakeholders that are linked to growth and productivity or efficiency and effectiveness.

In a BSC system, according to Kaplan (2009), the financial perspectives are guided by productivity strategies (improvement of the cost structure and increase in the use of assets) and growth strategies (expansion of revenue opportunities and increase in the value perceived by the customer). As for the objectives, Alvarez et al. (2019) opine that the financial perspective aims to raise questions about the value perceived by providers of financial resources, customer perspective and mapping opportunities to obtain additional revenue. Other authors, such as Modak

et al. (2019), highlight that the BSC indicators, within the financial perspective, are related, in general, to the variation of profit, to the operational cost and to the reduction of fines.

The customer perspective aims to identify the customer and market segments in which the organization competes. Therefore, it is first necessary to define the best performance measures for the target segments and the central measures that are related to the adequate formulation of the organizational strategy. Among the main measures considered from the customer's perspective, there are: customer satisfaction, retention, acquisition of new customers, customer profitability and market and account share, building a sustainable relationship with the customer, differentiated value proposition and loyalty of target customers (Kaplan, 2005).

According to Kaplan and Norton (1996), these measures fall into three classes:

- a) Attributes of products and services (functionality, quality and price);
- b) Customer relationship (purchase quality, experience and personal relationship); and
- c) Brand building (image and relationship).

The BSC is also capable of reconciling the growth strategy with business excellence, which requires greater focus on non-financial initiatives (Kaplan, 2005). Consequently, it is important to highlight that the prospect of long-term revenue growth serves as an important parameter for validating the company's perpetuity and sustainability, in the face of market variations and threats, in addition to acting as an instrument to measure organizational performance. (Kaplan & McMillan, 2020).

Currently, organizations aim to increase their earnings or, at least, sustain them by reducing production costs. Regarding this understanding, Bataineh et al. (2018) reflect that a considerable part of these organizations adopts cost reduction as a business strategy factor, prioritizing strategic management accounting techniques to minimize waste, burdens, costs and expenses, among other commercial advantages.

Generally speaking, a costing system starts with a comparison between allowable cost and approximate cost estimate, then goes through several iterative steps of gap decomposition, value engineering, and cost estimate comparison. result with the goal. In view of this, the BSC appears to help organizations find a balance between lead time (delivery time), cost and quality/functionality (Rasolofodistler & Distler, 2018).

Performance appraisal is one of the main criteria for achieving customer satisfaction. Furthermore, it is noted that this parameter serves as a valuable guideline for manufacturing companies to achieve better customer satisfaction through sustainable product-service system practices. To this end, organizations must adopt proactive measures that maximize the learning capacity of the business, improving internal processes and efficiently managing customer relationships (Modak et al., 2019).

Another important variable with regard to the customer's perspective is the availability of the product and/or service. In most cases, the conditions relating to the availability of goods and services are closely related to customer satisfaction, allowing us to infer that the level of customer satisfaction can be affected as a result of failures in availability and supply, leading, consequently, to economic and credibility losses (Tjader et al., 2014).

The internal business perspective requires a focus on the effectiveness of internal processes, thus making use of indicators and tools to monitor and measure the activities with the greatest influence within the operating system (Rahayu et al., 2022). Given the above, it can be highlighted that effective internal business processes provide high quality products and services to meet customer needs (Park & Gagnon, 200, Rahayu et al., 2022).

Kaplan and Norton divided the company's generic value chain activities into four high-level process areas: (a) innovation; (b) customer management; (c) operations; and (d) regulations and environment. Each of these areas can include main processes and sub-processes. Thus, it appears that the organizational pie can be sliced in several ways (Huang et al., 2011).

The operation optimization approach is considered an efficient and effective alternative for achieving sustainable goals and objectives. It is also observed that the optimization of the operation is configured as one of the main attributes necessary for the continuous improvement of processes and internal activities, in addition to acting in favor of improving the level of performance (service of organizations). In addition, it is worth mentioning that optimization strategies comprise three levels: interconnection of the components that make up the system, design optimization and operations optimization (Zailan et al., 2021).

Continuous improvement is directly linked to dynamic open innovation, leading to the natural development of the organization and innovation processes. In view of this, organizations cannot stick only to internal measurements, given that dynamic indicators require an understanding of the organization's performance in relation to the external

environment. Therefore, it is concluded that continuous improvement is stimulated in an open, dynamic and innovative environment (Medne & Lapina, 2019).

On the other hand, measuring innovation performance presents itself as a challenge, due to the complexity and multidimensionality of innovation processes. Thus, an alternative is the use of the BSC method, which is evaluated as adaptable to the needs of the organization in any of its strategic areas (Hájek et al., 2018).

Customer orientation should not be restricted to gathering information about competitors and customers in the current environment, as it needs to anticipate changing trends in regulations or relating to the external macro environment (Ramakrishnan et al., 2019). In addition, Tanaamah et al. (2019) emphasize the need to consider some variables such as the level of customer satisfaction and the requirements related to project compliance.

The learning and growth perspective is probably the area that most companies value the least. However, this perspective is the "key piece" for the sustainable success of the organization in the future, as it is important to understand that growth must focus on measurable results to move the company forward.

In view of this, evidence indicates that the perspective on growth and learning fosters technical-scientific innovation and, consequently, the economic development of the company (Massingham et al., 2019). To achieve this goal, according to Park and Gagnon (2006), the perspective of learning and growth is based on several aspects, of which the following stand out: adequate infrastructure and work environment, maintenance of employee satisfaction and motivation, skills of employees and information systems.

Employee capabilities and skills are one of the necessary requirements to achieve business process improvement, as well as learning and growth to develop the organization, information systems capabilities and a favorable corporate climate (Yoshikuni & Albertin, 2017). According to Yang and Islam (2012), employee training is an internal business advantage, thus enabling the employee to react positively to changes. Therefore, it is worth mentioning that an organization must provide opportunities for growth and learning to employees to enable the achievement of goals and results (Dias Jordão & Casas Novas, 2013).

Another relevant point for the performance of a company is the organizational culture, which is linked to the behavioral expressions of certain groups of people, that is, the set of customs, dogmas and habits of a community. In other words, organizational culture is seen as the concrete manifestation of shared values and beliefs that

directly affect the behavior of employees, bringing benefits and challenges to the organization. It is important to note, however, that the nature of organizational culture implies how significant the collective assumptions of the members must be, both in the maintenance and in the articulation of the cultural pattern fostered by the company, thus allowing the determination and interpretation of its course of action over time (Kim & Chang, 2019).

Industry 4.0 increasingly focuses on disruptive technologies that are capable of having a series of significant impacts on supply chains (Tjahjono et al., 2017, Frederico et al., 2020). Among these technologies, the following stand out: virtual reality, simulation, 3D printing, big data analysis; cloud technologies, cyber security, Internet of Things; radiofrequency identification; machine-to-machine communication; automatic identification and data collection; robotics, drones, nanotechnology and business intelligence (Tjahjono et al., 2017, Frederico et al., 2020).

According to Iddris (2018), the current technological framework has significant potential to radically change supply chain operations and needs to be aligned with customer demands. Furthermore, these new technologies, especially Internet of Things and cyber-physical systems, may impact products and services, business models, markets, economy, work environment, organizational skills, profoundly modifying supply chains and traditional models of management (Pereira & Romero, 2017, Frederico et al., 2020).

III. THE AHP

The daily planning of micro and small companies has been influenced not only by marketing issues, there is even evidence that this transformation is encompassing a large number of criteria and sub-criteria (Oliveira et al., 2017).

From another point of view, there is also an indication of the need to review paths and positions in a shorter period of time than before the COVID-19 pandemic (Fitriasari, 2020), in addition to the emphasis that has been requested for the use of technologies in different sectors of the economy (Papadopoulos et al., 2020).

At the same time, there is the emergence of several organizational demands associated with new problems, as well as the need to gather opinions. To meet these reasons, in this work the hybrid use of the Analytic Hierarchy Process (AHP) with the BSC was selected.

Thomas Lorie Saaty (Saaty, 2008) proposed the AHP method in the 1970's, being a robust approach that helps decision making through the use of multiple criteria. According to Gonçalves (2016), this method makes it

possible to analyze complex and unstructured problems in different circumstances that involve decision making, not being limited to areas for its application.

The main feature of the AHP method is the use of peer comparisons, in which alternatives are compared on different attributes (criteria and sub-criteria) using weights (Louro et al., 2017). In a peer-to-peer comparison, this technique uses the judgment of a decision maker, using the nine-point Saaty scale as presented in Tab. 1. According to Santos et al. (2019), it is important to highlight that the decision maker's broad experience and/or in-depth knowledge of the problem help in this paired comparison.

Table 1: Scale for operationalization of the AHP

Numerical scale	Verbal scale
1	Equal importance.
3	Moderate importance.
5	Strong importance.
7	Very strong importance.
9	Extremely important.
2, 4, 6 e 8	Intermediate values between adjacent opinions.

Source: Saaty (1991).

In general, the AHP has been used to guide, support, evaluate, classify, select, among other objectives present in the literature, and there is also a wide variety of alternatives for different decisions, in which the indication of possibilities depends on a process. systematic and quantitative (Gonçalves et al., 2020). Usually, due to its versatility of use, this method makes it simpler to evaluate the relative weights of attributes compared to others (Câmara et al., 2020). The AHP operationalization procedure requires it to be carried out in four phases (Saaty, 2008). The first phase must be preceded by the understanding of a given problem and, therefore, in addition to the objective to be achieved, it is necessary to decompose this problem into a hierarchy, as shown in Fig. 1.

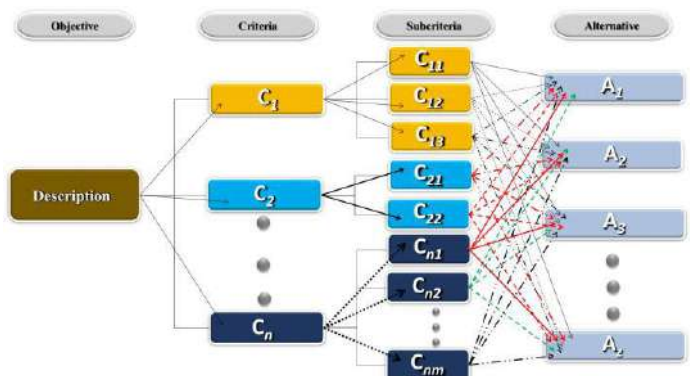


Fig. 1: AHP operationalization hierarchical structure

The decomposition of the problem studied allows obtaining feedback on trade-off information through peer comparison of elements that help decision making (Demuner et al., 2020). Therefore, according to Yaghoobi and Haddadi (2016), the different attributes that form a hierarchy can be remodeled into a matrix structure to elaborate a comparison matrix.

Thus, according to Santos et al. (2019) the term 'eigenvalue' is used to determine the relative weight of the attributes of the hierarchy. And, from this, according to Saaty (2008), the very principal value of Lambda max (λ_{max}) can be determined in Eq. 1 as follows:

$$\lambda_{max} = \sum_{i=1}^n \left(\sum_{j=1}^n a_{ij} \right) w_j \quad (1)$$

Criteria weights are obtained through a combination of relative weights in order to allow an aggregated comparison of all alternatives (Louro et al., 2017). From the consideration of this combination, as a consistency metric, the Consistency Index (CI) is derived from the following Eq. 2, where λ_{max} is the significant eigenvalue matrix and n is the number of classes (Saaty, 2008).

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (2)$$

However, to verify the Consistency Ratio (CR), as described by Eq. 3, is calculated as the consistency assessment between the peer comparison matrix (Saaty, 2008).

$$CR = \frac{CI}{RI} < 0.1 \equiv 10\% \quad (3)$$

The Random Consistency Index (RI) is the consistency identifier of a randomly generated reciprocal matrix, shown in Tab. 2 (Saaty, 1991).

Table 2: Random Index as a function of the matrix

n	2	3	4	5	6	7
RI	0.0	0.58	0.90	1.12	1.24	1.32

IV. METHODOLOGICAL APPROACH

This work sought to investigate strategic management practices that use KPI and, later, formulate a strategic map through a multidimensional approach in 5 steps. For this purpose, seven small technology companies located in the State of Espírito Santo (Brazil) were used as units of analysis. A survey was used with forty-two employees at the most varied organizational levels, namely: senior managers; supervisors; senior analysts; and financial, customer relationship and human resources managers considered to be specialists in these companies.

Thus, according to Rocha et al. (2020) the data collection instrument of the survey was a structured

electronic questionnaire, applied through institutional e-mail, adopting a confidence level (Z) of 90%, maximum sampling error of 5%, maximum percentage of certainty of 5% and, 24 the n considered as valid. Additionally, according to Gonçalves et al. (2020) the occurrence of missing values elements (missing data in the questionnaire) and outliers (Z score with interval $|z| < 3$, for a value of $p < 0,001$). The internal consistency of the data collection instrument was also investigated, as indicated by Acuña-Opazo et al. (2017), and Cronbach's alpha with a value greater than or equal to 0.7 was used as a verification measure. To help carry out these statistical analyses, the trial version SPSS 28.0 software was used.

KPIs were raised through a literature review, being used to compose the survey and then used in the operationalization and comparative judgments of the hybrid BSC-AHP approach (Doná et al., 2017). This approach was carried out through the concept of data triangulation, which enabled a broader understanding of the phenomenon studied (Gonçalves, 2016).

Within this context, the first step of the approach aimed to carry out a diagnosis of the internal and external environment of the units of analysis, being verified products offered, organizational processes, customers, competitors, suppliers and social and economic aspects. From this, it was possible to generate brief sectorial knowledge - small technology companies (Espírito Santo/Brazil) and, thus, generate elements to support the other stages.

Continuing, the second stage was carried out to detect business strategies. The third step aimed at distinguishing BSC-related KPIs based on the literature (Kaplan & Norton, 1993, Hasan & Chyi, 2017, Kaplan & McMillan, 2020, Rahayu et al., 2022) and conceptual development of a hierarchical structure for operationalization do AHP (Saaty, 2008, Gonçalves, 2016).

After identifying the weights of the KPIs obtained through the survey, the Expert Choice trial version software was used to operationalize the use of the AHP (fourth step). And, finally, the fifth stage carried out the investigation of strategies and perspectives, and consolidation of performance indicators through the weights obtained in the AHP for the elaboration of the strategic map.

V. RESULTS

In the initial sample of thirty-nine respondents previously selected through intentional sampling, 3 questionnaires were suppressed due to incomplete and missing information, and also to be considered outliers,

resulting in a total of 36 usable responses, which meet the interval $|z| < 3$, for a value of $p < 0.001$, thus, this sampling can be considered as valid (Gonçalves et al., 2020). The internal consistency of the data collection instrument, in general, was favorable with a Cronbach's alpha of 0.86, indicating - indirectly - good understanding on the part of the respondents (Acuña-Opazo et al., 2017).

Thus, to develop the strategic map based on the market realities of small companies in the technology segment that served as units of analysis, the five steps proposed in the methodological approach were developed. By compiling the survey results, it was possible to synthesize a general profile for the development of the necessary information to form the strategic map (first stage). In this way, in the second stage, different business strategies of the analysis units were identified (Table 3), such as the alternatives: lean; agile; postponement and Speculation as general solutions to the strategic objectives found, which also formed the support framework for the elaboration of this map. Continuing, considering the results of the previous steps in the third step, it was possible to obtain the proposed KPIs (Table 3).

From these results, the hierarchical structure used in the operationalization of the AHP was formed (Fig. 2), which was implemented in the Expert Choice software trial version (Gonçalves, 2016). In this way, considering the values assigned to the criteria (BSC perspectives), sub-criteria (KPI) and to the alternatives indicated by the companies' specialists (units of analysis), the data was modeled in this software (Doná et al., 2017).

In the fourth stage, compilations of peer judgments were performed based on the defined hierarchical structure (Fig. 2). Table 4 presents the weights assigned to each perspective, as well as the inconsistencies matrix linked to the comparison matrix. There was also a low degree of inconsistency, that is, a consistency index lower than the maximum specified ($CR < 0.1$) by Saaty (2008).

Table 3: Framework synthesis of the component elements of the BSC-AHP hybrid approach

Criteria	Subcriteria
Financial	Assets utilization customer; Revenue growth; Cost reduction.
Customer satisfaction	Customer satisfaction; Availability; Functionality.
Internal business	Operation optimization; Innovation process; Customer orientation.
Learning & growth	Employee capabilities; Organizational culture; IT capabilities.

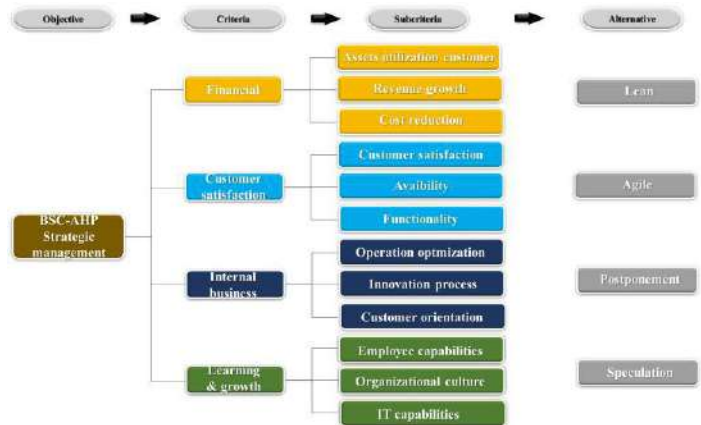


Fig. 2: Structuring the operationalization of the AHP

Table 4: Weights perspectives and inconsistency related to the comparison matrix

Criteria	Weights	Inconsistency
Financial	0.446	
Customer satisfaction	0.365	0.06
Internal business	0.131	
Learning & growth	0.058	

The global weight of each perspective and its contribution to the achievement of the general objective can be evidenced due to the low inconsistency observed (Table 4) and, therefore, an important indicative element for ordering the BSC. Regarding the perspectives of “Financial” and “Customer satisfaction”, these can be highlighted as fundamental in the preference of the respondents, something that corroborates the opinion of Moraes e Lima (2019) and Demuner et al. (2020), who emphasize as relevant the establishment of strategies that bring the company closer to the customers, with special attention to the relationship and final costs.

Learning & growth (0.058) can be seen as a criterion of less relevance when looking at the strategic horizon of small technology companies in the opinion of employees (Table 4). This is explained by Doná et al. (2017) that highlight the need to survive in a highly competitive and constantly changing market. On the other hand, Moraes Silva et al. (2020) predict that a continuous view of what happens to the company in its day-to-day is one of the determining factors of success in the segment of these companies.

