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

International Journal of Advanced Engineering Research and Science

(IJAERS)

An Open Access Peer-Reviewed International Journal

Journal DOI: 10.22161/ijaers

Issue DOI: 10.22161/ijaers.95

AI PUBLICATIONS

Vol.- 9 | Issue - 5 | May 2022

editor@ijaers.com | http://www.ijaers.com/

International Journal of Advanced Engineering Research and Science

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

DOI: 10.22161/ijaers

Vol-9, Issue-5

May, 2022

Publisher

AI Publication

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

Web: www.ijaers.com

International Editorial/ Reviewer Board

Editor in Chief

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

Cheif Executive Editor

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

Associate Editors

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

Editorial Member

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

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.1

A View of the Strategic Planning of Public Safety in the State of Rondônia from the view of Criminality and Social Vulnerability Indexes: A Micro and Mesoregional approach

Fabio Robson Casara Cavalcante[1], Carlos Alberto Paraguassú-Chaves[2], Lady Day Pereira de Souza[3], Ana Maria Morais da Fonseca Cavalcante[4], Fabrício Moraes de Almeida[5], Lenita Rodrigues Moreira Dantas[6], Carla Dolezel Trindade[7], Simão Aznar Filho[8], Ruy Drummont Smith[9], Simão Dolezel Aznar[10], Márcia Maria Rodrigues Uchôa[11], Marcélio Rodrigues Uchôa[12]

[1]PhD in Sciences: Socio-environmental development - NAEA / UFPA. Associate Professor, Federal University of Rondônia – UNIR.
[2]PhD in Health Sciences -University of Brasília - UnB, Brazil; Post-Doctor in Health Sciences - UnB and Degli Studi D'Aquila University - Italy. Full Professor at the Rio de Janeiro Institute Faculty, Brazil
[3]Master in Regional Development and Environment (UNIR). Professor at the Federal Institute of Rondônia, Camus Porto Velho, Brazil.
[4]Master in Agronomy from the Federal University of Pernambuco (UFPE), Brazil. Voluntary researcher at the Higher Institute of Health Sciences and the Environment of the Amazon – AICSA.
[5]PhD in Physics (UFC), with post-doctorate in Scientific Regional Development (DCR/CNPq). Researcher of the Doctoral and Master Program in Regional Development and Environment (PGDRA/UNIR).
[6]Geographer expert and lawyer. Researcher of the Institute of Health Sciences and the Amazon environment - AICSA.
[7]PhD in Law - Universidad Nacional de Lomas de Zamora (Argentina). Post-doctorate - Universita deli Studi di Messina (Italy). Full Professor at the University Institute of Rio de Janeiro - IURJ, Brazil.
[8]PhD in Law - Universidad Nacional de Lomas de Zamora (Argentina). Post-doctorate - Universita deli Studi di Messina (Italy). Full Professor at the University Institute of Rio de Janeiro - IURJ, Brazil.
[9]Master in Legal Sciences from the Autonomous University of Lisbon. Adjunct Professor at the Faculty Instituto Rio de Janeiro, Brazil.
[10]Graduated in Law. Master of Law Student, Specialist in Law. Professor at the University Institute of Rio de Janeiro, Brazil.
[11]PhD in Social Sciences from the Pontifical Catholic University (PUC/SP). Adjunct Professor at the Federal University of Rondônia, Brazil.
[12]PhD in Education from the Pontifical Catholic University of São Paulo (PUC/SP). Associate Professor at Faculdade Instituto Rio de Janeiro, Brazil.

Received: 01 Apr 2022,
Received in revised form: 25 Apr 2022,
Accepted: 30 Apr 2022,
Available online: 07 May 2022

***Keywords*— Strategic planning, Crime, Vulnerability, Microregions.**

***Abstract*—** *The issue of strategic planning for public security is recent in Brazil. Rondônia is no different. The question is whether the State's strategic planning includes approaches that characterize its mesos and micro-regions, from a reading brought by the construction of crime and social vulnerability indexes. Thus, the general objective of this research was to analyze the crime and social vulnerability indices of the municipalities of Rondônia, aggregating them in the micro and mesoregional perspective, in order to build a new vision for the strategic planning of public security at the state level. For this, the hypothetical-deductive method was adopted, as a line of reasoning. The methodology consisted of collecting data on secondary databases from official sources.*

Data were collected following the municipal logic aggregated by micro-regions of Rondônia. For the treatment of the data, the statistical tool SPSS, version 23, was used as an instrument to calculate the crime and social vulnerability indexes, based on the multifactorial analysis technique. It was possible to verify that the micro-regions of Porto Velho and Guajará-Mirim concentrated, on average, the highest rates of crime and social vulnerability, respectively. The two micro-regions highlighted, as already demonstrated, are inserted in the Madeira-Guaporé mesoregion. It is considered essential that public security strategic planning in Rondônia adopts meso and micro-regional technical criteria using quantitative and / or qualitative data subject to comparative analysis, like the one brought by the research, aiming to facilitate the decision making process in with regard to establishing different strategies to be taken in relation to the regions and their specificities that make them unique and specific, requiring different views for different scenarios.