KPIs related to different organizational levels (strategic, tactical and operational) and perspectives were identified in the survey. However, it is important to note that these KPIs must be cyclically reviewed and, along with that, strategic objectives and targets, in order to always be checking the company's market share and

positioning (Medne & Lapina, 2019, Rahayu et al., 2022). Sequentially, Table 5 shows the perspective weights for each relative KPI, plus each inconsistency related to each set of consistent responses.

Although there is diversity in the weights attributed to the perspectives, the results of the judgments that led to the knowledge of these weights, considering the fragment of small technology companies located in the State of Espírito Santo (Brazil), denote an understanding of what customers want. Another important evidence is the focus on basing the review of activities based on knowledge and on sharing information about customer needs.

Table 5: Subcriteria weights and inconsistencies

Criteria	Subcriteria	Weights	Inconsistency
Financial	Assets utilization	0.345	0.05
	customer Revenue growth	0.547	
	Cost reduction	0.109	

Customer satisfaction	Customer satisfaction	0.761	0.07
	Avaibility	0.166	
	Functionality	0.073	
Internal business	Operation optimization	0.229	0.07
	Innovation process	0.696	
	Customer orientation	0.075	
Learning & growth	Employee capabilities	0.205	0.02
	Organizational culture	0.078	
	IT capabilities	0.717	

And, finally, the fifth stage, also considering the survey carried out, investigated the relationships between existing strategic objectives between the perspectives of the BSC, in addition to the targets to be achieved, and the accomplishment of the KPI consolidation through the weights obtained in the AHP to the elaboration of the strategic map (Fig. 3).

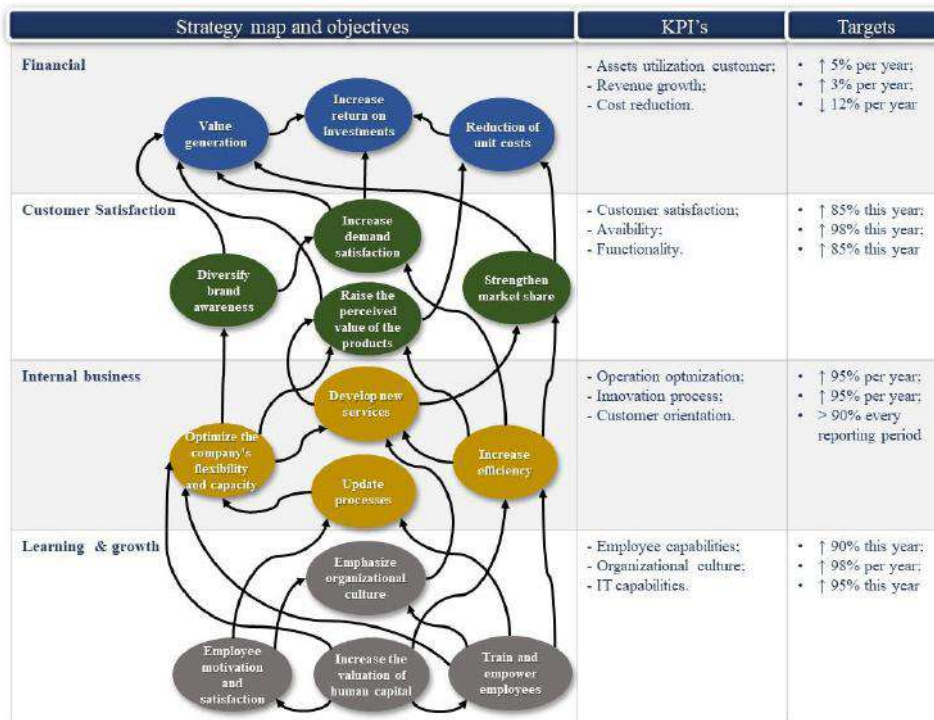


Fig. 3: Strategy map for small technology companies based on the BSC

The use of the hybrid approach BSC-AHP allowed to approximate the diversity of judgments in the hierarchical levels, being important to arrive at a more consensual and organizational opinion on the performance that could better represent the distinction of visions of the financial area, of customer relationship and of human resource Management.

VI. FINAL CONSIDERATIONS

The BSC-AHP integrated approach, as a decision-making tool presented in this article, proved to be efficient in dealing with problems of strategic management of small technology companies. The AHP added value to the process of choosing among several alternatives based on

multiple criteria and sub-criteria. For this reason, decision makers can perform simulations and sensitivity analysis on selection options and on criteria and sub-criteria to account for variations (changes) in paired comparisons and have a high degree of confidence in their judgment.

The strategic management and performance evaluation nowadays is a problem faced by the decision makers of small technology companies, mainly in the globalization era. In this way, the results of this work promote beneficial insights that contribute to prioritizing different perspectives of the BSC. Within this context, an approach is presented that extends the rational view to deciding which decision-level performance plays the most important role in overall performance measurement. At the same time, it also considers different BSC perspectives to sensibly prioritize them in the usual business operations.

We can assume that the future of BSC implementation and use will have no other form than the constant balance with other resources that help strategic management. Thus, in the process of applying the BSC, organizations will seek common sense and harmony between long term and short term, financial and non-financial, individual and organizational management, internal and external criteria, cause and effect, and effectiveness and justice, particularly in the sector of small technology companies. However, our concern is that the needs of customers have not reached the center of the BSC of these companies. Importantly, we do not underestimate the importance of the other perspectives, but argue that, especially for small tech companies, customer needs should be more central to the BSC.

For future research, an expansion of this work can develop such an approach with the help of different strategic approaches such as the SCOR® model (Supply Chain Operations Reference), SMART method, SWOT (Strengths, Weaknesses, Opportunities and Threats), etc., associated or used hybrid with resources that can allow a multi-criteria view such as AHP, Fuzzy Logic, FDA (Fuzzy Decision Approach), Fuzzy-AHP, ANP (Analytic Network Process), ELECTRE (Elimination et Choix Traduisant la Réalité), MACBETH (Measuring Attractiveness by a Categorical Based Evaluation Technique), PROMETHEE (Preference Ranking Method for Enrichment Evaluation), TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), etc.

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The green corn development and yield on different summer soil covering plants in the organic no-tillage system

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Abstract— The objective of this study was to evaluate the growth and yield of green corn cultivated under organic no-tillage system on different ground cover plants. The work was developed in the municipality of Domingos Martins, ES, Brazil (20° 22' 16.91"S and 41° 03' 41.83" W), being arranged in a randomized block design, with six replications and five production systems, consisting of: three soil covers in the organic no-tillage system - with sunn hemp, millet and sunn hemp/millet intercropping; and two systems without straw and with soil tillage - one organic and the other conventional. The double hybrid of corn AG 1051 was used, at a spacing of 1.00 x 0.20 m. Evaluations were carried out of stem diameter and plant height, at stages V5 (five developed leaves), V10 (10 developed leaves) and R3 (milky grains); ear yield with straw and without straw; average weight of 15 ears with straw and without straw; average length and diameter of ears without straw and the percentage of straw. For all agronomic characteristics evaluated, except for length and average diameter of ears without straw and the straw percentage, all the treatments studied were statistically superior to the conventional system treatment. The agronomic characteristic "yield" which is the most important among all evaluated, did not show statistical difference among all treatments under organic system. Therefore, both the organic system without straw and with soil tillage, and the organic systems with straw and without soil tillage using single sunn hemp, single millet and sunn hemp/millet intercropping are possible to be used with good corn yield.

I. INTRODUCTION

Due to its economic and social value corn is considered one of the most important crops worldwide. [1] In Brazil it is cultivated in all regions in monoculture, rotation, succession and intercropping, reaching a total production of 105,167.2

million tons in the 2019/20 harvest according to data from; [2] and with expected production between 121.4 to 182.7 million tons for the next decade. [3]

Although its production in grains is quite common green corn is an activity of high economic interest for the

producers as it presents continuous demand throughout the year and a high rate of income aggregation. Green corn is important for the national trade because it is typical of certain regions, being used in meals, mainly, in festive and cultural seasons in the preparation of derivatives, complements and human consumption. [4, 5, 6] Its cultivation takes place preferably on small and medium-sized properties [7] generating employment and income for the region where it is cultivated.

Corn has numerous uses among which in natura consumption stands out popularly known as “green corn point”, in which is also possible to prepare dishes such as the Brazilians “pamonha” and “curau”, cakes, ice cream, among others. [8, 9] According to the phenology of the corn plant the stage of development for green consumption is called “R3” or “milky grain”. [10]

Among the technologies used in maize cultivation, the no-tillage system (NTS) stands out. It is characterized by reducing production costs and improving soil quality, promoting higher yields without compromising the agroecosystem. [11]

This system has three basic assumptions: no soil disturbance, crop rotation and permanent soil covering with straw. [12] Among the advantages of the NTS stands out the protection of the soil against the direct impact of raindrops, the reduction of surface runoff and, consequently, increased water infiltration and availability for plants, and the reduction of soil loss and of nutrients by water erosion. [13] Associated with the input of organic residues and less soil disturbance there is an increase in content of organic matter in the soil which results in improvements in its physical, chemical and biological properties. [14]

However, the implementation of the NTS without the use of herbicides presents itself as a major challenge for research in organic agriculture. [15] An alternative would be the adoption of crop rotation with the use of green manure with Poaceae species and Fabaceae species which would produce a large amount of plant material to cover the soil. [16][17] and [18], mention that one of the factors that contributes to the effective success of the NTS are the crop rotations that provide a high addition of different types of crop residues to the soil, compensating for the rapid decomposition of straw in tropical climates, in order to maintain the protected soil surface for as long as possible and also increase the soil organic matter (SOM).

Among the species used in straw production Fabaceae stand out for fixing atmospheric N₂ and presenting a low C/N ratio (< 17.5) in their mass, which combined with the presence of soluble compounds and the reduced amount of lignin and polyphenols in their tissue, [19, 20] favors the rapid decomposition and mineralization of residues, with an

expressive contribution of N to the soil-plant system, but with a reduction of the essential ground cover for the NTS. [21, 22]

Grasses, in turn, characterized by a high C/N ratio (> 30) are more persistent in soils contributing for relatively high amounts of dry matter as they produce more aerial biomass and have an expressive root system, characteristics that improves the soil physical properties, on the other hand occurring frequent immobilization of N by decomposing microorganisms that use this nutrient contained in the soil in order to decompose the phytomass of grasses. [19, 23, 24]

[25] and [26] referring to the dynamics of N in the soil argue that the ideal would be a straw with an intermediate C/N ratio of the vegetable residue (17.5 to 30) in order to achieve a balance between the ground cover maintenance given by the persistence of plant remains, and the availability of N for subsequent crops. According to these same authors the intercropping of grasses with legumes in cropping systems promotes the above-mentioned ideal condition in addition to the greater distribution of roots at different depths in the soil.

In this context it is necessary to consider the importance of NTS in the success of organic green maize culture, reducing production costs, improving soil quality, promoting higher yields and less impact on the agroecosystem. However, there is a need for more in-depth studies in order to identify which are the best Poaceae species and Fabaceae species to be used for this purpose, for each specific agroecosystem. Thus, the objective of this work was to evaluate the development and productivity of green corn cultivated under NTS on different cover crops in the organic production system in the mountainous region of the state of Espírito Santo – Brazil.

II. MATERIAL AND METHODS

The work was conducted at the Agroecology Reference Unit (ARU) of INCAPER in Domingos Martins-ES, Brazil (20 ° 22 '16.91 "S and 41 ° 03' 41.83" W), at an altitude of 950 m. In this region average maximum temperatures in the warmer range between 26.7 and 27.8 °C and the average minimum temperatures in the cooler months range between 8.5 and 9.4°C. Annual average rainfall is 1,800 mm.

The entire ARU has been cultivated under organic management since 1990 with an area of 2.5 ha subdivided into 15 permanent fields where horticulture experiments are conducted. In the first ten years of research the focus was mainly on the generation of technologies for management of organic compound, of soils and of crops. From the 10th to the 20th year of the project the priority was researches about the planning of organic systems and the generation of

soil management technologies that were long-lasting considering the cumulative effects of several years of cultivation. [27]

The general organic management of soils of fields has been carried out through the recycling of biomass using crops rotation also grasses and legumes plants appropriate to supply cultural remaining to the soil; through the application of organic compound inoculated with poultry manure; and practices such as green manure, use of mulch, crop rotation, applications of biofertilizers via soil and leave and other which lead to recycling, mobilization and availability of nutrients. It is worth mentioning that fertilizations with organic compound have been carried out on the basis of 15 t ha⁻¹ (dry weight) for most crops resulting in an average annual contribution of 22.5 t ha⁻¹, considering the average of 1.5 cultivation of vegetables per year, per field. [27] These were the characteristics of the organic compound used in fertilizations from 2009 to 2011: N, P, K, Ca and Mg; 2.0, 1.2, 1.5, 6.0 and 0.6 dag. kg⁻¹, respectively; Zn, Fe, Mn, Cu and B: 223, 16.1, 804, 50 and 36 mg.dm⁻³; MO: 48 dag.kg⁻¹; and C/N: 13/1.

This research was conducted at the 05 field in 720 m² of area that is in NTS since 2009.

The field was divided into plots physically isolated by concrete slabs buried at 0.40 m depth where were conducted successive cultivations under summer and winter covering plants as well as intercropping between both. The evaluated species were cabbage on sunn hemp and maize; eggplant on white lupine and black oats; green corn on black oats and white lupine; cabbage on corn and sunn hemp; green corn over corn and sunn hemp; green maize again on white lupine and black oats because the previous field was lost by attack of capybaras; cabbage on white lupine and black oats; and lettuce on black oats, and white lupine.

The trial was conducted from September 2019 to March 2020. The chemical characterization of its soil was performed before its implementation at a depth of 0-20 cm and it is shown in TABLE 1.

Table. 1: Means of the chemical characteristics of the soil before the implementation of the trial

Attributes	G	L	G + L	OS	CS
pH H ₂ O	6.9	6.8	6.9	6.8	5.4
P (mg dm ⁻³)	870.9	975.8	1076.0	971.4	145.3
K (mg dm ⁻³)	623.0	445.4	463.0	387.0	197.0
Ca (cmol _c dm ⁻³)	13.2	13.4	14.2	14.6	5.5
Mg (cmol _c dm ⁻³)	3.4	3.5	3.7	3.4	0.8
Al (cmol _c dm ⁻³)	0.0	0.0	0.0	0.0	0.1

H+Al (cmol _c dm ⁻³)	1.7	1.7	1.7	1.6	4.5
SB (cmol _c dm ⁻³)	17.8	18.4	19.3	18.6	6.8
t (cmol _c dm ⁻³)	17.8	18.4	19.3	18.6	6.9
T (cmol _c dm ⁻³)	19.5	20.1	21.0	20.8	11.3
MO (dag kg ⁻¹)	5.1	5.4	5.5	5.1	3.6
Zn (mg dm ⁻³)	33.1	43.0	45.4	45.7	12.9
V(%)	91.2	91.3	92.0	92.3	60.3
Fe (mg dm ⁻³)	60.6	57.0	56.4	58.0	134.4
Mn (mg dm ⁻³)	96.6	102.5	104.7	102.0	82.7
Cu (mg dm ⁻³)	2.1	1.83	1.74	2.0	5.3
B (mg dm ⁻³)	0.6	0.4	0.5	0.6	0.3

CS– conventional system without straw; OS–organic system without straw; G– organic NTS with grass straw; L– organic NTS wit legume straw; G+L–organic NTS with grass + legume straws.

It was installed in a randomized block design, with six replications and five treatments, totaling 30 experimental plots with dimensions of 6.0 x 4.0 m, with a total area of 24.0 m² and a useful area of 16.0 m². The treatments consisted of three soil coverings in the organic NTS (G - organic NTS with grass straw; L - organic NTS with legume straw; G + L - organic NTS intercropping and two systems without covering and with tillage system, one organic and the other conventional (OS - organic system without straw; CS - conventional system without straw). For treatments under soil cover were used millet (*Pennisetum americanum*) as the grass specie, sunn hemp (*Crotalaria juncea*) as legume specie and the intercropping between both species.

The cover plants were sown on September 25, 2019 both in single and intercropped crops spaced 0.33 m between rows. The density of seeds in single crops was 29 grams per parcel for millet (12 kg ha⁻¹) and 91 grams per parcel for sunn hemp (38 kg ha⁻¹). Sowing densities and seed costs were reduced by half in intercropped crops due to planting in alternate rows.

Weeding was carried out between the lines of the cover plants at 18 days after the emergence of corn (DAE)and the irrigation according to observation of visual aspects of the cultures and previous practical experiences of ARU field employees.

The cover crops were mowed with a motorized backpack mower at 82 days after sowing. Samples of these plants were collected using a square measuring 1x1m on aside randomly placed in each experimental plot. Sub-samples were taken from these samples to quantify fresh weight and

dry weight. For drying the sub-samples was used an oven with forced air circulation at 65°C for a period of 10 days.

Planting fertilization was performed on the same date that the cover plants were mowed using organic compound at a dose of 17.89 tha^{-1} (dry matter) uniformly distributed by haul over all experimental plots in organic management. These were the characteristics of the compound: N, P, K, Ca and Mg; 2.8, 0.7, 5.0, 3.3 and 0.5 dag kg^{-1} , respectively; Zn, Fe, Mn, Cu and B: 151.4, 13014, 455.3, 45.3 and 9 mg.dm^{-3} ; C:O: 18.4 dag.kg^{-1} ; and C/N: 6.5. In the plots in conventional cultivation the planting fertilization for corn was carried out with 280 kg ha^{-1} of urea according to soil analysis and fertilization recommendation according to the Lime and Fertilization Recommendation System program. [28] There was no application of supplementary fertilization in coverage in the plots in organic cultivation in order to understand the effect of N from straw; nor in the plots in conventional cultivation so that there would be no competitive advantage from this treatment over others.

The suitable for consumption in the form of green maize the hybrid AG 1051 was sown on December 19, 2019 using a special for NTS manual seeder adopting a spacing of 1.00 m between lines and 0.20 m between plants with a density of four seeds per hole. Subsequently it was thinned to one plant per hole recommending a population of 50,000 plants ha^{-1} . A greater number of seeds were sown per hole to avoid failures in planting as the presence of birds that feed on seeds and newly emerged plants was found in the area.