I. INTRODUCTION

When starting this work, we sought to analyze the issue of public security in Rondônia based on the logical construction line brought by Cavalcante[1]**.** This level of understanding allowed the context of the motivating impact of this research to be reached. Thus, based on the Rondonian meso and micro-regional view, Cavalcante [1]reinforces the existence of two very different realities at the state level that, in some way, have been impacting the respective societies linked to each of these regions of Rondônia. But, knowing this scenario, it is necessary a historical synthesis brought by the aforementioned author that we consider important to insert the reader in this context. That said, throughout its history, the state of Rondônia was consolidated due to events that marked not only the intrinsic context of its territory, but the result of a broader scenario, both nationally and internationally. To begin this line of thought, we must first emphasize three moments that, in our view, marked institutional life in this portion of the Western Amazon.

Adopting a temporal and spatial cut, the first moment, with a direct impact from the geopolitical point of view of the country, we can mention the issue of gold exploration in the Guaporé region, in the early 18th century. This fact allowed Spain and Portugal to dispute the possession of these lands, putting in check the political-administrative design brought by the Treaty of Tordesillas, of 1494. In this 15th century Treaty, Spain was sovereign over this territorial portion. However, during the period of the Iberian Union (1580-1640) it delegated to Portugal the right to its lands in the Amazon. But, with the discovery and exploration of gold in Guaporé, under Portuguese administration, it made it possible for Portugal to begin its formal claim to the sovereignty of these lands. The end of this episode was the signing of a new agreement between the two nations, known as the Treaty of Madrid, of 1750. Thus, this event allowed, in fact, the Portuguese dominion over these lands, once linked to Spain. In principle this represented, in some way, the first global geopolitical revision of the modern world, beginning in the 16th century. The symbol of this phase is represented by the Forte Príncipe da Beira, in the municipality of Costa Marques (Vale do Guaporé), built to guarantee Portuguese sovereignty over this large expanse of land on the right bank of the Guaporé River.

Such annexation allowed to arrive at the national territorial design practically to what is known today from maps, with the exception of the current state of Acre, which highlights the historical importance of this period. It should be noted, however, that despite the magnitude of the fact, it is still little explored in terms of cultural identity in the region, thus indicating a fertile field for scientific investments and public policies in this sense. However, the definitive design of the Brazilian territory and, therefore, of the state of Rondônia took place, according to Cavalcante[1]**,** from the two main institutional changes that took place in the region: a) Madeira-Mamoré Railroad - EFMM; b) BR federal highway 364. In summary, the Madeira-Mamoré Railroad, the result of a new international agreement, no longer between Spain and Portugal, but now between its former colonies, Bolivia and Brazil, allowed the annexation of Acre to Brazilian territory, due to the signing of the Treaty of Petrópolis in 1903. Rubber, the main economic activity at the time, would have been the motivator of this litigation. From that episode onwards, the boundaries of borders were practically finalized in Brazil.

The symbol of this process is in the railway stations between Guajará-Mirim and Porto Velho and their remnants, such as the coasts, the trains, the rails, the iron

bridges that struggle with time to remain firm on the horizon, despite the tropical climate. Thus, the map of Brazil owes much to these two historical moments that occurred in the region of the valleys of the Guaporé, Mamoré and Madeira rivers. Finally, the last of the episodes refers to the change from the railway modal to the road modal, after the definitive deactivation of the EFMM, in 1972.

With the BR 364 federal highway, according to Cavalcante[1]**,** a new development axis is strengthened, no longer in the Madeira-Guaporé mesoregion (under the influence of the EFMM), but in the East mesoregion of Rondônia (under the influence of the federal), which now concentrates political and economic power, influencing strategic decisions at the territorial level, culminating, in 1981, with the institutionalization of the state of Rondônia with the current 52 municipalities in Rondônia. In this way, the rules of the game quickly began to be dictated by the influence of the relationship of space and power conducted by the East Rondoniense mesoregion, which became the main economy of the State. The Madeira-Guaporé mesoregion, on the other hand, lost economic power and began to absorb a period of strong socio-environmental policy that, in both cases, ended up generating distinct cultures among the societies of Rondônia [1]**;** [2];[3]. In this way, allowing the construction of the assumption that the economic model observed in the consolidation of the state of Rondônia, as a result of the developmental policies of the integrated colonization projects, idealized by the federal government, was agriculture and that this model has, over time, characterized the economic power of the State with a strong participation in the state GDP. With a few exceptions, the Madeira-Guaporé mesoregion, with greater environmental weight, watches the advance of this economic segment without directly participating in the process [1]**.**

Based on this context, are the realities observed in the two mesoregions, from the point of view of crime rates and social vulnerability, consistent with this view presented? What new can this approach indicate in terms of strategic planning in public security management in Rondônia? Thus, there is no doubt that strategic planning in the public sector has been gaining more and more space in the Brazilian scenario in view of the need for more efficiency, effectiveness and effectiveness in the conduct of its public policies in favor of improving the quality of life of the population in general. However, the context for the elaboration and discussion of a strategic vision to be implemented is preceded by technical studies capable of allowing the public manager and his team responsible for the discussion and construction of the general guidelines to be inserted in the plan, a scenario that allows taking decision making, as possible, and agile, in the face of a complex and unequal environment. The general objective of the present research is to analyze the crime rates and social vulnerability of the municipalities of Rondônia, aggregating them in the micro and mesoregional perspective, aiming to build a new vision for the strategic planning of public security at the state level. As specific objectives, it is intended to: a) Determine the municipal indices of crime and social vulnerability; b) Determine the average performance of the indices for each of the eight micro-regions of Rondônia; c) Graphically construct the relationship between crime and social vulnerability at the municipal and micro-regional levels of the State. It is also worth highlighting the hypotheses that guide this study: If the crime and social vulnerability rates identified by the research point to a scenario of greater impact in the micro-regions of Porto Velho and Guajará-Mirim, then the context of the approach brought by the research finds a foundation and makes logical and coherent the inequalities brought about in the mid-regional scope of Rondônia, which must be taken into account for the strategic planning of the State's public security; If the crime and social vulnerability indices identified by the research point to a dispersed micro-regional scenario, with no trend related to mesoregional aspects, then the logic of approaching the regions with greater environmental weight is not sustainable, which makes it consistent with the current strategic planning of public security in Rondônia.

II. THEORETICAL FOUNDATIONFUNDAMENTAÇÃO TEÓRICA

2.1 Strategic planning in the public sector: concepts and fundamentals

Strategic planning is a management technique of fundamental importance, which allows the organization to know the environment in which it operates, providing a sense of direction and avoiding risks in its actions[4]. Planning is a process that precedes and presides over action[5] For Pfeiffer [6] strategic planning has two purposes: 1) concentrate and direct existing forces within an organization in such a way that all its members work in the same direction; 2) analyze the organization's environment, and adapt it to it, so that it is able to react adequately to the challenges it faces. This author reveals that the intention is for the organization to conduct the development process so as not to be driven by external and uncontrollable factors. However, he emphasizes that this does not mean assuming that the future is controllable, but only that the analysis of changes and the possibilities of adaptation increase an organization's room for maneuver to

better deal with eventual conflicts or crises that may arise.Rezende [7] in turn, emphasizes that the construction of a strategic vision cannot ignore the limitations that the financial and institutional reality imposes on its implementation, under penalty of loss of credibility of the planning effort. Much less, it comes down to the need to integrate planning and budget, as provided for in the constitutional provisions [7].

For this author, it is in the territory, whose occupation is impacted by changes in the economy and demography that accentuate disparities and conflicts and threaten the sustainability of the country's economic union. Thus, in the absence of a spatial strategy, conflicts and antagonisms create an unfavorable environment for federative cooperation and, therefore, increase the difficulties for the reconstruction of planning. As for the identification of risks, he emphasizes that they need to be properly evaluated so that the government can anticipate their outbreak and include the necessary measures among the priorities to be met.

In general, Matias-Pereira[8] emphasizes that planning is an essential practice, both in public and private administration, due to the benefits that the instrument brings to organizations. In public administration, Santos [9] states that given the current complexity, characterized by the scarcity of resources and growing demand from the population, it is essential to act in a strategically planned way in public institutions. In this sense, Rezende [10] highlights that the definition of strategies and their translation into a plan have little effect if the effective conditions for their implementation are not adequate. These conditions, according to the author, depend on the capacities that public bodies have to exercise their responsibilities, even taking into account the limitations imposed by the regulations in force.