Weeding was carried out between the lines of the plots in organic and conventional systems at 23 and 38 DAE corresponding to the V5 and V10 stages of corn according to observation of visual aspects of the culture and previous practical experiences of the URA field employees.

At 23, 38 and 79 DAE, respectively, at stages V5, V10 and R3 the following evaluations were carried out on ten plants randomly identified in the useful area of the plot: stem diameter and plant height from the ground until the insertion of the last leaf completely expanded. Treatment means were compared by Tukey test at 5% probability.

At stage R3, ninety ears per treatment were harvested and evaluated for ear weight with straw - EWS (kg ha^{-1}), ear weight without straw - EWNS (kg ha^{-1}), average ear weight of 15 ears with straw - AEWS (g), average ear weight of 15 ears without straw - AEWNS (g), average ear diameter - AED (mm), average ear length - AEL (cm) and percentage of straw - SP. The straw percentage data were transformed by the function $y = \arcsen [\sqrt{x/100}]$ being submitted together with the other characteristics evaluated to the analysis of variance and the means compared by the Tukey test at 5% probability.

In evaluating of the similarity between treatments a matrix with the means of the variables was created and subsequently, a dendrogram was constructed using the mean Euclidean distance to measure the distances between treatments and the method of hierarchical grouping of complete linkage. For statistical analysis, the R program [29] was used.

III. RESULTS AND DISCUSSION

3.1. Cover crop dry matter production

In the evaluation of green and dry matter yield of cover crop sit was observed that for green weight there was a statistical difference between the means of treatments, with treatment G + L being superior to treatment L, but not different from G. For dry weight, however, no differences were observed between the treatments studied (TABLE2).

Table.2: Means of the characteristics green weight and dry weight of cover crops.

Treatments	Green weight (kg. ha^{-1})	Dry weight (kg. ha^{-1})
L	31566.7 b	9417.3 a
G + L	50466.7 a	12372.6 a
G	42666.7 ab	11282.7 a
Mean	41566.7	11024.2
CV (%)	28.47	24.44

¹Means followed by the same letter vertically do not differ by Tukey test at 5% probability. G – Organic NTS with grass straw; L – Organic NTS with legume straw; G + L – Organic NTS with grass + legume straw.

[30] working with several species of cover crops, including single millet and sunn hemp, concluded that these species produce sufficient biomass for the formation and maintenance of a straw layer in the NTS and can be recommended for the NTS in that region.

In the same way although there are variations according to the form of distribution of the residue on the soil and its rate of decomposition, it is important to use cover crops that produce phytomass in good quantities and that have persistence on the soil, it is observed that the amount of residues generated in this work exceeds the generally recommended for the NTS which is at least 50% of the soil surface covered. [31,19,32]

3.2. Green corn development

Plant height associated with stalk diameter are important aspects for green maize crop yield since larger plants tend

to be more productive, probably because they accumulate greater amounts of reserves in the stalk. [33] The absorbed and photo assimilated nutrients produced during the vegetative phase will be used in the reproductive phase for grain filling, in addition to providing plants resistant to lodging and breakage. [34] In addition, taller maize plants will have competitive advantages over weeds, which will result in less mowing, reducing the system's production costs. [35]

In this study the agronomic trait plant height showed a significant difference in stages V10 and R3 (TABLE3 and 4). At stage V10, the NTS treatment with legume straw (L) had the highest average, followed by the organic system (OS), NTS with grass straw (G) and NTS treatments with intercropped straw (G+L), which had equal statistical averages among themselves and, lastly, the CS treatment (conventional system without straw) was observed, which presented the lowest average height among all treatments at this stage.

Table. 3: Means of plant height at stages V5, V10 and R3 of green corn.

Treat.	Plant height (cm)		
	V5	V10	R3
CS	16.90 a	59.15 b	219.05 b
OS	23.60 a	70.30 ab	243.50 a
G	22.82 a	64.98 ab	245.12 a
L	24.23 a	73.65 a	246.30 a
G + L	23.33 a	70.57 ab	247.00 a
Mean	110.03		
CV (%)	6.51		

¹Means followed by the same letter vertically do not differ by Tukey test at 5% probability. G – Organic NTS with grass straw; L – Organic NTS with legume straw; G + L – Organic NTS with grass + legume straw.

Table. 4: Means of stem diameter at stages V5, V10 and R3.

Treatments	Diameter (mm)		
	V5	V10	R3
CS	12.41 c	24.18 a	21.75 c
OS	17.15 a	26.42 a	25.83 a
G	14.90 ab	25.85 a	24.28 ab

L	14.68 bc	24.30 a	23.47 bc
G + L	16.63 ab	24.67 a	24.47 ab
Mean	21.40		
CV (%)	6.57		

¹Means followed by the same letter vertically do not differ by Tukey test at 5% probability. G – Organic NTS with grass straw; L – Organic NTS with legume straw; G + L – Organic NTS with grass + legume straw.

It is known that the use of leguminous species as cover crops provides a contribution of atmospheric N to the system via symbiotic fixation, [36,37] reducing the C/N ratio and increasing the rate decomposition of the straw which provides a faster release of nutrients, with emphasis on the N. [21,22] This may explain the fact that treatment L, corresponding to sunn hemp in single cultivation showed the highest average.[33] and [38], comparing predecessor crops and N doses observed greater plant height, greater ear insertion height and greater grain yield, when corn was sown after the hairy vetch and sunn hemp (Fabaceae). However, when sown after black oat and millet (Poaceae) the results obtained were inferior which proves, then, the benefit of using Fabaceous as cover crops.

At stage R3 for this same trait, all treatments were statistically superior to CS treatment.

As for the characteristic stem diameter there were significant differences in stages V5 and R3 (TABLE 4), and in both stages it is observed that the highest means were obtained, in descending order, in the OS, G and G+L treatment, followed by L and, finally, in CS treatment.

For the CS treatment, the means lower than the others, observed both for plant height and stem diameter (TABLE 3 and 4) in the various stages mentioned, can be explained by the following factors: i) the N offered at planting, in the dose of 128.8 Kg ha⁻¹, comes from urea, a highly volatile N source; ii) as it has been under conventional management since 2009, all the benefits of the application of organic compost and the use of NTS were not observed in this treatment, resulting in lower levels of soil organic matter (SOM) and nutrients in general, as can be seen in TABLE 1; iii) in physical destructuring and oxidation of the SOM due to continuous soil disturbance; iv) in lower soil biological conditions; v) low moisture retention and; vi) greater probability of erosion occurrence. [39, 40, 41]

Otherwise in the case of the OS treatment, which had the highest average stalk diameter at stages V5 and R3, soil tillage may have increased the rate of SOM mineralization, with consequent release of N, which probably favored the green maize growth. According to [42] the SOM decomposition rate in a conventional preparation system is practically twice as high when compared to NTS. It is

important to emphasize this treatment is also included in those that use NTS since 2009, as other experiments are implemented, and therefore it presents a high rate of initial SOM, in the same way as the treatments under NTS in this work.

[43] and [44] evaluating the effect of velvet bean, pigeon pea, styling and jack bean cover crops; black oat, white lupine and black oat/white lupine intercropping, used as green manures and cover crops, concluded that stalk diameter is influenced by green manure and that the use of jack beans and lupine -white in monoculture and intercropped with black oat provided greater diameter of the corn stalk.

3.2. Green corn yield

According to [45] the average Brazilian productivity of ears without straw is between 9,000 and 15,000 Kg ha⁻¹, which indicates that the values verified in this work (TABLE5), which ranged from 10,656.67 Kg ha⁻¹, for the treatment CS, at 13,093.33 Kg ha⁻¹, for treatment G, are within expectations.

It is also observed in TABLE 5 that there was no statistical difference between the treatments for all the production components evaluated (EWS, EWNS, AEWS and AEWNS), except for the CS treatment which showed the lowest mean with statistical difference for the others treatments.

However, it is important to note despite the above about the statistical analysis of the data it is noted that there was an important difference in productivity and average weight of ears without straw among the studied treatments: G had the highest average productivity of ears without straw (EWNS) totaling 13,093.33 kg ha⁻¹, which meant 2,436.66 kg ha⁻¹ more ears produced compared to CS treatment. In addition, the average weight of 15 ears without straw (AEWNS) for treatment G showed ears weighing an average of 261.87 g., while for treatment CS, ears weighed an average of 213.13 g.

Table. 5: Means of ear yield characteristics - EWS (kg ha⁻¹), EWNS (kg ha⁻¹), AEWS (g) and AEWNS (g).

Treat.	EWS	EWNS	AEWS	AEWNS
CS	13946.67 b	10656.67 b	4184.00 b	3197.00 b
OS	17977.78 a	12538.33 a	5393.33 a	3761.50 a
G	19298.89 a	13093.33 a	5789.67 a	3928.00 a
L	17642.78 a	12388.33 a	5292.83 a	3716.50 a
G + L	18537.78 a	12161.67 a	5561.33 a	3648.50 a

Mean	17480.78	12167.67	5244.23	3650.30
CV (%)	8.23	5.25	8.23	5.25

¹Means followed by the same letter vertically do not differ by Tukey test at 5% probability. G – Organic NTS with grass straw; L – Organic NTS with legume straw; G + L – Organic NTS with grass + legume straw.

Works referring to the direct planting of corn on winter and summer cover plant species show as a result that the use of a Poaceae species alone as a cover plant and depending on the size of its fragments on the soil, leads to reduced productivity because due to its high C/N ratio, there is a decrease in the availability of N in the soil caused by microbial immobilization during the process of plant decomposition. Therefore, it is recommended to use Fabaceae in intercropping with Poaceae in order to increase the availability of N in the system, which will result in increased corn grain yield. [46, 47, 26, 38, 48]

This possible immobilization of N from the soil, however, did not occur in the present work for the Poaceae straw treatment referring to the use of millet in single organic cultivation under NTS. This can be attributed to the high content of pre-existing SOM [28] due to the NTS being used in the area since 2009 and also due to the history of organic soil management in the area, where there is, according to [27], a 77% increase in SOM in 20 years. Therefore, even though the N in the residue was immobilized by microorganisms this did not result in a visual deficiency of this nutrient in the plant nor in a reduction in green corn productivity.

It should be noted that the lowest mean for all productivity components was found for the CS treatment and this can be explained by the same reasons mentioned above in relation to the lowest mean plant height and stem diameter (TABLE6) also obtained for this treatment.

For the values of both diameter, average length of ears and percentage of straw, it is noted in TABLE6 that there was no significant difference between treatments.

Table. 6- Means of the characteristics mean ear diameter – AED (mm), average ear length – AEL (cm) and percentage of straw (PS).

Treatments	AED	AEL	PS
CS	41,88 a	22,75 a	23,47 a
OS	48,13 a	19,57 a	30,05 a
G	48,93 a	19,84 a	31,85 a
L	48,33 a	19,28 a	28,31 a

G + L	48,03 a	19,31 a	33,89 a
Mean	47,06	20,15	29,51
CV (%)	10,89	26,14	12,39

¹Means followed by the same letter vertically do not differ by Tukey test at 5% probability. G – Organic NTS with grass straw; L – Organic NTS with legume straw; G + L – Organic NTS with grass + legume straw.

According to [49] and [50] ear diameter is directly linked to grain filling and number of grain rows per ear and, together with ear length, are some of the characteristics that determine the yield potential of the crop. of corn.

In opposition to the result above (TABLE 6), [51] and [52] working on the conventional NTS found that green manure significantly influenced the diameter and length of ears, which can be explained by the general condition of the soil always cultivated under the conventional system being considered inferior to that of the soil cultivated over years under agroecological practices [27] which results in a more evident response of the commercial crop in relation to green manure in the conventional management system.

A multivariate analysis was carried out using a dendrogram to observe the groups of treatments regarding production characteristics. Fig. 1 shows the graphical distribution of the five treatments studied. It is observed that the dendrogram in Fig. 1 suggests the existence of two homogeneous groups: group A formed by the CS treatment and group B, formed by the other treatments. These results confirm those seen in TABLE5, in which higher yields were observed in the OS, G, L and G+L treatments when compared to the CS treatment.

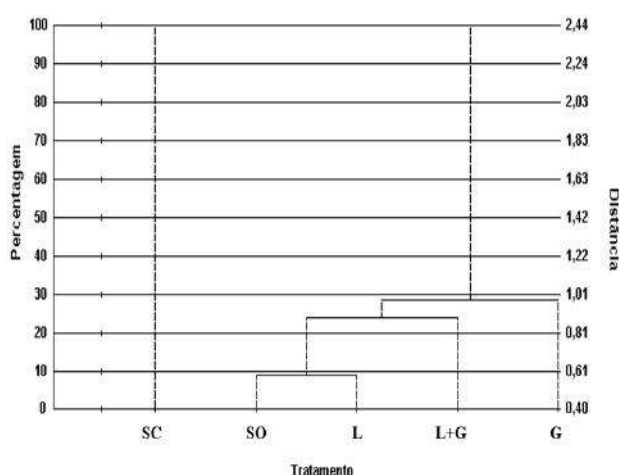


Fig. 5: Distribution of clusters with five treatments in relation to green corn production characteristics

IV. CONCLUSION

For all agronomic characteristics evaluated in this work, except for length and average ear diameter and percentage of straw, the organic treatments with or without cover crops were statistically superior to the conventional system treatment (CS);

There were statistical differences for the variable plant height at stage V10 and stem diameter at stages V5 and R3 among treatments under organic system with and without straw;

The characteristic “productivity”, which is the most important among all those evaluated, did not show any statistical difference among all treatments under organic system; and

Due to the fact that the area of implementation of this experiment has been under organic management for 31 years, there were positive changes in several soil properties over time resulting in an absence of response from organic systems with plants of cover in relation to the organic system without cover plant. Thus, it is concluded that these two types of systems mentioned, using single sunn hemp, single millet or intercropping sunn hemp/millet, are possible to be used in the conditions tested in this work, with high straw production and good corn yield.

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The Influence of Bullying and Malocclusion on the Quality of Life of Adolescents

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**Keyword— Bullying, Adolescent;
Orthodontics, Malocclusion, Quality of
Life.**

Abstract— Objective: To evaluate the association of bullying and malocclusion with the quality of life of adolescents and their families. **Methods:** 93 young people with an average age of 13.7 years participated in this research which, at the beginning of orthodontic treatment, presented some type of malocclusion that compromised facial aesthetics. The classification of malocclusion was performed by analyzing the initial orthodontic documentation. The impact of malocclusion on quality of life was measured by self-administered questionnaires CPQ (Child Perceptions Questionnaire) and PPQ (Parental Perceptions Questionnaire) which contained questions grouped into 4 domains: oral symptoms, functional limitations, emotional well-being and social well-being. The Kidscape questionnaire was applied to assess the occurrence of bullying. The statistical analysis of the data obtained was by means of summary measures, using the Spearman coefficient and the Kruskal-Wallis tests or Fisher's exact test. The level of significance adopted was 5%. **Results:** The occurrence of bullying related to malocclusion was observed in 44 young people interviewed, and in 86.36% of these adolescents, the phenomenon happened before orthodontic treatment and had negative consequences on quality of life, especially in the related item of emotional and social well-being. The malocclusions that most related to Bullying were in Class II descending order, followed by Class III and finally the deep overbite. **Conclusions:** There was an association between the occurrence of bullying, the type of malocclusion and an improvement considered in the quality of life of adolescents after beginning orthodontic treatment.

I. INTRODUCTION

Adolescence is considered to be a special phase of human development characterized by physical, psychological and emotional changes, which can have an impact not only on the young person in question, but also on his family and social life ^{1,2}.

During the transition from adolescence to adulthood, some factors may represent obstacles to the

construction of self-esteem and psychosocial development of young people, which will serve as a foundation for a healthy adult life ^{1,3}.

In this scenario, bullying can be considered a threatening obstacle ^{1,4}. Intentional character, not caused by the victim, bullying is a type of violence characterized by an aggressive, repetitive behavioral disorder, which aims to cause some physical or moral damage to someone

who is weaker or unable to defend him/herself. The victim of this type of violence suffers threat, exclusion, discrimination and, in more extreme cases, physical aggression^{4,5}.

Considering that the discrepant physical stereotype in relation to the aesthetic standards of beauty advocated by society is one of the motivations for the occurrence of *bullying*^{6,7}, added to the fact that malocclusion has a great impact on facial aesthetics⁸⁻¹⁰, therefore, it is important to verify the impact of malocclusion on the occurrence of *bullying*. In addition, considering that orthodontic treatment aims to correct malocclusion and consequently facial aesthetics, this study aims to assess the association of *bullying* with malocclusion and the impact of orthodontic treatment on the quality of life of adolescents.

II. MATERIAL AND METHODS

This retrospective longitudinal study was approved by the Ethics in Research Committee of the University City of São Paulo (UNICID) under protocol number 2.135.906. 200 Brazilian adolescents participated in this research, with ages varying from 10 to 18 years old, accompanied by their respective guardians, with malocclusion with impaired facial aesthetics. Of this total, 93 young people were selected, with an average age of 13.7 years, who were undergoing treatment at the Orthodontics Clinic of UNICID and who met the following inclusion criteria: I) patients who contained orthodontic documentation complete; II) who had Class II, Class III malocclusions, open bite, diastema or severe overbite; III) individuals who showed visible improvement in the context of malocclusion during treatment or after completion of treatment. This study excluded patients who did not remember the initial situation related to their malocclusion, prior to orthodontic treatment and those whose parents or guardians did not authorize their participation in this study.

The description of the malocclusion was obtained by analyzing the initial orthodontic documentation of these patients. The severity of the anomaly was characterized by the number of missing teeth in each arch, the degree of crowding, the presence or absence of diastemas and the detection of pronounced horizontal or vertical overlapping.

The questionnaires were, before their application in this research, audited by two professionals in the field of Psychology, with experience in behavioral assessment of children and adolescents who assessed whether the language used was in accordance with the chosen age group, thus facilitating their understanding.

To assess the impact of oral health on adolescents' quality of life, the *Child Oral Health Quality of Life Instrument* (COHQOL) questionnaire was used in this research^{5,7,10-13}. The questionnaire was subdivided into: *Parental Perceptions Questionnaire* (PPQ), *Family Impact Scale* (FIS) and *Child Perceptions Questionnaire* (CPQ)^{11,12,14}.

The CPQ⁽¹¹⁻¹⁴⁾ questionnaire consisted of 37 items, grouped into 4 domains: oral symptoms (n = 6), functional limitations (n = 9), emotional well-being (n = 9) and social well-being (n = 13), however, to facilitate research, the number of questions was reduced to 16, divided into the four domains. The frequency of events that occurred on teeth, lips, jaws and mouth in the last 3 months was evaluated. Each of the CPQ domains can vary from 0 to 16, and the higher the score, the worse the quality of life. The total domain can range from 0 to 64.

Regarding the oral health of adolescents and their degree of commitment to their well-being, this questionnaire presents the following statement: "Would you say that the health of your teeth, lips, jaws and mouth is ..." and "How far does the condition of your teeth, lips, jaws and mouth affect your life in general?" (Supplementary file - questionnaire).

The *Parental Perceptions Questionnaire* - PPQ questionnaire applied to parents / guardians evaluated the effects of orthodontic treatments on the well-being and quality of life of adolescents. The domains that characterize oral symptoms and functional limitations can range from 0 to 28, emotional well-being from 0 to 32, social well-being from 0 to 44 and total from 0 to 140. The higher the score, the higher the impact on family members' quality of life.

The *Family Impact Scale* - FIS questionnaire evaluated the effects of oral conditions on the well-being and daily lives of adolescents and their families, the domains that represent family activities. In this case, ranging from 0 to 20 points, the domains of emotions and conflicts from 0 to 16 and the question regarding financial difficulty will be evaluated.

The *Kidscape* questionnaire^{5,15} was used to assess the occurrence of bullying among adolescents. In this case, the aspects related to the frequency with which the adolescent suffered bullying, its consequences, the type of intimidation suffered, the sex of the perpetrator and whether the victim of the assault was also a perpetrator of bullying were considered.

All research participants were verbally instructed on how to answer the questionnaire and were instructed to sign the Informed Consent and Informed Consent Form (ICF), as well as their rights and the possibility to interrupt

their participation in the study at any time, without any type of consent. Penalty, since participation was voluntary. It was also informed about the confidentiality of the information obtained and informed that the only personal data to be collected would be age and gender. The questionnaires were applied in the presence of the researcher, in a quiet and reserved environment, without imposing a time limit, with pauses allowed to resolve any existing doubts when filling out the answers.

After exploratory data analysis using summary measures, the results were processed by the statistical program The SAS System for Windows (Statistical Analysis System), version 9.4. SAS Institute Inc, Cary, NC, USA. The variables were tested sequentially, considering the significance level of 5%. The correlation between the responses of adolescents and guardians was assessed using Spearman's Coefficient. The comparison between types of malocclusion was performed using the Kruskal-Wallis or Fisher's exact tests ¹⁶.

III. RESULTS

93 teenagers participated in this study (58.06% female and 41.94 male), accompanied by their respective guardians (56.52% mother, 27.17% father, 9.78% brother or sister and 6.52% grandfather or grandmother). The age varied between 11 and 14 years old.

Comparing the results obtained through the CPQ^(11,14) and PPQ questionnaires, there was a difference between the opinions of adolescents who consider their oral health relatively good (80%), and that of their guardians who classified it as regular (41%) (Figure 1a).

In relation to quality of life (Figure 1b), the responses of adolescents and guardians were equivalent in 60% of the sample, with agreement by both parties when they state that the quality of life of these young people is moderately affected by oral health. However, there was a report from a small portion of these adolescents who reported that their quality of life is not affected by their oral health, and none of those responsible indicated this alternative.

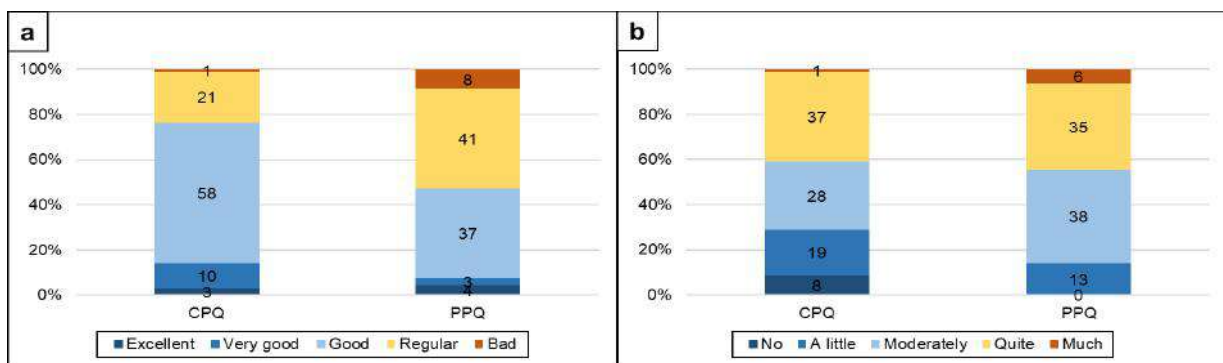


Fig.1: a) Distribution of responses on oral health; b) Distribution of responses on quality of life.

Analyzing the responses of the CPQ^(11,14), it can be concluded that most of the interviewed adolescents reported discomfort related to oral symptoms and also some type of functional limitation, due to the presence of malocclusion (Figures 2). As noted, the most highlighted problems were pain and difficulties in eating and speaking.

It can be concluded that most of the interviewed adolescents reported discomfort related to oral symptoms and also some type of functional limitation, due to the presence of malocclusion (Figures 2a and 2b). As noted, the most highlighted problems were pain and difficulties in eating and speaking.

Analyzing the responses of the CPQ^(11,14), it can

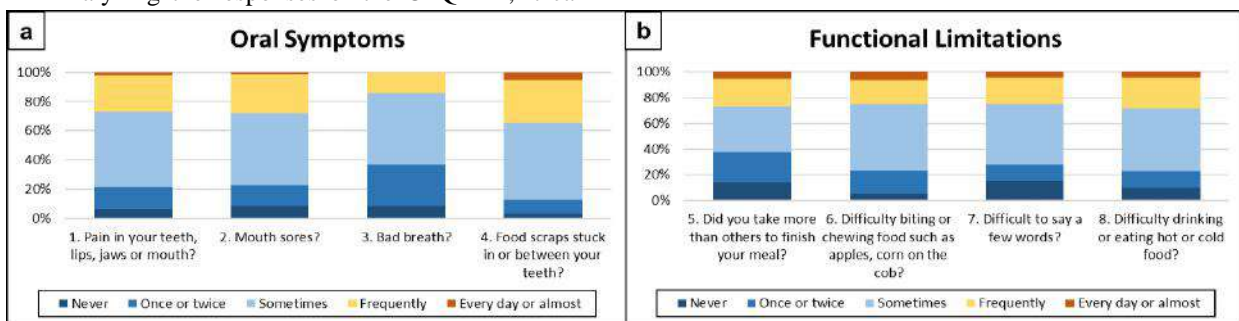


Fig.2: a) Distribution of responses that form the oral symptom domain; b) Distribution of responses that form the functional limitations domain.

It is noted that there is a moderate positive relationship between the responses of patients and guardians for domains related to oral symptoms, functional limitations, emotional and total well-being. For social well-being, there was no significant correlation between the responses of parents and adolescents ($p>0.05$). The number of observations in this analysis varies between domains because only the pairs (adolescents, guardians) who answered all the questions that form the respective domain are considered. An analogy was observed between the responses of adolescents and guardians.

Taking into account the quality of life of family members of adolescents with oral pathologies, it can be seen that these problems interfered with the family's daily life. According to the answers obtained in the FIS questionnaire, the great majority of the guardians reported that they had to leave their work for some reason related to oral health and also problems related to the emotional need

of these young people, who showed jealousy and discussions in the family environment. They also reported concerns related to the reduction of opportunities that these adolescents could have in life due to these malocclusions. There were reports of financial difficulties from these families due to the presence of malocclusion in the patients interviewed (Figure 3).

The results obtained from the Kidscape questionnaire indicate that 47.31% of the participants have already suffered some type of bullying, with 86.36% of the adolescents reporting harassment before orthodontic treatment and 79.55% of the participants consider the consequences to be bad, half of which (50%) the frequency of bullying happened several times. Regarding the type of aggressor, 50% left girls and 88.64% suffered so-called verbal bullying. Among the adolescents studied, 19.51% stated that they had already practiced some type of bullying (Table 1).

Table 1 – Kidscape questionnaire (bullying)

Question	Category	N	%
Have you ever suffered any kind of intimidation, aggression or harassment?	Yes	44	47,31
	No	49	52,69
If so, was it before or after you started your orthodontic treatment?	Before	38	86,36
	After	6	13,64
What were the consequences of the intimidation, aggression or harassment suffered by you?	It had no consequences	5	11,36
	Some badconsequences	35	79,55
	Terrible consequences	4	9,09
How many times have you suffered bullying, aggression or harassment?	Made you change school	0	0,00
	Once	9	20,45
	Almost every day	13	29,55
Who bullied, assaulted or harassed you?	Several times	22	50,00
	Many times a day	0	0,00
	Boy	14	31,82
What kind of intimidation, aggression or harassment did you suffer?	Girl	22	50,00
	Boy and girl	8	18,18
Have you ever bullied, assaulted or harassed someone?	Physical	4	9,09
	Verbal	39	88,64
	Sexual	0	0,00
	Emotional	0	0,00
Have you ever bullied, assaulted or harassed someone?	Racist	1	2,27
	Yes	16	19,51
	No	66	80,49

Making a comparison between the adolescents who have already suffered bullying and the types of malocclusion involved in this study, we notice a statistical difference in the proportions ($p < 0.0001$). In the question "Have you ever suffered any kind of intimidation, aggression or harassment?", It was found that 71.74% for Class II and 71.43% for Diastemas did not suffer any type of harassment. However, 56.25% for Class III, 100% for patients with vertical overlap such as anterior open bite (AOB) and 63.64% for Overbite suffered some type of

intimidation, aggression or harassment.

Regarding the practice of bullying, significant differences were found between the groups of malocclusion ($p = 0.0003$). The group that most practiced bullying was the overbite one (63.64%), followed by diastema groups (33.33%), Class III (26.67) and then Class II (7.89%). Of the interviewees, none stated that they intimidated, assaulted or harassed someone due to the previous open bite (AOB).

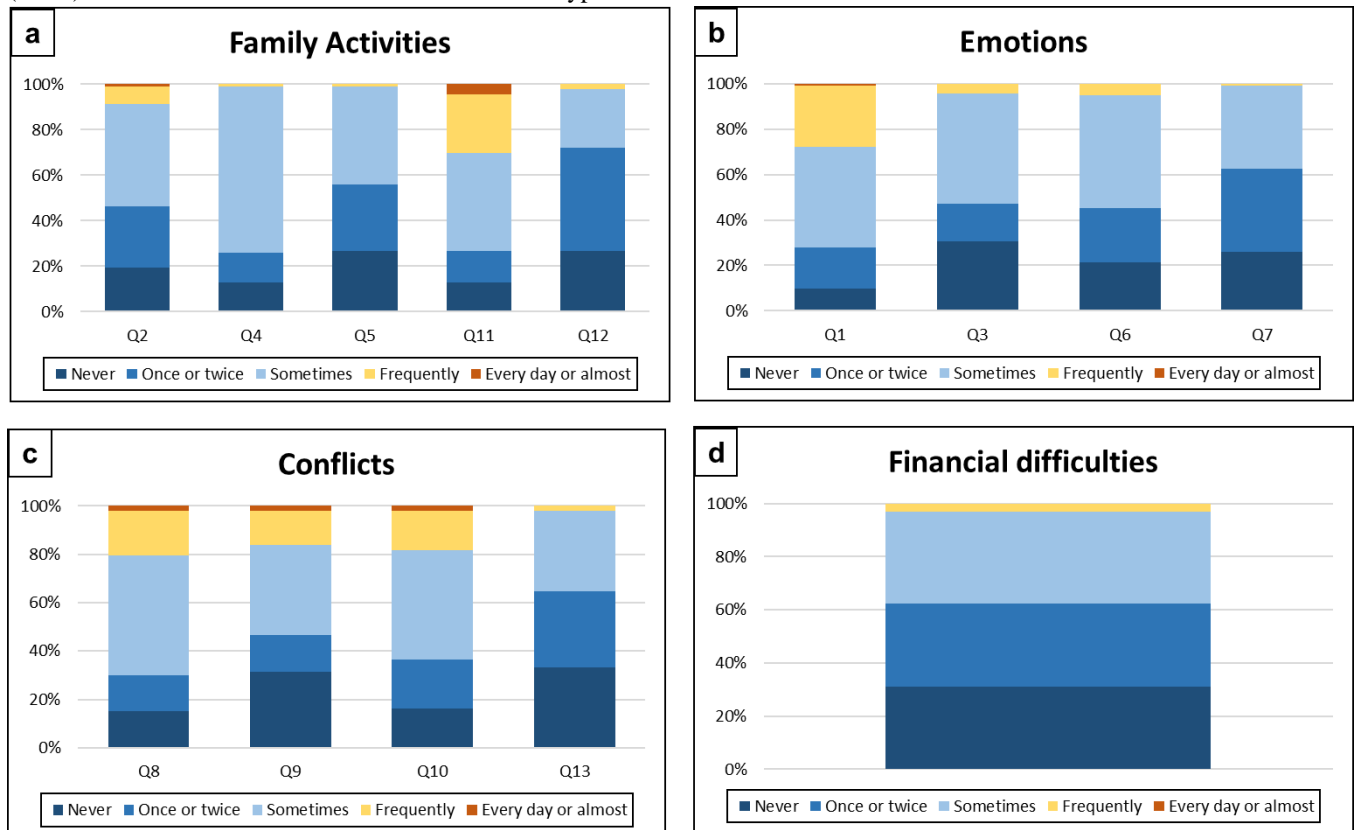


Fig. 3: a) Distribution of responses that form the family activities: Q2) Has your sleep been interrupted?; Q4) Did you have to leave work for any reason related to your child's oral health (eg pain, consultation with the dentist, surgery)?; Q5) Had less time for you or your family; Q11) Did it require more attention from you or other family members?; Q1) Did it interfere with family activities at home or elsewhere?; b) Distribution of responses that form the domain of emotions: Q1) Were you upset?; Q3) Did you feel guilty?; Q6) Were you concerned about the possibility of your child having fewer opportunities in life (for example, to date, marry, have children, get a job that she likes)?; Q7) Did you feel uncomfortable in public places (eg stores, restaurants, parties) with your child?; c) Distribution of responses that make up the conflict domain: Q8) Were you jealous of yourself or other family members?; Q9) Did you blame yourself or another family member?; Q10) Did you argue with yourself or other family members?; Q13) Did it cause disagreement or conflict in your family?; d) Distribution of answers to the question about financial difficulties.

IV. DISCUSSION

The negative impact of malocclusion on adolescents' quality of life is related to the harmful consequences that interfere with their psychological, physical and social well-being¹⁷. Consequently, they can cause aesthetic problems that, in turn, can be related to episodes of bullying, directly affecting self-esteem and the quality of life of young

people. Taking this fact into account, it can be said that malocclusion affects the individual both physically and psychologically and socially¹⁸.

The methodology used in this study was based on the work carried out by Canadian researchers¹⁹, that developed the *Child Perceptions Questionnaire*, which consists of a group of questionnaires with specific versions

for each age group *Child Perceptions Questionnaire* – CPQ_(8–10) for children from 8 to 10 years old²⁰ and the *Child Perceptions Questionnaire* – CPQ^(11–14) for the age of 11 to 14 years old²¹. According to the aforementioned authors, these instruments are adapted to concepts related to child health and can be applied at different stages of development and also in different oral conditions.

The cultural difference between countries can influence the validity and reliability of the data obtained by applying the questionnaires²². Given this fact, we chose to use the *Child Perceptions Questionnaire* – CPQ_(11–14) model translated²³ and culturally adapted into Portuguese in this research²⁴.

It is justified to use this instrument to assess the quality of life of the adolescents involved in this research, since CPQ^(11–14) assesses the consequences generated by children's oral problems, which occurred in the last three months prior to its application. This questionnaire is divided into four domains: oral symptoms, functional limitations, emotional well-being and social well-being, in addition to two questions that address the perception of oral health and general well-being.

The sample of this research was composed of 93 adolescents, with ages varying from 11 to 14 years old, accompanied by their parents and those with Class II, Class III malocclusion, anterior open bite, overbite and diastema. Fernandes et al.²⁵ evaluated school children aged 11 to 14 years old and found a significant correlation between the impact on quality of life and the need for orthodontic treatment, showing an expressive relationship with functional limitation ($p = 0.02$), emotional well-being ($p = 0.05$) and the social ($p = 0.03$). The authors concluded that the need for orthodontic treatment and the negative impact on the quality of life of these individuals indicate the possibility of interceptive orthodontic treatments in childhood, thus reducing the problems reported by young people and reducing the impact of these malocclusions on quality of life.

Most of the time, the criticisms arising from some aspect of the health or appearance of these adolescents negatively influence their self-esteem, becoming a predisposing factor to suffer and practice bullying^{5,17}.

The results showed that 47.31% of the adolescents suffered from *bullying*, a rate considered high. Most adolescents with malocclusion suffered from this harassment before orthodontic treatment and have also practiced this aggression as a form of self-protection, as found in the literature^{17,18,26,27}. In this context, there is a combination of low self-esteem, provocative aggression and probable psychological change. Adolescents who

suffer from this type of problem deserve special attention, as the act of humiliation comes from the need to cover up some type of limitation of the aggressor/victim. Generally, these adolescents are unpopular with the group, are rejected by their colleagues and the vast majority have behavioral problems, psychosomatic and psychological symptoms and referral to psychiatric treatment is highly recommended^{4,5}.

Of the 44 young people who declared themselves victims of bullying, most of them claimed to have suffered the aggression several times, characterizing the phenomenon by its repetition, as found in the literature^{4,5,18}. As a consequence of these acts, 79.55% of the harassed ones classified as bad and reported that the most common intimidation was verbal, which may include practices that consist in insulting and attributing vexing or humiliating nicknames to the victims, damaging their self-esteem, and may trigger behavioral and emotional disorders, as well as antisocial behaviors, such as: aggressiveness and violence, suicidal thoughts, smoking, and low school performance^{4,5}.

For the assessment of quality of life, the scores were considered equal to 0 (has no impact) and ≥ 1 (has an impact). It was observed that most students reported an impact on quality of life, and functional limitations were the ones that had the most negative impact, followed by the domain of oral conditions, influencing the emotional well-being of these adolescents, since the majority were upset, irritated due to their oral health, also interfering in their social interaction. This result was also found in the study by Seehraet *al.*²⁸ that proved that the presence of malocclusion has a great psychosocial impact. Another study by Marshman, Gibson and Benson²⁹, in the United Kingdom, which also demonstrated the impact of malocclusion on quality of life, mainly in the domains of emotional and social well-being. In view of these findings, it can be suggested that this impact on quality of life related to emotional and social well-being is linked to the fact that malocclusion, from the patient's point of view, harms his aesthetics more than his function.