For De Toni[11] strategic planning is about government management, the art of governing – when we ask if the government is moving towards where it wants to go, if it is doing what is necessary to achieve its objectives, if it is starting to debate the planning problem. Thus, for this author, the big question is whether the organization is dragged by the rhythm of day-to-day events, like the force of the current of a river or if it knows where to get and concentrates its forces in a defined direction. In this way, it points out that planning, seen strategically, is nothing but the science and art of adding greater governance to our destinies both as people and as organizations or countries. Therefore, government planning, according to De Toni[5], can be defined as a collective political process, coordinated by the State, which, through increased government capacity, carries out a strategic project for society.

For Lopes[12] governmental planning, according to its sphere of action, can be classified as: a) national (defining goals and guidelines for the nation), b) regional (limited to the economic and social peculiarities of a region), c) urban (circumscribed to the growth of a city environment) or sectoral (linked to a specific sector, such as education or the environment). Therefore, it is in the public administration, according to Cunha [13], that the responsibility for defining the Government's strategy in all its public policies is found. For this author, this process of defining actions involves negotiations and conciliation of interests of different groups and social movements, which is essential for the effectiveness of planning. It also reveals that this strategic definition constitutes an intelligent mapping of actions aimed at achieving a shared future, as well as a description of the path used to achieve the government's objectives. Thus, a government's strategy is largely expressed in its governmental planning.

On the topic of planning, Souza[14]considers it to be the fundamental administrative function, serving as the basis for all other functions employed. In addition to this vision, it reveals that in the case of Governments, planning aims to define society's future goals and establish the means to achieve them, so that social transformations are not determined by external or fortuitous circumstances, but rather be a result of conscious decisions generated by managers and inhabitants. In this sense, Cardoso Jr.; Melo[15] emphasize the need for institutions that encourage long-term actions. For Rezende [7] and Rezende[10] in a Federation such as the Brazilian one, a national project cannot be confused with a federal government plan. It must have broader purposes, aimed at building a strategic vision of long-term national interests, which includes the actions required to promote these interests and the measures necessary for their defense in the context of international relations. For Melo[16] continuity in public policies and in the performance of government bodies, over successive administrations, can be achieved through guidance from a long-term development policy or a development plan. This author emphasizes that the expression “long term” should be redundant, were it not for the fact that, with some frequency, the term “development” is used in reference to short-term events and changes.

2.2 Strategic planning in Brazil and Rondônia

In Brazil, as in the rest of Latin America and the Caribbean and in other relatively less developed countries, more systematic planning experiences began in the 1930s in the wake of public policies designed to face the consequences of the 1929 Crisis. In general, they were limited to a few sectors considered priority in each country

– with emphasis on energy, transport, basic sanitation [17].Starting in the 1940s, Brazil launched numerous development plans. As historical examples, we can mention the SALTE Plan – Health, Food, Transport and Energy (l947), the Goals Plan (l956) and the National Development Plans (I and II –PNDs, from l972 to l974 and from l975 to l979), respectively) [18].According to the aforementioned author, with the crisis of l979 and the decrease in the availability of external resources, the deficit in public accounts caused a cycle of uncontrolled inflation in the country that contributed to the weakening of planning. With the redemocratization, government planning once again stood out as an inescapable attribution of the State, being foreseen in the Federal Constitution of l988 through the obligation to prepare pluriannual plans.

De Toni[5]highlights that in the recent history of the country, post-redemocratization, government planning was slowly resumed in a different perspective from the seventies and eighties: more indicative and regulatory, but integrated into the public management dimension and more participatory and decentralized.

According to Santos[19], the current formal model of governmental planning is anchored, in particular, on two bases: the Federal Constitution (CF), which determined and gave outlines to three planning instruments (Pluriannual Plan - PPA, Law of Directives Budgets – LDO and Annual Budget Law – LOA); and the 2000 budget reform, which sought to integrate plan, budget and management. For the author, despite the constitutional declarations, the three instruments still lack a lot of evolution to fulfill the objectives for which they were created. For Vaz[20], redemocratization stimulated pressure from society for citizen participation, transparency and social control of governments. For Santos [19], despite the attempt to organize State action, the current model was not able to lead formal planning to a sufficient position to adequately subsidize government coordination.

In this context, Rezende [7] and Rezende[10] considers that the planning and budget model established by the 1988 Constitution did not represent a major innovation. For the author, the change caused a loss for planning, because instead of dealing with a national plan, the PPA, it was reduced to a federal government plan, with each state and also the municipalities taking care of the elaboration and execution of the own PPAs, without any mechanism having been instituted to seek greater articulation of the plans of each entity of the Federation. In the conception of Rezende [7], the root of the problems that affect the quality of planning is the absence of a national project, supported by a strategic vision of the challenges that the country faces to promote a balanced economic development, in the triple perspective under which this balance must be observed – social, regional and sectoral – in addition to being environmentally sustainable. In this sense, he states that the horizon of the PPA is too short.

In the case of Rondônia, Cunha; Neves[21] reveals that the planning experience begins when the first planning attempt is made, in 1977, with the elaboration of the first Rondônia Goals Plan, whose objective was to obtain a document that contemplated claims, not only in the scope of segments the public sector, but also involving representatives of other segments of society. The visit of government technicians to each municipality and locality represented the first experience of "participatory planning", as investments began to be made as a result of opinions and meetings with the various communities [21]. In the current Strategic Plan for Rondônia 2019-2023, it is reported that Rondônia is among the newest states in Brazil, having been a federal territory and, finally, a federative unit only in the second half of the 20th century. Therefore, his youth characterized insertions of state planning in an already constituted reality, with the economic cycles of the past and existing local characteristics, shaping his current urban and economic conception. In view of this, it is exposed that five foundations were established for the design of the plan, namely: "[...] The first foundation is the commitment to consider regional peculiarities with social and environmental responsibility, with sustainability as a guideline for protagonism of Rondônia as a model for the development of the Legal Amazon. The identification of the current forces of change is key in the construction of planning, which must be aligned with current trends and uncertainties and strategies of the main actors for the realization of a vision of the future as reliable as possible - this is the second foundation. The third foundation consists of structuring the Plan based on the great legacies that it intends to leave for the years to come. The definition of priorities must reflect pragmatism and feasibility, so that few good legacies are delivered, causing a relevant positive impact for the current and future generations.

The study and analysis of other existing plans and those under construction, the alignment of strategic actions with the 2020-2023 Multiannual Planning (PPA) and the Rondônia State Sustainable Development Plan (PDES), were considered for the preparation of this document, and the compilation of what is most concrete and tangible in these inputs for the formulation of this – this being the fourth and penultimate foundation. The last foundation refers to thinking about the well-being of the citizen, which defines that all the battles that need to be won by

Rondônia were built from indicators and goals that directly impact the result for the Rondônia, as it is the mainstay of the strategy and the raison d'être of the state administration [22].The Strategic Plan for the state of Rondônia 2019-2023 has seven thematic axes: management and strategy, health, safety, education, citizenship, economic development and environment and territorial development. For each of them major battles, key results and initiatives were defined.

2.3 Strategic public security planning in Brazil and Rondônia

According to the Federal Constitution of 1988 in Chapter II, Art. 6, security is a social right: "These are social rights to education, health, food, work, housing, leisure, security, social security, maternity and childhood protection, assistance to the destitute, in the form of this Constitution" [23].According to Kahn; Zanetic [24]until recently, in Brazil, the problem of public security was understood as something that concerns only the state government and, within it, specifically the organs of the criminal justice system: police, prosecutors, judiciary and prison administration. Also according to the authors, the main argument for not being involved in the issue of public security was the fact that art. 144 of the Constitution assigns the responsibility for civil and military police to the state government. With that, from a limited conception of security, caused by the Federal Constitution itself, the federal and municipal actions were compromised.

Since the enactment of the Constitution in 1988, several plans and public security programs have been developed and presented by the federal government with a view to implementing public policies to prevent violence and reduce crime. Highlights include the National Public Security Plan (1991); I National Human Rights Program (1995-1996); National Public Security Plan (2000); II National Human Rights Program (2002); Public Security Project for Brazil (2003-2006); National Program for Public Security with Citizenship - Pronasci (2007-2010); Safer Brazil Plan (2012); National Homicide Reduction Plan (2015); National Public Security Plan 2016/2017; National Public Security and Social Defense Policy (PNSPDS), 2018.

The 2000 National Public Security Plan is considered the first national and democratic security policy focused on stimulating technological innovation; it alludes to the improvement of the public security system through the integration of security, social policies and community actions, with which it is intended to define a new public security and, above all, a novelty in democracy [25]. However, in the view of Ballesteros [26] public security policies in Brazil have, as a rule, been designed and implemented in a fragmented and poorly planned way. Also according to the same author, unlike what happened with other rights supported and reformulated by the Constitution, the right to security and order, as well as the organizational structure that should guarantee them, was restricted to the list of some police organizations, passing away from the citizen characteristic attributed to the other spheres of Brazilian social life, which was beginning to be reconfigured.