The final score for the CPQ ranged from 0 to 44. This data is in agreement with other studies²⁰, in which the score also varied from 0 to 40 points.

The results obtained demonstrated the importance of orthodontic treatment of malocclusions that compromise facial aesthetics. The literature also emphasizes the influence of orthodontic treatment on the quality of life of adolescents through a considerable improvement in their standard of living after orthodontic treatment, especially in the emotional fields and in the social relationship of these individuals^{17,18,30}. The results of this research are

compatible with this fact, since significant changes were also observed in the daily lives of young people and their families involved in this study.

In fact, it is important to know the impact of malocclusion on the quality of life of adolescents and their families in order to develop new strategies and campaigns to treat these problems. These measures, in addition to solving or minimizing oral problems, also restore the quality of life of young people, providing them with a development of daily activities such as eating or speaking better, in addition to healthy emotional and social development^{7,17,18}.

V. CONCLUSION

This work has shown that there is evidence that orthodontic treatment during adolescence improves the quality of life of these young people and their families, especially in their emotional and social well-being. Thus, it is necessary to develop instruments that help health professionals to diagnose not only oral disease, but also the quality of life of these patients. It is concluded that there was an association between the occurrence of bullying, the type of malocclusion and the improvement considered in the quality of life of adolescents through orthodontic treatment.

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Supplementary file – questionnaire



Bullying Questionnaire (Simplified)

1) Have you ever suffered any kind of intimidation, aggression or harassment?

Yes No

2) If yes, it was before or after you started your orthodontic treatment?

Before After

3) What were the consequences of the intimidation, aggression or harassment suffered by you?

It had no consequences Some bad consequences

Terrible consequences Made you change schools

4) How many times have you been bullied, assaulted or harassed?

Once time Almost everyday

Several times Many times a day

5) Who are you intimidated, assaulted or harassed?

Boy Girl Boy and Girl

6) What kind of intimidation, aggression or harassment did you suffer?

Physical Verbal Sexual Emotional Racist

7) Have you ever intimidated, assaulted or harassed someone?

Yes No

8) What do you think could have been done to solve this problem?

THANK YOU FOR HELPING US !!!!!

Annex E – CPQ Questionnaire – Quality of Life Assessment**Quality of life impact assessment questionnaire (CPQ)**

This research is being developed to better understand the problems caused by your teeth, mouth, lips and jaws. By answering these questions, you will be helping us to learn more about the experiences that teenagers have about these problems.

Please, REMEMBER:

- a) Do not write your name on the questionnaire;
- b) Answer sincerely what you can. Do not discuss anything with anyone about the questions while you are answering them. Your answers are confidential, no one will see them;
- c) Read each question carefully and think about your past experiences when you answer them;
- d) Place an (X) in the answer space that best matches your experience.

SOME QUESTIONS ABOUT YOU:

Male

Feminine

Date of birth: ____/____/____

How would you rate the health of your teeth, lips, jaws and mouth?

Great Very good Good Regular Bad

Does the condition of your teeth, lips, jaws and mouths affect your overall quality of life?

No A little Moderately A lot Very much

QUESTIONS ABOUT YOUR ORAL PROBLEMS

In the last 3 (three) months, how often have you had?

1. Pain in your teeth, lips, jaws or mouth?

Never Once or twice Sometimes Often
 Every day or almost every day

2. Mouth sores?

Never Once or twice Sometimes Often
 Every day or almost every day

3. Badbreath?

Never Once or twice Sometimes Often
 Every day or almost every day

4. Food scraps stuck in or between your teeth?

Never Once or twice Sometimes Often
 Every day or almost every day

For the following questions, answer whether this happened because of your teeth, lips, jaws and mouth:

In the last 3 (three) months

5. Did it take longer than the others to finish your meal?

- Never Once or twice Sometimes Often
 Every day or almost every day

In the last 3 (three) months, because of your teeth, lips, mouths and jaws, how often have you had:

6. Difficulty biting or chewing foods like apples, corn on the cob?

- Never Once or twice Sometimes Often
 Every day or almost every day

7. Difficult to say a few words?

- Never Once or twice Sometimes Often
 Every day or almost every day

8. Difficulty drinking or eating hot or cold food?

- Never Once or twice Sometimes Often
 Every day or almost every day

Questions about your feelings and / or sensations: Have you ever experienced this feeling because of your teeth, lips, jaws or mouth?

If you felt this way for another reason, answer "never".

9. Are you angry or frustrated?

- Never Once or twice Sometimes Often
 Every day or almost every day

10. Were you shy, embarrassed or ashamed?

- Never Once or twice Sometimes Often
 Every day or almost every day

11. Are you upset?

- Never Once or twice Sometimes Often
 Every day or almost every day

12. Were you worried about what other people think about your teeth, lips, mouth or jaws?

- Never Once or twice Sometimes Often
 Every day or almost every day

Questions about your activities in your spare time and in the company of others.

Have you ever had these experiences because of your teeth, lips, jaws or mouth?

If for any other reason, answer “never”.

In the last 3 (three) months, how often do you:

13. Did you avoid smiling or laughing when you are with other children?

Never Once or twice Sometimes Often

Every day or almost every day

14. Did you argue with other children or people in your family?

Never Once or twice Sometimes Often

Every day or almost every day

15. Did other children bother you or call you by nicknames?

Never Once or twice Sometimes Often

Every day or almost every day

16. Have other children asked you questions about your teeth, lips, jaws and mouth?

Never Once or twice Sometimes Often

Every day or almost every day

THANK YOU FOR HELPING US !!!!!

Annex F - Parental Perceptions Questionnaire– PPQ**ORAL HEALTH QUESTIONNAIRE: PARENTS 'REPORT / RESPONSIBLE**

Dear parents or guardians

This questionnaire aims to assess the effects of orthodontic treatments on children's well-being and quality of life. Please answer all questions.

To answer the question, place an (X) in the space next to the answer that best describes your child's experience. If the question does not apply to your child, please answer "never".

Do not talk about the questions with your child, as in this questionnaire we are only interested in the opinion of those responsible.

Section 1: Health and well-being

1) How would you rate the health of your child's teeth, lips, jaws and mouth?

Great Very good Good Regular Bad

2) To what extent is your child's general well-being affected by the condition of his teeth, lips, jaws or mouth?

No way Very little Moderately A lot Very much

Section 2: The following questions address the symptoms and discomfort your child may experience due to the condition of their teeth, lips, mouth and jaws.

In the past 3 (three) months, how often has your child had:

3) Pain in teeth, lips, jaws or mouth?

Never Once or twice Sometimes Often
 Every day or almost every day Do not know

4) Bleeding gums?

Never Once or twice Sometimes Often
 Every day or almost every day Do not know

5) Mouth sores?

Never Once or twice Sometimes Often
 Every day or almost every day Do not know

6) Bad breath?

Never Once or twice Sometimes Often
 Every day or almost every day Do not know

7) Food scraps in the roof of the mouth?

Never Once or twice Sometimes Often

Every day or almost every day Do not know

8) Food debris stuck inside or between the teeth?

Never Once or twice Sometimes Often

Every day or almost every day Do not know

9) Difficulty biting or chewing food such as apples, corn cobs or meat?

Never Once or twice Sometimes Often

Every day or almost every day Do not know

In the last 3 (three) months, because of your teeth, lips, mouth and jaws, how often does your child:

10) Did you breathe through your mouth?

Never Once or twice Sometimes Often

Every day or almost every day Do not know

11) Did you have trouble sleeping?

Never Once or twice Sometimes Often

Every day or almost every day Do not know

12) Did you find it difficult to say a few words?

Never Once or twice Sometimes Often

Every day or almost every day Do not know

13) Did it take longer than others to finish your meal?

Never Once or twice Sometimes Often

Every day or almost every day Do not know

14) Did you have difficulty drinking or eating hot or cold food?

Never Once or twice Sometimes Often

Every day or almost every day Do not know

15) Did you have difficulties to eat foods that she would like to eat?

Never Once or twice Sometimes Often

Every day or almost every day Do not know

16) Has the diet been restricted to certain types of food (example: soft foods)?

Never Once or twice Sometimes Often

Every day or almost every day Do not know

Section 3: The following questions refer to the effects that the conditions of the teeth, lips, mouth and jaws can have on feelings and their daily activities.

In the last 3 (three) months, because of your teeth, lips, mouth and jaws, how often has your child been:

17) Upset?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

18) Irritable or frustrated?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

19) Anxious or afraid?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

In the last 3 (three) months, because of your teeth, lips, mouth and jaws, how often does your child:

20) Did you miss school (for example: due to pain, consultation with the dentist, surgery)?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

21) Did you have difficulty paying attention in the classroom?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

22) Didn't want to speak or read aloud in the classroom?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

23) Didn't want to talk to other kids?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

24) Did you avoid smiling or laughing in the company of other children?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

In the last 3 (three) months, because of your teeth, lips, mouth and jaws, how often does your child:

25) Were you worried that you think she is not as healthy as other people?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

26) Were you worried that you think she is different from other people?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

27) She was worried that she didn't look as good as other people?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

28) Did you act shyly, embarrassed or ashamed?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

29) Was it the target of play or nicknames by other children?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

30) Was it excluded by other children?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

31) Didn't or couldn't play with other children?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

32) Did not or could not participate in activities such as sports, clubs, theater, music, school trips?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

33) You were worried that you think she has few friends?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

34) You were worried about how other people think about your teeth, lips, mouth or jaws?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

35) Other children asked about her teeth, lips, mouth or jaws?

Never Once or twice Sometimes Often

Every day or almost every day Do not know

THANK YOU FOR HELPING US !!!!!

Annex G - Family Impact Scale Questionnaire (FIS)**QUESTIONNAIRE ON THE IMPACT OF ORAL CONDITIONS FAMILY INVITATION: PARENTS 'REPORTS**

Dear parents or guardians

1. This questionnaire aims to assess the effects of oral conditions on children's well-being and day-to-day lives and the effects on their families. Please answer all questions.
2. To answer the question, please put an (X) in the space next to the answer that best describes your child's experience. If the question does not apply to your child, please answer "never".

Please do not discuss the questions with your child, as in this questionnaire we are only interested in the opinion of parents / guardians.

The following questions address the effects that the child's oral condition may have on their parents or other family members.

In the past 3 months, because of your child's teeth, lips, mouth or jaws, how often do you or another family member:

01. Got upset?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

02. Has your sleep been interrupted?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

03. Did you feel guilty?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

04. Did you have to leave work for any reason related to your child's oral health (for example: pain, consultation with the dentist or surgery)?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

05. Did you have less time for yourself or your family?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

06. Were you concerned that your child might have fewer opportunities in life (for example: dating, getting married, having children, getting a job that she likes)?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

07. Did you feel uncomfortable in public places (for example: shops, restaurants, parties) with your child?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

In the last 3 months, because of the teeth, lips, mouth or jaws, how often does your child:

08. Were you jealous of yourself or other family members?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

09. Did you blame yourself or another family member?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

10. Have you argued with yourself or other family members?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

11. Did it demand more attention from you or other family members?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

In the past 3 months, how often has the condition of your child's teeth, lips, mouth or jaws:

12. Did it interfere with family activities at home or elsewhere?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

13. Did it cause disagreement or conflict in your family?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

14. Did it cause financial difficulties for your family?

- Never Once or twice Sometimes Often
 Every day or almost every day Do not know

Your child is of the sex: Male Feminine

Your child's age is: _____ years.

The questionnaire was completed: Mother Father Other _____

THANK YOU FOR HELPING US !!!!!

Edu-communication in research groups in the North region of Brazil

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Keywords—Brazilian amazon, Edu-communication, Research Groups.

Abstract—This paper has analyzed the research groups in the North region of Brazil that approach edu-communication. The search has happened in the Research Groups Directory – Lattes Platform – CNPq. The aim has been to identify groups that propose edu-communication interventions in the referred region, as also some of their actions. The methodology of this study has had the bibliographic research about the theme as approach and, through the access to the data in CNPq's Directory platform, it was possible to analyze the research groups with a cutout of those that act in the North region. Five of these groups, out of the 39 found in all Brazilian institutions, have been identified. Within the reading of information presented by the Capes's research directory and the analysis of the lattes resume of the group leaders, the groups that are being active in edu-communication proposals, using its several applicability to promote their research, have been highlighted. It has been indicated and identified the profile of each group and their core motivations/aims in developing studies on the theme.

I. INTRODUCTION

Edu-communication is a word that has been developed and resigified in Brazil by Ismar Soares, even though it is still in the birth stage internationally (Sahão, 2020, p. 41). Its conception aimed to represent the procedure in which education and communication merge themselves allowing a communicative ecosystem that educates and an education that communicates. Those processes mean to, whenever necessary, make use of the most suitable technologies available in the environment to accomplish their purposes.

For Soares (2002, p. 24), edu-communication is “the set of actions inherent to planning, implementing and evaluating processes, programs, and products destined to create and strengthen communicative ecosystems in presential or virtual educational environments, besides improving the communicative coefficient of educational actions, including the ones related to de use of information in the learning process.”

In this way, the information recourses must be facing education. In this perspective, Freitas (2015, p. 02) highlights that "education and communication are two Fields that have plural converging points, for both are

essential for the occurrence of real social transformation and reform." As close as they are, these concepts merge into one, allowing a succession of actions that must be searched according to their particularities. The author complements that "these two Fields associated authorize the democratization of information, culture, and knowledge, contributing therefore to a social structure based on the practice of citizenship."

Thus, this approach contemplates interdisciplinary studies, involves social intervention themes, and looks for resolutions to the social practices in which it acts, setting itself as a process of intervention and reflection in one's actions.

Therefore, to address edu-communication is understanding that its applicability has a vast range of genres and functions. The importance of this article is emphasized due it verifying what has been developed in the northern region of Brazil in the research groups that address edu-communication. It has been sought to map the major research groups of the locality, outline the profile of each one, and identify their core motivations in developing studies regarding this topic. This procedure has been carried out to enlarge the knowledge about the theme in the multiple acting fields that edu-communication is inserted.

The present study has been developed through Capes's directory of research groups, using the descriptor *educomunicação*, during the dates 16th and 17th of March of 2021, with data revision on the 8th of February 2022. Thirty-nine groups have been identified in all Brazilian states. The acting areas have been: Communication, Education, Arts, Law, Collective Health, Linguistics, and Philosophy. Through the collected data, the groups that pointed for research held in the northern region of Brazil have been selected, in which appeared only five groups. Out of these, specific characteristics such as name, research line and or descriptive analysis, and coordinators have been pointed out.

During the days 4 and 8 of February 2022, articles and book chapters publications from each group leader have been searched, filtrating only these concerning edu-communication. It has been done to scan the situation of the academic production theme-related in these groups.

The methodology consisted of reading the information presented by the research directory of Capes and analyzing *lattes* resumes of the group leaders, exhibiting these pieces of information, and comparing these data with the displayed theoretical framework.

II. THEORETICAL FRAMEWORK

Communicating is fundamental to social relationships. It is through communication that subjects are integrated

into the environment, discovering and reinventing themselves. Communicability has always been present in society, since primitive times, in which humankind used to communicate through gestures and noises, until current days. Currently, communication has become something indispensable for men to survive in face of a new intellectual, technological, scientific reality, and in all social fields. In the educational field, communication has gained a core position since it is through this means that knowledge is built. Through the junction of education and communication, one created the term edu-communication. For Sartori (2020, p. 43), "Edu-communication has constituted a response within the Latin-American context and has conquered international space. The term edu-communication, coined by the Uruguayan educator-communicator Mario Kaplún, was adopted as a paradigmatic reference, according to Ismar de Oliveira Soares (2002), during the Media and Education Forum, who recommended that Communication colleges included the discussion on education in their curriculum so that professionals trained in Communication could expand their area of expertise, including educational processes."

In the studies of the Communication and Education Society of the University of São Paulo, coordinated by the professor Ismar de Oliveira Soares, who dedicates himself to research on education and communication, the concept of edu-communication is attributed to the Argentinian Mario Kaplún, when he related education and communication. That is, education is accomplished through the act of communicating, according to Freitas (2015). Freire (1967) already had mentioned in his works that education permeated communication, highlighting dialogue as a tool of knowledge.

Thus, the term edu-communication establishes itself in favor of a critical world Reading, having a plurality of functions; since communication and education are broad fields, they cannot be presented as one extremely closed definition. Given this, "Edu-communication must be understood as a set of actions. It is interdiscursive and interdisciplinary. The areas are worked on as possible and subjected to complementarity. Educate through communication, communicate through education". (Messagi, 2010, p. 7).

In the light of it, edu-communication is an action that involves two ways of understanding and knowledge, when the dialog elevates the communication to the speakers and the receivers, where both have freedom of expression, speaking and being heard with the same level of importance, adding knowledge and respecting the individualities. Communication following through the path of comprehension, without closing the term, is seen by Messagi (2010, p. 5) in this way: "simply explaining,

communication is a form of social interaction that occurs through messages, that have to have some meaning. It is a process of sending and receiving information and ideas between people. It is the act of sharing, breaking the isolation and producing a social encounter”.

Social interaction is a field sown with meanings, values, expressions, ideas, etcetera. As arises the need to be shared and integrated, and it is due to the communication process, independent of the language and the cultural practices used, these messages need to be sent and understood. In this vision, edu-communication, as a junction of education and communication, has an interdisciplinary area that permeates several sections. Conforming to Marques e Borges (2016, p. 11), "it is important to stand out that edu-communication goes beyond the instrumental vision of just inserting technologies in the education universe, in the same way, it is not restricted to the range of education for a critical reading of the media.”

The fact of not restricting the edu-communication does not mean that it does not have established objectives. This practice, in general, aims to expand the knowledge that prioritizes the whole of society without distinguishing social classes since everyone must have the right to information and knowledge. Information and knowledge are the starting point to the intellectual development of society, and soon these broaden to the political and economic areas, with a solid base in democratization, where it can be seen and applied in the social environment.