According to Brasil[27], the national territory has been experiencing difficulties in the implementation of public policies, whose roots lie much more in the form and mechanisms of federative articulation and coordination (between levels of government) and of the republic itself (between State bodies and Powers) than in the absence of initiatives. The country needs to look at the governance mechanisms of the public security and criminal justice system, in order to give maximum effectiveness, efficiency and efficiency to the efforts that are being made and interrupt the cycle of fear and violence that challenges the public power and threatens the society [27]. It is known that population insecurity and crime reduction are not issues of immediate solution and, however, given the current stage, this issue does not involve only specialists in the area, but an initiative between federal, state, municipal governments, civil society and other organizations [28].

With regard to the state of Rondônia, according to Lessa[29].in 2003, the State Public Security Plan of Rondônia was created in 2003, with the objective of "reducing by at least 40% (forty percent) the number of crimes per one hundred thousand inhabitants, in the period from 2004 to 2007". During the period between 2008 and 2017, Rondônia's public security policy was not the result of sectoral strategic planning, given that there was no state plan [29]. In 2019, Decree No. 23,698, of February 27, approves the Strategic Plan for Public Security, Defense and Citizenship of the State of Rondônia (SESDEC), for the period from 2018 to 2030. It is worth noting that the strategic plan of SESDEC and subordinate institutions, with a time horizon of 2018-2030, aims to "make Rondônia a developed, competitive, modern State with excellence in public management, socially fair and environmentally sustainable", concentrating efforts, in order to seek a "Rondônia for peace", committed to overcoming challenges to guarantee people a safe environment with less violence and crime.

However, for the achievement and excellence in the vision of the future, starting from the premises focused on the areas of results regarding public security, the aforementioned strategic plan for public security in Rondônia directs strategic actions from the perspectives of

cooperation, social justice, science and innovation: Carry out dynamic and innovative management with a focus on improving public security services; Provide public security policies, aiming at the culture of cooperation between public bodies and society; Improve public security services and modernize strategic management through partnerships; Transform public security with an emphasis on people, seeking to improve the productivity and motivation of employees; Increase budgetary participation and strengthen the capture of extra-budgetary resources; Base actions on research and development to generate innovation and technology; Decision making based on social, political, economic and cultural contexts, with distributed information; Base decisions on knowledge of the external and internal environment, in order to impact the results, through monitoring and evaluation; Provide quality infrastructure for public security agencies; Promote an integrated work process, focused on efficiency; Promote the well-being of employees; Strengthen public security agencies and community police actions; Promote collaborative relationship between public security bodies, external bodies and society; Prioritize preventive, repressive and inspection actions for internal security at borders, ports and airports; Promote planned actions for the institutional growth of the secretariat and its bodies; Ensuring integrated training actions for bodies linked to public security; Rational use of financial, human and institutional resources; Strengthen and create a fundraising mechanism for sustainability for institutional development.

Regarding the Rondônia Strategic Plan, 2019-2023, the issue of public security is also presented as one of the axes in this document. The axis encompasses state actions that prevent and repress violent actions against property; and those of a character more focused at the level of individuals, comprising the entire state public security system. In the plan, the major strategies intended to meet the security needs of the population were concentrated in the four main stages of the flow of the state public security system (intelligence, prevention, coercion and social reintegration), with the challenges presented as being: Technological modernization in the prevention and investigative process of the police, in order to establish a high rate of elucidation of violent crimes in the State. The reduction in the rate of violent crimes against property and traffic, in order to make Rondônia the safest state in the northern region; The implementation of alternatives to the current model of the prison system, both for the reduction of overcrowding and for the resocialization of the prisoner.

For Ballesteros [26]the effectiveness of the public security system results from the ability to articulate multisectoral and interorganizational interventions aimed at preventing crime or overcoming its consequences after it has already occurred. This articulation is fundamentally based on an efficient management of resources, information and strategies, which favors participatory formulation and implementation and is supported by constant and reliable monitoring and evaluation instruments, to correct the course of interventions, to consolidate well-established and socially legitimate practices. Ferreira[30]states that, in the current scenario of society, where violence and crime persecute the State as one of its most serious problems, the strategic planning tool is basic to preventive and repressive preparation and control. According to this author, a new vision of prevention and social response to the problems and damage caused by urban violence and crime is needed, which can provide a very useful tool for government management.

2.4 Contextualization on the topic of crime

Crime has worsened daily in Brazil, drastically affecting the lives of its citizens [31]. The accelerated growth of violence and the State's inability to promote crime control policies raised the discussion on public security to the main concerns of Brazilian society [32]. According to Waiselfisz[33], Brazil is currently among the countries with the highest homicide rates in the world, whether based on an absolute or relative criterion. Brazil is currently ranked 14th in the world in terms of intentional violent deaths and 2nd in absolute numbers [34]. Brazil currently has a rate of 30.5 homicides per 100,000 people, the second highest in South America, after Venezuela, with 56.8. In total, around 1.2 million people lost their lives to intentional homicides in Brazil between 1991 and 2017 [35]**.**

In the diagnosis of homicides in Brazil, produced by the Ministry of Justice [36]**,** the following macro causes of homicides in the country were identified: (i) gangs and drugs; (ii) property violence; (iii) interpersonal violence; (iv) domestic violence; (v) conflicts between civil society and police; and (vi) lack of State presence. In addition to factors that are transversal to all homicides, such as: availability of firearms and accumulation of social vulnerabilities.

Santos; Kassouf[31]emphasize that the costs of crime to society are relatively high. Material damage, public and private spending on its prevention and combat are just some of the elements that make up the costs of crime for society. In addition, they cause other costs, no less important, such as the reduction of the stock of human capital, the reduction of the quality of life, the reduction of tourist activity and the loss of attractiveness of new productive investments and/or the expulsion of existing ones.

In Brazil, the distribution of deaths from violent causes is not restricted to a region, state or municipality, but impacts Brazilian society in general, causing loss of life, threats and fear. Also, it does not occur homogeneously, but varies between these territories and in each space over time [37].According to the Atlas of Violence 2019 [38], the evolution of homicide rates between 2007 and 2017 was quite different across Brazilian regions. In recent years, while there was a residual decrease in the Southeast and Central-West regions, there was a certain stability of the index in the South region and accentuated growth in the North and Northeast. According to Riccio et al.[39], a recent but serious phenomenon is the internalization of violence that has grown in medium and small cities in the last two decades in the wake of drug trafficking. According to the authors, new demands arise for an overburdened criminal justice system in its various spheres. According to these authors, the characteristics of each region and the social relations they produce interfere with existing crime patterns. Thus, border regions, intensive agriculture or large urban centers have specificities in relation to the incidence of violence.

The federal government and Brazilian sub-national units and civil society organizations have sought to integrate actions to combat crime in large and medium-sized cities in the country. The experiments to contain the alarming crime rates, however, proved to be unsuccessful in most of them [40]. With regard to the Amazon, in Northern Brazil, Fraga[41] points out that the region is experiencing a significant increase in indicators of violence, and its large territorial extension and the absence of an adequate public security policy make the problem difficult to face, contributing to its expansion. The author emphasizes that violence in this region is traditionally related to conflicts over land tenure, the illegal exploitation of its natural resources and the appropriation of the spaces of the traditional communities inserted there. Added to this is the geographic location, on the border with cocaine-producing regions, which places it on the route of international trafficking.

Deluchey[42]reports that in the more rural regions of the Amazon, homicides seem to accompany the pioneering fronts of deforestation and the intensification of human activities (mining and soy).The concentration of “firearm homicides” follows the arrival of pioneering human activities in areas of deforestation and the transformation of the Amazonian rural territory into areas of intense cultivation, mainly soybeans. However, the discussion on the public agenda about crime in the Amazon has privileged the debate on the preservation/conservation of its biodiversity, the survival of the Amazon forest, deforestation and fires, national defense and protection of borders, among others no less relevant. In a way, the defenders of the criminality agenda in the academic and political agenda have not been successful in the relevance of the theme [40].According to Machado [43], the history of the colonization of Rondônia can explain the violence and the large number of conflicts that permeate its society, since its colonization repeated, to a large extent, the very history of the colonization of Brazil with the decimation of indigenous peoples and deterritorialization of traditional peoples. The number of homicides recorded in Rondônia, compared to other states of the federation, is very high and represents social conflicts that have not yet been dealt with, since most of them are related to people who work in the field, in mining and in large enterprises, which they leave to behind a trail of unemployed, displaced, deterritorialized, in short, people without work and without perspectives, marginalized [43].

According to Lessa; Silva[44] due to the geographic position of Rondônia, with 1,343 km of territorial area bordering Bolivia, the State has a significant portion of crimes that occur in its territory related to transnationality. According to the authors, the crimes of robbery and theft of vehicles (taken to Bolivia to serve as currency for drugs), homicides (the result of settling accounts between traffickers), smuggling, embezzlement, among other crimes, are common. However, the authors consider that the main illicit activity in the state's border area is related to the trafficking of drugs, diamonds and weapons. The dispute over the domain of territories for the distribution and sale of drugs also reflects their numbers on crime. Pereira-Filho;Tannuri-Pianto; Sousa[45] emphasize that crime has become, in recent periods, one of the biggest Brazilian social problems, and has increasingly demanded, in addition to financial resources, more planning, operational intelligence and coordination in the various attempts to overcome it. Therefore, in Deluchey[42] view, building proposals for public security means taking into account the context in which criminal violence is exercised, and the interests it serves. Once this examination has been carried out, the author also suggests proposals for changes in the exercise environment of this public sector, before expressing proposals related to public security itself.