Regarding social means, edu-communication can be interpreted in many forms. Under the studies of Marques and Borges (2016), in the United States, edu-communication is delimited as an education to a critical reading of the media and for the technological intercession within education; while in Latin America, it is comprehended through the means of public communication movement, standing out in the management of communication in education spaces. A third interpretation is a literacy through communication, promoted by Paulo Freire, perspective in which Mario Kaplún has based his studies and, by that, adequated the term as means to achieve education through communication.

For Soares (2002), the communicative practice establishes an action in the educational spaces, contributing to the social and cultural learning proceedings. Messagi (2010) complements that the process is itself one of the first methods of edu-communication. For the author, this idea of the process comes from the dialog, with the participation of all, having five principles: the first one is in the essence of communication and education, as knowledge generator; the second is the

recognition that, by right, the social agents must have access to the information resources; the third principle is up to the democratic management through the use of technologies; the fourth principle turns to the communicative practice as service of citizenship and, finally, electing participative procedures in all action and enlarging the multiple forms of expression (MESSAGI, 2010, p. 10).

The upper-quoted edu-communication by Messagi (2010) is a concept that puts the man as the subject of the action, who can transform the world which inhabits. In this way, Soares (2021) defends edu-communication as practices aimed at training within educational spaces with technological support, yet enlarging the forms of expression of the communities, improving the levels of communication, and the development of citizenship. It is understood that edu-communication is also a chance of placing social and cultural movements with crucial roles within a society that seeks commitment, respect, and dialog. For Freitas (2015, p. 12), “we can understand the emergence of edu-communication as a result of a practice towards citizenship, and not only of the reflections of philosophers and theorists, restricted only to the field of formal education.”

Following this philosophy of understanding the diverse applications of edu-communication, Soares (2002) mentions that the concept of edu-communication was born through the practices of militancy, through political and ideological processes, and not in the universities. It happened due to the need for communication with the social environment in which, per the available means, it was possible to more effectively communicate in society, seeking to discuss their regional issues.

When thinking in all these dynamics of struggles for freedom, where the term edu-communication is born, it is clear that its applicability is found in numerous social aspirations, that it can be a means of the criticality of the participation of the social agents, being a space for the dialog, listening, and understanding of the whole, as well as a set of technological tools inside the educational field in the learning processes and as means to communicating different languages and cultural expressions, in which happens the transmission and enlarging of the knowledge.

Because of it, edu-communication is broadening its activity field, leaving the institutionalized spaces for the non-formal spots of education, as a path to a more participative society, with knowledge, and with it being able to form a truly democratic society. By not being an often discussed concept in Brazil, the present article aimed to verify what has been produced in the Northern region in the research groups that contemplate edu-communication.

III. RESEARCH GROUPS IN EDU-COMMUNICATION FROM BRAZIL

The practice of communication directed to education already existed before it was established as edu-communication. Besides being seen as an indispensable tool for the subjects' formation, communication also creates opportunities for improving the individuals participating in the process. It is important to stress that the dialog shouldn't be limited as the only way of building knowledge, but all the forms of representation of the social subjects. As a consequence of that, there is an increase in the research groups that embrace edu-communication.

Edu-communication is a space to compound and experiment with new methodologies facing social comprehension and is also a process of simplifying learning. It is possible to affirm that edu-communication is a new form of acting in society, in different social contexts, where one seeks to learn to hear and communicate, therefore generating a dialog between different experiences. The research in the edu-communication aims to interpret these multiple paths of discussion.

According to the research developed in the Research Groups' Directory – CAPES, during the days 16th and 17th of March 2021, there were identified 64 research groups with the descriptor *educomunicação*. From that were selected the 39 groups that contained the referred term in their names or research lines. After this survey, the groups were organized by their field of activity. This division shows that, primarily, the areas of Communication and Education are the ones that are more strongly related to the concept of edu-communication. It is evident in the following table:

Table 1: Research Groups with edu-communication descriptor.

Area	Number of Groups
Communication	20
Education	12
Arts	3
Law	1
Collective Health	1
Linguistics	1
Philosophy	1

Source: ResearchGroupsDirectory - CAPES

Based on the uppertable, it can be seen that the communication course has more studies concerning the

edu-communication due to its intrinsic relation with the topic. The following presents the education field, which complements the existing concept. é notório que o curso de comunicação tem mais estudos voltados para a educomunicação por conta da sua intrínseca relação com a temática. Segue-se a área da educação, que complementa o conceito em questão. Here are listed the groups, organized by area.

Table 2: Research Groups in Communication.

Communication:
1-APHRODIASPORA – Black Women, Visual Culture, Politics and Edu-communication in Urban Suburbs Research Society – UERJ
2-Episcom – UFCG - Campina Grande
3-Edu-communication Epistemology: fundamentals, methodology and intervention areas - USP
4- Communication and Education Study and Research Group – UESC
5- Communication Science, Information, Design and Art Studies and Research Group (INTERFACES) - UFAM
6-CriaNegra: Modern Languages, Education and Communication - UNIPAMPA
7-GEPPETE: Studies and Research Group: teacher, school and educational technologies - UFPR
8-RHECADOS –Ethnical-Racial Hierarchy, Communication and Human Rights - UNEB – State of Bahia
9-Objor Semiárido–Journalism, Gender and Edu-communication Research Group - UFPB
10-ObECom –Edu-communication Observer - UFCG
11-NEFICS -Serial Fiction and Audio-visualities Studies Society - UFPR
12-LABDIM –Media Discursivities and Socio-cultural Practices Laboratory- UEMG
13-Journalism, Edu-communication and Citizenship (Educom.JOR) - UNEMAT
14-Edu-communicative Paradigm Research Group– UFCG
15-Multimedia Media Press Research Group - UNESP
16-Edu-communication Studies and Research Group - UFSJ
17-Media knowledge and environment: Amazon Sights -

UFRR
18-Communication and Education Research Group - UFMS
19-GESJOR –Semiotic Studies in Journalism Group - UNIRR
20-Innovation, Development and Research in Edu-communication Laboratory - USP

Source: Prepared by the authors.

The research groups in the communication area listed above aim dialogs with themes concerning antiracist-education; black women and knowledge creation; media activity in the Brazilian northernerst; analysis of the history of edu-communication and its principals, and fundaments; folk communication; art and the new teaching technologies. They also research media environments as a process of scientificity, permeating the afro-gaicho cultural field; curriculum in all the cultural approaches, including digital ones; teachers' formation; distance education and the pedagogical practices, whether audiovisual or those related to reading and writing. In the area of communication, there are also the interpretation and identification of the numerous language forms facing human rights, health, citizenship, and education, with sights directed to the organization of Amazon.

In this way, the research groups that have edu-communication in their topics tend to establish a communication integrating subject and world, promoting comprehension of the events surrounding them. This knowledge can transform a Society, respecting the democratic approach, developing, thereby, all social areas, their questions, and existences. Edu-communication is a way to go through intellectual development, seeking dialogues to fill the gaps from the lack of communication with knowledge, a very present need in the new society model, where technologic tools gain even more space, influencing people's way of thinking, acting, and deciding. Therefore, edu-communication is an educational technique that can be seen as means to seek solutions and answers for local, regional, or national adversities.

So, the importance of edu-communication studies in the education field is in developing the subjects, broadening their world vision. Thus, the education area stands out as the second with most research groups that include the theme of edu-communication. As it is possible to observe next, there are 12 groups total.

Table 3: Research Groups in Education.

Education:
1- Education, Technology and Society - UNINTER-PR
2-Edu-communication and Afro-Brazilian Cultural Production – PUC
3-Interdisciplinary Studies in Education and Communication – UFCG
4-Technologies, Communication and Education – GTECOM – UFU
5-Education and Arts in Different Spaces Research Society - UFV- Viçosa
6-Edu-communication Research Society (NUPEDU) – UFCG
7-Innovation, Development and Application of Digital Technologies in Education –Federal Technological University of Paraná – UTFPR
8-Researcher Group in Environmental Education, Communication and Art – GPEA – UFMT
9-Teaching, Language and Digital Technologies Research Group (GPD LTD) – UFPE
10-Education, New Technologies and Ethnical-Racial Studies Laboratory (LENTE) - UFRN
11-Multimedia Research Laboratory - UFC
12-NEET –Education and Technology Studies Society - IFRS

Source: Prepared by the authors.

The studies highlighted in the educational field lead to research in the education areas focusing on the languages, cinema, audiovisual, methodologies to the teachers' formation, philosophy of education, interculturality, and Afro-Brazilian studies. The groups Analyse the artistic, mediatic expressions and cyberculture. In respect of the pedagogical practices, the emphasized data include research lines in didactics, literacies, biology, Portuguese, innovation, and teaching and comprehension, while in the curriculum, aim communication, education, technologies, and educational ethics, as well as scientific literacies with the contemporary textuality, Fields in which the edu-communication broadens its studies.

It is worth mentioning that edu-communication presents in different languages and applicabilities. For Messagi (2010), “the edu-communicative practice consists, primarily, in promoting education, reflection, and the

humanist and critical thinking through the study and the production of the media as a lever for education and constructing a more humanizing society.”.

On the other hand, Soares (2021) points out at least four possible applications: the education for the reflection with criticality, media uses, use of technologies and information, and the communication between the groups and subjects. In this way, edu-communication has presented itself in different study fields and research groups of numerous academic areas. Until the present moment of the research, the studies of edu-communicated stood out in the ranges of arts, law, philosophy, collective health, and linguistics. Below is highlighted the study groups in each field.

Table 4: Research Groups in Arts.

Arts:			
1-GTRANS	-Arts,	Cultures	and
Sustainability Transdisciplinary Research Group - Federal University of São João Del-Rei – UFSJ			
2-Art-Education Study Group - IFRJ			
3-Heritage, Art and Culture in the Amazon Study Group (GPAC) – UFRR			

Source: Prepared by the authors.

In the art field, the themes that stand out in the research are art, science, sustainability, teacher’s formation performance, arts teaching in the elementary, professional, technological, and college education, education, memory, identity, know-how, and languages. The following areas have presented Only one research group. As follows:

Table 5: Research Groups in Law

Law:			
1-Amazon Juridical Studies and Research Center-CEJAM – UNIR			

Source: Prepared by the authors.

In the law field, there has been identified only one group with studies related to human rights, edu-communication, intercession, and access to justice.

Table 6: Research Groups in Philosophy.

Philosophy:			
1-Philosophy Teaching and Philosophical Education Studies and Research Society- Regional PlanaltoCatarinense – UNIPLAC			

Source: Prepared by the authors.

In the philosophy studies, it has also been found only one research group, active in the research in education and the teaching of philosophy, besides edu-communication itself.

Table 7: Research Groups in Collective Health.

Collective Health:			
1- Group of Philosophical Studies in Social Representations - UESB			

Source: Prepared by the authors.

The research group that emerged from the collective health field has its studies fixated on the social representation of the health and sickness processes, edu-communication, and educational practices in familiar health.

Table 8: Research Groups in Linguistics.

Linguistics:			
1- Interaction, languages and professor’s (multi-) literacy – UNITAU - UNITAU			

Source: Prepared by the authors..

Ultimately, in the Linguistics area, it has been detected research related to the teaching-learning of foreign languages, language conception, teaching-learning and the subject, edu-communicative practices, communicative devices, and the media languages in the formation of the language teacher.

IV. RESEARCH GROUPS IN BRAZIL’S NORTH REGION MAPINP

The previous identifications are related to all national research groups, summing thirty-nine groups that involve edu-communication in their studies. In the following paragraphs, there are cutouts of the five research groups that operate in the Northern region.

The first group, identified as Communication Science, Information, Design and Art Studies and Research Group (INTERFACES), was created in 2004. It is within the communication field, predominantly in Applied Social Sciences. Its leaders are Francisco Carneiro da Silva Filho, with one published article in the area, and Gilson Vieira Monteiro, with two published articles related to the field. – UFAM. It is a certified group, acting through the Federal University of Amazonas. Its core research lines are media communicational environments and scientific informational processes. According to impact information described in *lattes* platform, the research group has “Concluded the research project call ‘The History of Media in Manaus’ financially supported by the Amazonas

State Research Support Foundation (Fapeam), and, during a year, has participated in the evaluation of the Scientific Communication Program of the Fapeam itself. It is a partner with the Research Group in Communication and Digital Technologies (Comtec) from the Methodist University of São Paulo (Umesp), and, recently, has celebrated an agreement with the Amazonas em Tempo Newspaper for a weekly publication, on Thursdays, as part of the InterMAIS section for Science and Technology (www.intermais.ufam.edu.br). The group has proposed the establishment of the Post-Graduation in Communication Sciences Program (PPGCCOM) and has launched the InterMAIS magazine, which is accessible through the address www.intarfaces.ufam.edu.br".

The group has 11 members with Ph.D., four members with master's degrees, one with a professional degree, four undergraduates, and four members within the "others" category. One of their research lines has been identified as fully inserted in the field of edu-communication for working with media communication environments. This proposal allows the strengthening of the diverse set of communication, prioritizing Amazon issues and turning it as a way for the region's development by the results of their research.

For being a group from the communication area, it is believed that it may create models and techniques so that the numerous localities and regional communities have (in)formation access conditions, hence getting to mold their realities. It resembles what Messagi (2010) proposes in his studies of edu-communication, about putting the subjects in front of their actions, enabling them to transform their realities.

The second group has been acting at the Federal University of Roraima since 2015. The group is named Heritage, Art, and Culture in the Amazon Study Group (GPAC), in the Arts area. The major themes are linguistics, modern languages, and arts. The existing research areas in the group are Communication, Memory, and Identity; Teachers Training and Educational Practices: Edu-communication, Knowledge, and Languages; Poetical and Artistic Languages. It is led by professors Leila Adriana Baptaglin and Vilso Junior Chierentin Santi. According to his *lattes* resume, he has three published articles and three published book chapters about the topic, while she has published ten articles and four book chapters on the theme.

In accord with data collected through the *lattes* platform, the impact of the research group is characterized as "Attentive to the Art, Education and Communication Fields, GPAC target working with communicational, educational, and artistic processes, aiming giving visibility to Amazon region traits. The work

with Heritage backs up the comprehension and historical value of the Amazon region, enlarging its sight as a cultural shed. Working with communication broadens the possibilities of interlocution with different languages. The education magnifies the Knowledge and spreads the artistic Languages, and the opening to the cultural topics allows the understanding of the theoretical/practical construction of the Amazon region. Thus, GPACs job reverberates in the cultural instances, in the comprehension, valuing e spread of the Heritage, the Arts and the Culture of the Amazon region to further regions and countries."

The group presents five members total in the Ph.D. among the categories of researchers (2), students (2), and foreign collaborators (1). Master's Degrees sum six researchers and five students. Undergraduates members are seven, besides one Associate, and in the "others" category, there are only two researchers.

It has been verified that the GPAC group is active, having studies groups that directly debate the edu-communication theme, like its concept, applicabilities, and interventions with activities in social practice. The group develops action that echoes in communities of the region through numerous dynamics with education-art-culture. On these occasions, they are not only part but also involve local subjects, for applying or even extending their knowledge for the whole community. A key role developed is raising support for culture as an education tool, emphasizing its subjects for their know-how, knowledge sharing, and communication between culture, art, and information. These group actions contemplate the sight of Soares (2021), who defends edu-communication as being the knowledge constitution among the diverse educational spaces with the expanse for the whole of the community individuals.

In the communication field there is the third group, that is presented as Media, Knowledge and Environment: Amazon sights. Having its predominant area in the Applied Social Sciences, its research lines are concentrated in Ecomédias and environment; Environmental Edu-communication; Journalism and Environment. Its leader is the professor Simão Farias Almeida, in whose *lattes* resume was not possible to find publications about edu-communication. Created in 2015, the group is certified by the Federal University of Roraima.

The group states that "In the scientific production in Brazil and abroad, they research about journalism, cinema and environmental and climate change information, animal, postcolonial studies and ecofeminism. They have published scientific articles and the books Planet crises in Journalism about Roraima; the journalistic coverage of climate change in Roraima; Time representations in

journalism of climate change and environmental damage; Ecocritic of the metaphorical-interpretative cartography in the climate change, climate and environmental damage in non-fictional; Ecological Crisis and Cultural Representation in Latin America; Belo Monte: crying voices; Media, information and environment; Environmental Journalism in Amazon: information sources in the covering of deforestation in The Para's Liberal Newspaper; Environmental Journalism in book format: allegories and subjectivities; Journalism, Environment and Amazon: the deforestations in The Para's Liberal and Amazon's Critique Newspapers."

Among the entirety researchers that work in the group themes, there are six associated with the Ph.D. title, six with the Master's title, two with the specialization title, six with the undergraduate title, and the "others" category has four researchers.

Based on the data exposed by the group, it has been verified that these researchers operate in the environmental area, addressing issues such as climate change, for example. Edu-communication has been used as proposals to make these research interact with numerous organizations/systems that manage environmental topics, having a sight directed to the Amazon. The importance of this job shows up by allowing these researchers to get to know and intervene in the regional environmental questions, searching for solutions for the improvement and development of the Amazon. The group uses the edu-communication by its mediatic application and as a tool to elaborate a critic, as the ones pointed out by Soares (2021), in the four areas of application proposed to the existing concept.

The fourth group, named GESJOR – Semiotic Studies in Journalism Group, has been acting since 2009 in the Federal University of Rondonia. Placed in the communication area, predominantly in the Applied Social Sciences, the group has professors LuziaAlziraZuin e Larissa ZuimMatarésio as leaders. The first leader has two indicated publications in her *lattes* resume directs to the edu-communication. The group research lines lean towards the know-hows, reflections, and practices to read and write the world and limits and possibilities to the Amazon transformation.

About the group's goals characteristics, those: "It proposes to investigate the signification processes in the printed and electronic journalism, as well as dedicates itself to the research of the history and epistemology of the semiotic, the journalism, and the social media. Therefore, the research group activities will be oriented through the Semiotics' methodology, either French or American originated. Besides these two strands, the group will

consider, When necessary, the theoretical perspectives of Russian Semiotic and further theoretical researchers of the Social Communication area and the Journalism subarea. The group still qualifies to research the knowledge that transforms the reality of political, media, and artistic practices. In this perspective, it represents a positioning of the researchers that compound the group in the sense of, even though the numerous Communication subareas, recognize the need to study more specifically the Social Communication, the Right to Communication and the reliable information, the internet."

Finally, the fifth group is also in the Federal University of Rondônia, named Amazon Juridical Studies and Research Center – CEJAM, acts since 2005, in the Law area. Led by professor Aparecida LuziaAlziraZuin e Delson Fernando Barcellos Xavier, its research lines are pointed to Human Rights, edu-communication, intercession, and access to justice. It has not been found other publications by the referred female professor, besides the upper-listed.

The presented purposes of the research group are: "to research the issues related to Human Rights, Right to the City, States and environmental-urban planning Rights in the scope of Amazon (artificial environment), Social Rights, primary in the State of Rondônia: to study the impacts caused by the consumer relations in the traditional and indigenous populations, and the Amazon environment; to promote and to implement projects and events aiming to aware and consolidate the interest for the research, preservation and social-environmental development of the Amazon; to study the shape and the effects of the application of the primitive knowledge by the traditional and indigenous populations from Amazon, related to the nature maintenance (natural and cultural environment); to research about the biodiversity and biopiracy; to research about the ways of social communication in a perspective of Law and Sociology; to research about Communication and Information Security."

Referring to the formation of the researchers, the group consists of 15 members in the Ph.D. category, four in the Master Degree category, 12 in the Professional Master Degree category, eight in the specialization category, 11 in the Undergraduate Degree category, and eight in the 'others' category.

Concerning this fifth group, it has been verified that it is operating in human issues in Amazon. As a region rich in human culture, as riverside, indigenous, quilombo, and rural/countryside populations, it demands the preservation of its cultures and knowledge. It has been understood that it is a duty of these researchers, besides the research

itself, to develop actions that allow these human/cultural dynamics to be seen, understood, and comprehended.

The edu-communication here present is in the sharing of ideas, cultures, traditions, and wisdom for it to be seen and valued. By relating to these realities, the researchers shall enlarge their research, prioritizing the information that allows their own subjects can know their rich socio-diversity.

Essentially, the analysis of the informed data by the several research lines in groups from the Northern region indicates incursions in numerous themes. Lastly, it is possible to note that all groups use edu-communication as a strategy for viable interventions in the Brazilian Amazon region. The objectives of these groups always prioritize communication as a way of broadening education, and these researchers understand that it is only possible to change the social, cultural, economic, and political realities through research and investigations that bring visible results.

This information aims to develop and highlight the Amazon by its intellectual and scientific capacity, not only through its biodiversity exploitation.

Thereby, the five groups of the Northern region that contemplate the edu-communication as a strategy for their research and applications have in their thematic lines: Media communicative environment; Knowledge and Languages; Ecomedia and environment; Knowledge, reflection, and practices to read and write the world; and Human Rights. It demonstrates that edu-communication is an interdisciplinary field.

V. FINAL CONSIDERATIONS

The mobilization towards the creation of the research about the theme concerning edu-communication is due to its concept's applicability, because of its interdisciplinary characteristics, in which specific reading and dialog according to the researched topic are made. The collected data through the research has allowed a sight of these numerous fields in which edu-communication has been applied, encompassing areas that pass through education, communication, arts, philosophy, law, and collective health until linguistics. This research has happened in all national research groups, but with an emphasis in the northern region. It has been realized that edu-communication is a new social action representation dynamic, having education and communication as guides.

Another observation of this research groups analysis points out a small number of acting groups in the northern region. Edu-communication could awake even more interest of different researchers, in a way that they could

acknowledge its possible applications, from a large field as far as its particularities, according to each region and area realities. However, it is clear that, since it is relatively recent, the term has not been well absorbed by the academic environment. This data is still confirmed due to the small number of group leaders' publications about the theme. Following it, GPAC is the highlight as the group with the vastest number of publications in this area.

Therefore, it has been verified that in cited research lines the themes closer related to edu-communication appear more frequently, as in Communication, Education, and Edu-communication itself. These research, by being placed in the northern region, also include, often, topics as Amazon and Sustainability.

Once edu-communication is still establishing itself, it can be researched, to expand its uses and possibilities, especially in the Brazilian northern region ambit.

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Design of a Robotic Vehicle with Real-Time Video Streaming

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Keywords— Radio Frequency, Remote control, Robotic vehicle, Surveillance, video streaming

Abstract— The paper presents design of a robotic vehicle with real-time video streaming. Prior to advancements in technology, military personnel and wild life researchers were used for these tasks (Intelligence gathering, Surveillance and Reconnaissance), and would risk injury and possible death to accomplish them. The need for safer means of performing these surveillance operations have become a pressing need over the years. Hence, this work aimed at developing a Robotic Vehicle capable of providing real-time video surveillance for military and wild life research operation applications. The Robotic Vehicle is made up of radio frequency based remote control, a PWM-enabled motor driver IC for efficient mobility, an OV2460 camera, and ESP32-CAM with Wi-Fi enable for video streaming without internet connection. The ESP32-CAM also serves as a web server which can be accessed by any device's browser connected via Hotspot setup. The robotic vehicle tested successfully and communicates effectively with remote control unit on the average of 0.5km distance.

I. INTRODUCTION

The world of control is an exciting field that has exploded with new technologies where the Internet of Things vision becomes a reality. Today, IoT with AI is used to make applications such as intelligent transportation, smart security, and smart home. The wireless communication technique is beneficial in IoT nowadays [1]. Robotics and automation is the field which has made lot of impacts on industrial as well as household applications from last few decades. The reason behind the wide use of robotics is its ability to make changes in previously made systems and also it is time consuming [2]. It is crucial to ensure proper surveillance for the safety and security of people and their assets. The development of an aerial surveillance system might be very effective in catering to the challenges in surveillance systems. Current systems are expensive and complex. A cost-effective and efficient solution is

required, which is easily accessible to anyone with a moderate budget. In aerial surveillance, quad copters are equipped with state-of-the-art image processing technology that captures detailed photographs of every object underneath [3]. During war, military people enter uncharted territory where they would sometimes become victims of surprise enemy attack. This robotic vehicle would be a method to trace out the enemies and use that information to make a tactical move. It is having all the necessary accessories to trace enemies like: long range camera which captures and live streams the video to the control station, sensors to detect the presence of human being and GPS/GPRS system to determine and transmit the position of the enemy targets. The system can substitute the soldier in border to provide surveillance as well for reconnaissance circumstances [4].

II. REVIEW OF RELATED WORKS

In [5], an IoT Based Surveillance Robotic Car Using Raspberry PI was developed. The robot car was equipped with necessary sensors and controlled over the internet. Smart Surveillance Robot for Real-Time Monitoring and Control System in Environment and Industrial Applications presented in [6]. Their robot system called InterBot 1.0 was equipped with long-range communication system via 2.4 GHz 6-channel remote and also short range via HC-05 (Bluetooth module). The Results show the efficiency of Interbot 1.0 in monitoring real-time environments. A Hand Movement Controlled Robotic Vehicle with Wireless Live Streaming Feature was Designed and implemented in [7]. Their robot system comprised of the transmitter, the receiver and the live streaming section. Live streaming was successfully achieved by interfacing a common network (Wi-Fi), a laptop, Raspberry pi, and two software (Virtual Network Computing (VNC) and Foundation Internet Nouvelle Generation (FING)) together to ensure the surveillance feature for the user.

In [8], Surveillance robot to monitor the work performance in hazardous area was developed. Their robot was embedded with sensors for identifying any obstacle and human via Wi-Fi and provides live streaming to the Admin. The robot is operated over Wi-Fi using Bynk App Software. Web-based Application for Mobile Robot using IoT Platform was developed in [9]. The Web application based processed commands are transmitted to the control unit of the robot through Wi-Fi and this robot controlled through web application via mobile phone.

In [10], an embedded Mobile Robot for Surveillance Applications was developed. Their mobile robot was connected wirelessly via a low power ZigBee module to the control station. This allows the operator control the mobile robot motions and monitoring the physical events in the operating environment. During testing, the mobile robot shows that it can run continuously for approximately 6.5 hours at a motor shaft speed of 25 rpm without need to recharge the battery.

A rover with live video transmission was implemented in [11]. The Arduino is connected to Bluetooth module through UART protocol and programmed for speed control and motion control of rover. The commands from the Arduino through Bluetooth device, controls the motion of the rover. The robotic vehicle can be used for number of applications especially in surveillance, military and security.

III. DESIGN METHODOLOY

The robotic vehicle comprises of hardware and software systems. The design approach adopted for the robotic vehicle is prototyping method for hardware implementation and agile method for software implementation. The block diagram used to achieve the aim is shown in fig.1

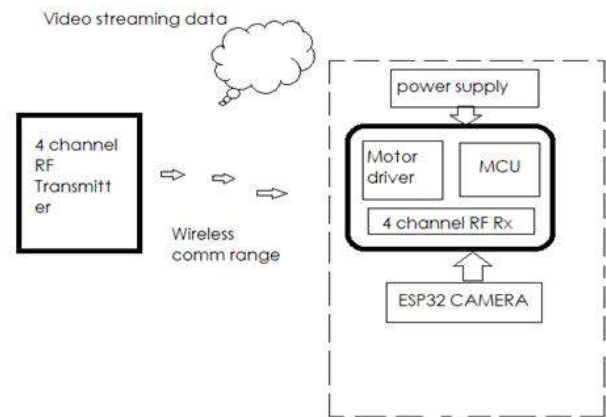


Fig.1. Block diagram of the robotic vehicle

3.1 Robot Hardware

The robot system hardware comprises of Remote Control, Microcontroller, Mobility, Visual Sensor and Streaming, and Power Supply units.

A. Remote control unit: consists of Radio Frequency (RF) transmitter and Receiver responsible for enabling unmanned control of the robotic vehicle over a long distance. The maximum distance the robot can communicate with the remote controller is 0.5km. The communication frequency of the robot is calculated using equation 1.

$$D = 10^{\frac{(P_L - 32.44 - 20 \log f)}{20}} \tag{1}$$

Where: D = Distance (km);

P_L = Maximum Path Loss (dBm); f = Frequency (MHz)

Maximum Path Loss (P_L) is calculated using equation 2

$$P_L = \text{Transmit power} - \text{receiver sensitivity} + \text{gains} - \text{losses} - \text{fade margin} \tag{2}$$

Finally, the remote control frequency calculated is 425.647MHz for communication with robot.

B. Microcontroller: is basically for processing signals and controlling each component to function optimally. The Receiver unit of the Radio Frequency remote module is interfaced with the microcontroller unit. This is done because Radio Frequency module alone cannot achieve the mobility model required to drive the robotic vehicle. This mobility type is possible through Pulse

Width Modulation (PWM); signals that activate variable speed control in the Motor Driver IC. For this purpose, an 8-bit Microcontroller, which is capable of generating the required PWM signal is required.

C. Mobility unit: is the part of the robotic system responsible for the movement of the vehicle. It comprises of the Motor Driver IC and the 5V DC motors. The Arduino Uno Microcontroller sends instruction to the Motor Driver Module, which control the mobility of the robot. Signals sent by the 4 channel RF module to the Microcontroller provide the microcontroller with information necessary to driving the Mobility unit. The 4 channels of the RF module basically enable the controller drive the mobility unit to the left, right, forward and reverse.

D. Visual Sensor and Streaming unit: is responsible for taking the visual sensory data in form of pictures and videos that would be necessary to navigate the surveillance robot remotely. The main aim of this unit is to achieve wireless streaming of video data without internet connectivity. For this to be possible, this unit requires camera module (for visual capture implementation), microcontroller (for processing the captured images or videos), and communication module (for data transmission between the robot and the user. The flow chart used to achieve this module is shown in fig.2.

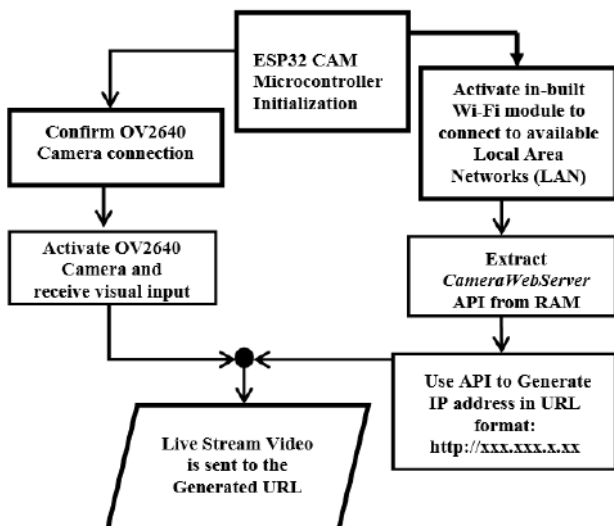


Fig.2: Flow Chart for Visual Sensing and Video Streaming

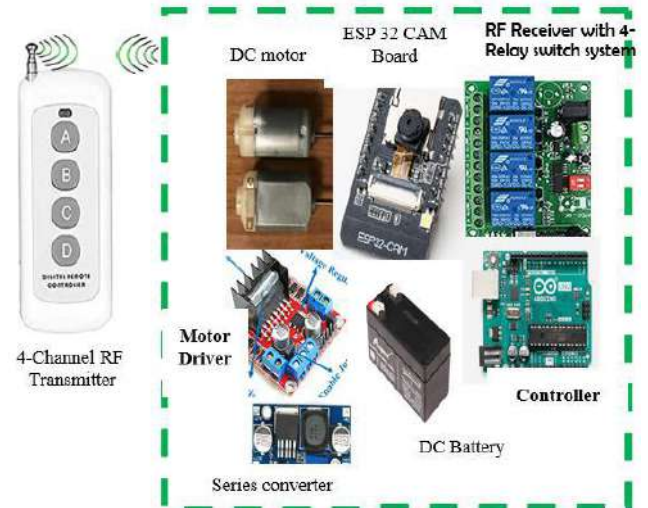


Fig. 3: Robotic Vehicle System

E. Power Supply: The system is powered by a 12V 1.3 Ah DC Battery which supplied required voltages to various components of the robotic vehicle. It was chosen because of its maintenance-free, valve regulated, long service life, deep discharge recovery and resistant to high temperature.

However, the robot system hardware diagram representing various components used is shown in fig.3.

3.2 Robotic Vehicle Software

The Tool used for programming microcontrollers is Arduino Integrated Development Environment (IDE). It is a cross-platform application that is written in functions from C and C++. The Arduino IDE (fig.4) is where the codes that serve as the intelligence of the system are written, compiled and sent to the Arduino Uno board as well as the ESP32 CAM. The programming language is embed C.

3.3 RF Transmitter and Receiver Operation and Circuit Diagrams

The RF module consists of a transmitter and a receiver, which are easily installed and integrated into any embedded system design and employs an 8-bit code for their function. They are reprogrammable; the receiver possesses a “learn” button from which a previous code can be deleted and another code can be uploaded or “learned”. The maximum range of the module in free field is 200m. This is the effective maximum range of the transmitter signal under optimal conditions, or in the open field with free line of sight. However, with an antenna, the range can be increased to over 500m. The circuit diagram for the Transmitter is shown in fig.5.

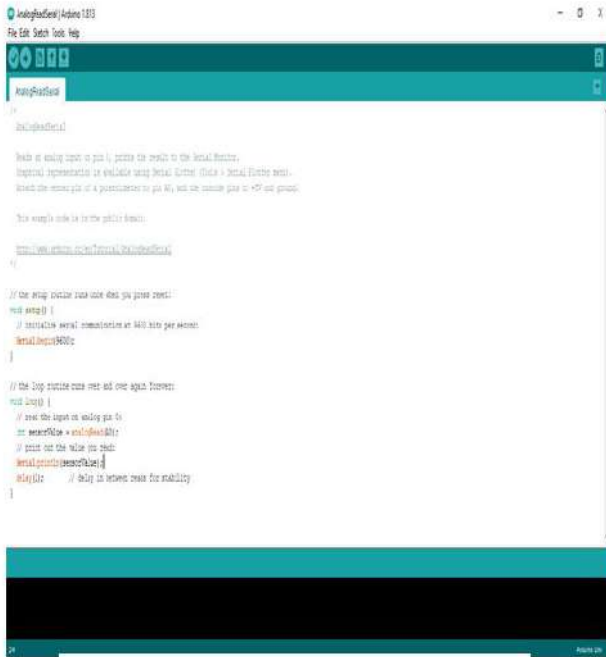


Fig.4: Arduino IDE for Robot coding

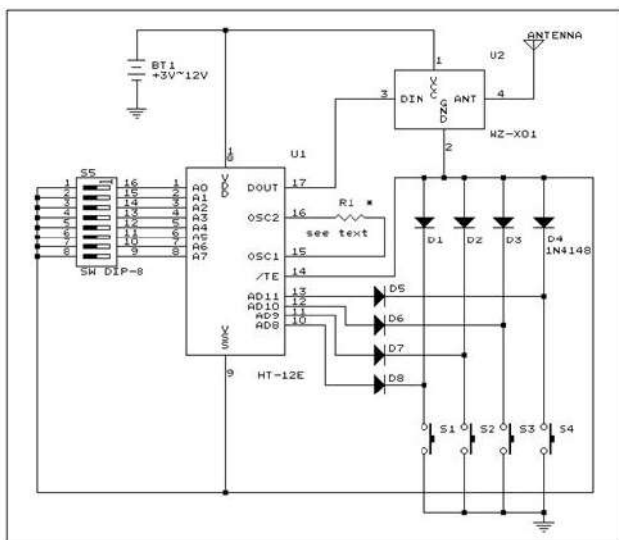


Fig.5. Remote control transmitter of the robotic vehicle

In receiver unit (fig.6), the U1 receives and decodes the data from the transmitter. Then it compares the input date with its local addresses for any match. After that, it runs an error check to determine if there is any unmatched code. If no unmatched code is found, the input data is transferred to the D8~D11 pins. As a result, the VT pin is set to a HIGH state indicating a successful data transfer. The U1 output controls the 4 PNP transistors, which are connected differently to the 4 relays. Anytime S1-S4 switches are engaged, the TE pin is switched low, as a result, the encoder chip U1 and the transmitter module U2 are

powered and then the encoder scans and transmits the status of the 12 Bits address and the data serially. Four Relay channels are coupled with the Receiver section and the section is designed to drive a 4-point relay output. This output can then be used to control DC and AC devices, which in this case will be the input pins of the Arduino Uno microcontroller. The clamps on the Relay devices are NO / NC (normally open / normally closed).

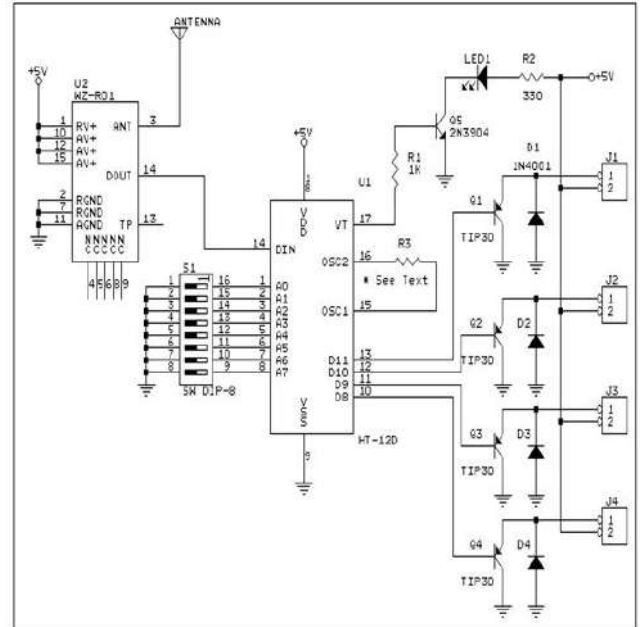


Fig.6: RF Receiver's unit

3.4 Remote control coding and Flow Chart

Embed C programming language used in writing the codes in Arduino IDE platform. The 4-Channel RF module initiates whatever decision microcontroller takes. The microcontroller executes action to effect motor driver that controls the wheels. The sequence of operations starts from the RF module to the Arduino Uno, to the motor driver and finally, to the wheels. The flow chart used to actualize the remote control and mobility coding is shown in fig.7.

3.5 Microcontroller Firmware Algorithm

The firmware code is the program that drives the microcontroller board. The firmware code of the designed system was written following these steps:

- Step 1: Execute Single loop run-time process
- Step 2: Ask or wait for remote input
- Step 3: Is there Remote input?
- Step 4: If No, go back to step 2; if yes, go to step 5
- Step 5: Check which button was pressed
- Step 6: Check how the button was pressed; Long press or short press

Step 7: If long press, go to 8; if short press go to 9

Step 8: Call up function/process assigned to short press of a particular button input remote.

Step 9: If TTL (Transistor-Transistor Logic) protocol is ON, activate streaming at a static IP address.

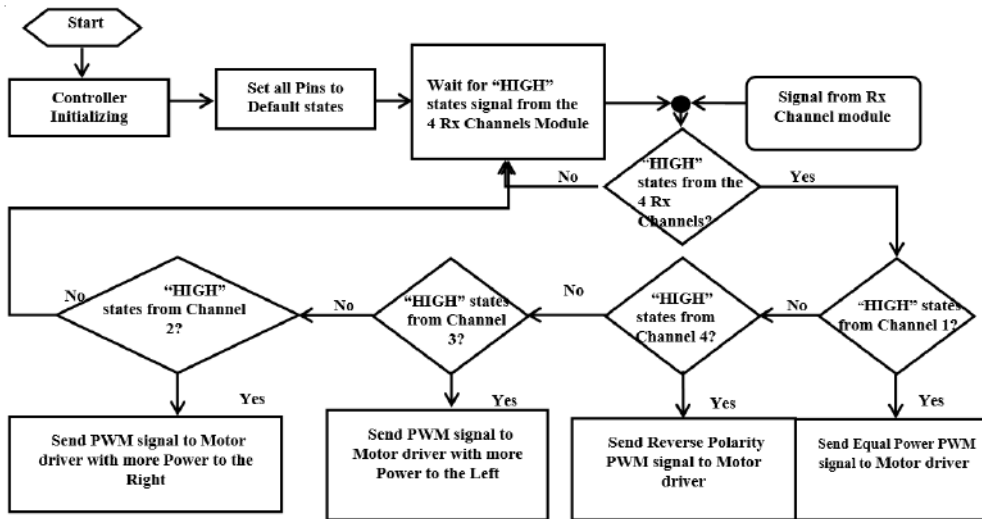


Fig.7: Remote control and Mobility flow chart

3.6 Simulated circuit of the Robot system in PROTEUS

The robot system was simulated using PROTEUS software as shown in fig.8.

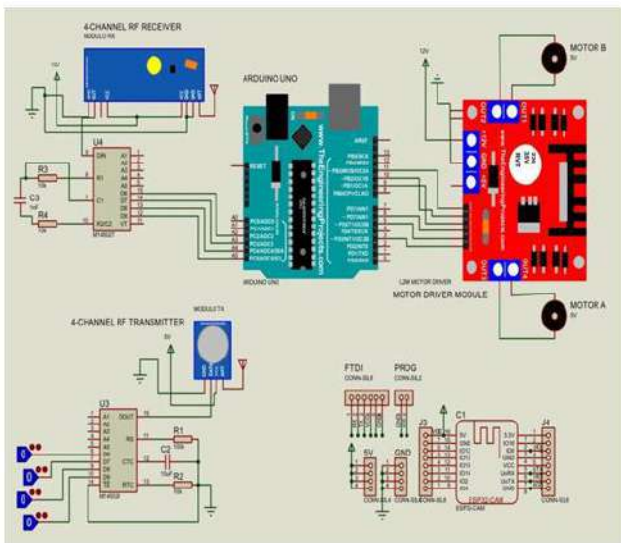


Fig.8: Robot System simulated in PROTEUS

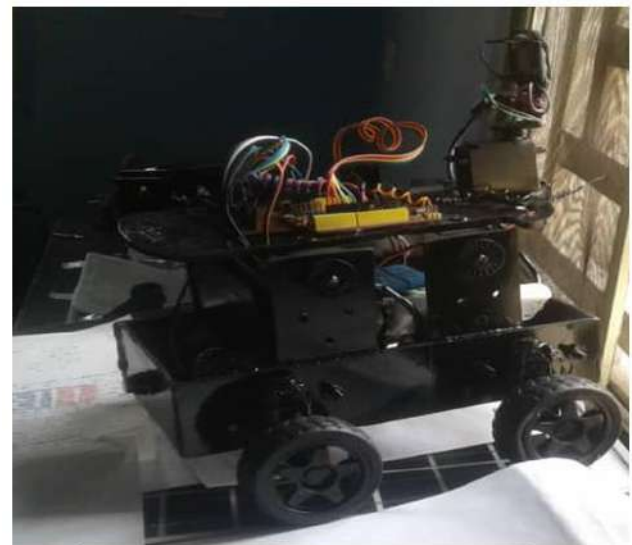


Fig.9: The picture of the robot system

The complete built real time robot for video streaming is shown in fig.9.

IV. RESULTS OBTAINED

4.1 Remote Control Distance Test

Before the system is coupled, the remote sensing module was tested to ensure that all four channels are in good working condition. The four channel 433MHz RF module has an inbuilt reliability test to ensure that it is in proper working conditions. The Receiver module has an inbuilt LED, which is connect to the four channels. When a Channel button is pushed on the Transmitter module, the corresponding LED is turned ON. The diagram for the set is shown in the Fig. 10.

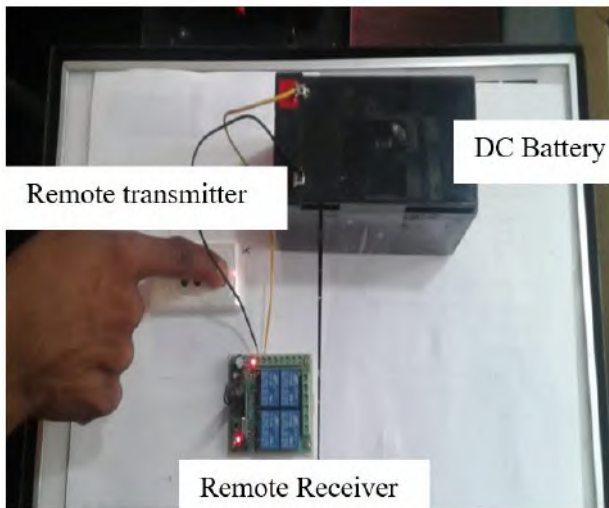


Fig.10: Remote control test diagram

4.2 Mobility Test

The mobility test was done to determine the effectiveness of the motor driver IC deployed to perform the mobility operation. The four output pins of the Motor Driver Module were read with a multi meter to ensure that the switching operation was done accurately. The common terminal of the multi meter was placed on the ground pin of the Arduino Uno microcontroller, and the signal terminal connected to the output pins of the motor driver IC as shown in fig.11.

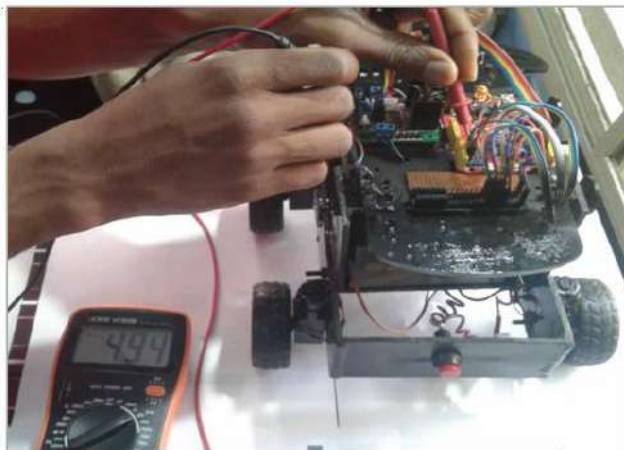


Fig.11: Multi-meter reading of motor driver IC

After reading, table 1 shows each wheel voltage of the robot on the forward, reverse, right and left motion.

Table 1: Test Results for the motor driver IC setup

Robotic Vehicle Motion Models	Wheel Configuration			
	Multi-meter Readings for each wheel: Voltage (V)			
	Right 1	Right 2	Left 1	Left 2
Forward motion	4.95	0	4.97	0
Reverse motion	0	4.89	0	4.91
Right Turn	2.45	0	4.95	0
Left Turn	4.98	0	2.37	0

4.3 ESP32 setup & Wi-Fi connectivity test

The Arduino IDE was configured to be compatible with the ESP32 CAM board for effective code upload. The IDE was configured by installing a JSON file in the “Additional Board Manager URLs” field located in the “preferences” section’s dialogue box. The Wi-Fi configuration code was uploaded to the board through Local Area Network (LAN) setup. The ESP32 board runs the Wi-Fi code successfully which automatically connected to the LAN. The code block screen shot of the successful test is shown in fig.12.

```

ROBOTIC_VEHICLE_WIFI_CONNECTION | Arduino 1.8.13
File Edit Sketch Tools Help

ROBOTIC_VEHICLE_WIFI_CONNECTION
#include "WiFi.h" // ESP32 WiFi include
const char* SSID = "ROBOTIC VEHICLE";
const char* WiFiPassword = "ROBOTICVEHICLE";

void ConnectToWiFi(){
  WiFi.mode(WIFI_STA);
  WiFi.begin(SSID, WiFiPassword);
  Serial.print("Connecting to ");
  Serial.println(SSID);
  int i = 0;
  while (WiFi.status() != WL_CONNECTED){
    Serial.print(".");
    delay(500);
    if (++i % 10 == 0){
      Serial.println(F(" still trying to connect"));
    }
  }
  Serial.print(F("Connected. My IP address is: "));
  Serial.println(WiFi.localIP());
}

void setup()
{
  Serial.begin(115200);
  ConnectToWiFi();
}

void loop()
{
  delay(1000);
}
    
```

Fig.12: Wi-Fi tested connection code

4.4 ESP32 CAM board camera test

The ESP32 CAM board camera was tested also. The IP address of the robotic vehicle changes as network disconnection and reconnection. This was not seen as a problem because the system alerts the control station (connected phone or laptop) to the change and sends the new IP address. The web video streaming and camera streaming setup is shown in fig.13.

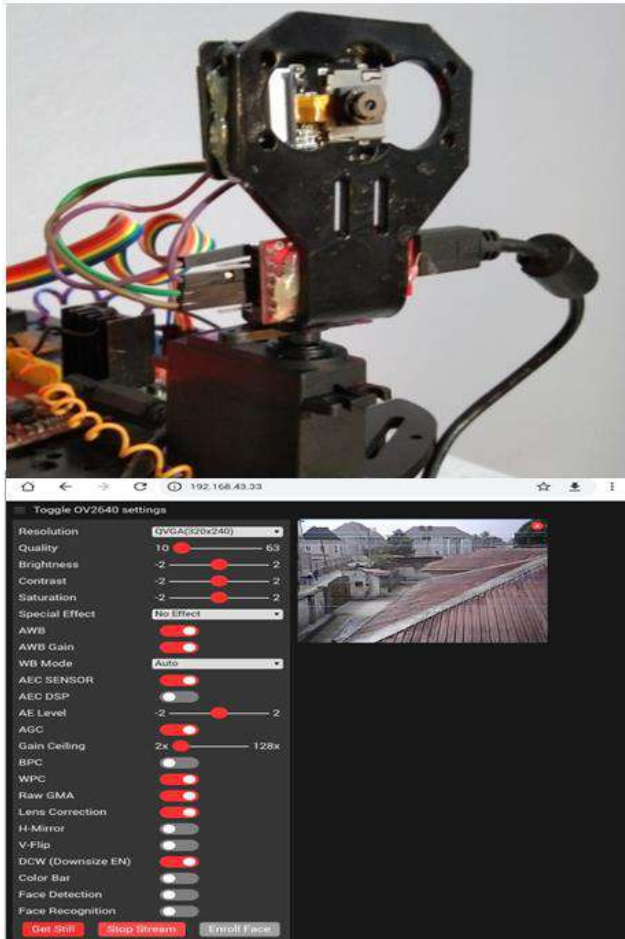


Fig.13: Video streaming and Camera streaming setup

V. CONCLUSION

The design of a robotic vehicle with real-time video streaming is implemented and tested. The developed robot system is capable of taking video of any suspicious event and sends the video footage via Wi-Fi to the operator's smart phone for further action. The remote unit is responsible for sending signals to the robot system. The control signals are sent by the microcontroller to the mobility unit which consists of H-bridge, PWM-enabled Motor driver IC, and the motor driver IC that controls the wheels according to the military motion model adopted in the system operation. This model gives the robotic vehicle four (4) modes of movement: forward motion, right turn

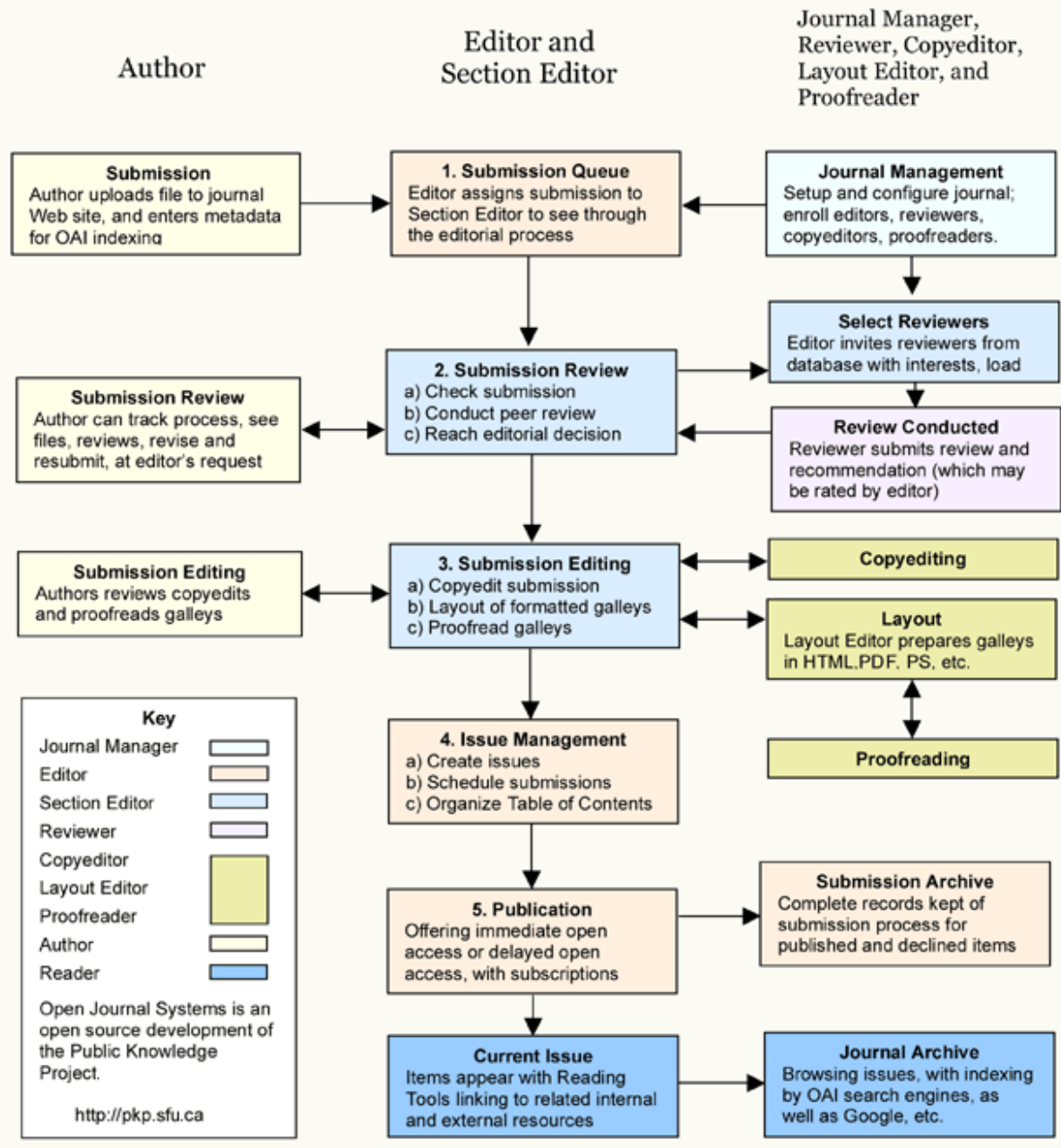
motion, left turn motion, and reverse motion. The visual sensing and streaming unit is responsible for visual data of the Robotic vehicle. This unit is driven by the ESP32 CAM; a 32-bit Wi-Fi enabled IoT board which has an OV2640 camera with about 2 megapixel quality and more than 30fps. The power unit of the system is 12V DC which caters for all the electronic components on the system except the ESP32 CAM which required 5V. The system was designed to communicate effectively with remote control distance of 0.2km and could go as far as 0.5km in a Line-of-Sight operation. The ESP32 CAM served as a web server, enabling the video to be accessed over a Uniform Resource Locator (URL) which can be accessed from anywhere in the world with internet connection. To further enhance on the robotic system, solar cell can be deployed as means of charging the battery and control mechanism established to ensure smooth steady operation of the robot at any given time.

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