2.5 Contextualization on the topic of social vulnerability

The word vulnerable comes from the Latin verb “vulnerare”, which means to hurt, to penetrate. Due to these etymological roots, vulnerability is a term generally used to refer to predisposition to disorders or susceptibility

to stress [46]. The approach to vulnerability is characteristically interdisciplinary and strongly anchored in the Social and Human Sciences, seeking to understand, in addition to epidemiological determinants, the dimension of the senses and meanings of subjects' exposure to certain risk situations, as well as the implications and differentiated effects of these exhibitions in individual and interactive trajectories [47].

The issue of social vulnerability is not new, as this terminology has been commonly applied by social scientists from different disciplines for quite some time. The theme is characterized by a complex conceptual field, consisting of different conceptions and dimensions that can focus on economic, environmental, health, rights, among many others. Although this theme has been worked on over the years, it should be noted that it is a concept under construction, given its magnitude and complexity [48]. Social vulnerability is the negative result of the relationship between the availability of material or symbolic resources of actors, whether individuals or groups, and access to the structure of social, economic, cultural opportunities that come from the State, the market and society [49].

The vulnerability framework allows us to understand the ways in which individuals face adverse events and adopt certain behaviors, not according to the view of a rational subject who guides his action only by the availability of information, but from the perspective of a subject imbricated in a dynamic system of relationships and constraints of different orders (social, political and economic), which influences their choices and conditions of existence [49]. The situation of vulnerability combined with turbulent socioeconomic conditions causes great tension among young people, which directly aggravates the processes of social cohesion and, in some situations, encourages an increase in violence and crime [50]. In Brazil, violence is present in most cities, where high crime rates are accompanied by social inequality, misery, government failure, inefficiency of policies in the area of security and frustrations generated by the consumer society [50]. In this context, considering the latest available data on crime and social vulnerability, it remains to analyze the context of Rondônia from the perspective of strategic planning for public security and discuss new approaches that may arise from this logical approach.

III. METHODOLOGY

For the development of the present study, the hypothetical-deductive method was adopted as a line of reasoning.The methodology consisted of collecting data in secondary databases, from official sources of the Brazilian government. Data were collected following the municipal logic aggregated by microregions of Rondônia. The research analyzed the microregions of the State, considering the IBGE methodology, which classifies Rondônia with two mesoregions and 8 microregions, namely: i) Madeira-Guaporé mesoregion, involving the microregions of Porto Velho and Guajará-Mirim; ii) East Rondoniense mesoregion, covering the micro-regions of Ariquemes, Ji-Paraná, Alvorada do Oeste, Cacoal, Colorado do Oeste and Vilhena.

Table 1: Counties surveyed according to micro and mesoregions

Mesoregions	microregions	Municipalities
Madeira-Guaporé	microregion Guajará-Mirim	Costa Marques, Guajará-Mirim, São Francisco do Guaporé
	microregion Porto Velho	Buritis, Campo Novo de Rondônia, Candeias do Jamari Cujubim, Itapuã do Oeste, Nova Mamoré, Porto Velho
East Rondoniense	microregion Alvorada D'Oeste	Alvorada D'Oeste, Nova Brasilândia D'Oeste, São Miguel do Guaporé, Seringueiras
	microregion Ariquemes	Alto Paraíso, Ariquemes, Cacaulândia, Machadinho D'Oeste Monte Negro, Rio Crespo, Vale do Anari
	microregion Cacoal	Alta Floresta D'Oeste, Alto Alegre dos Parecis, Cacoal, Castanheiras, Espigão D'Oeste, Ministro Andreazza, Novo Horizonte do Oeste, Rolim de Moura, Santa Luzia D'Oeste
	microregion Colorado do Oeste	Cabixi, Cerejeiras, Colorado do Oeste, Corumbiara, Pimenteiras do Oeste

microregion Ji-Paraná	Governador Jorge Teixeira, Jaru, Ji-Paraná, Mirante da Serra, Nova União Ouro Preto do Oeste, Presidente Médici, Teixeirópolis, Theobroma, Urupá, Vale do Paraíso
microregion Vilhena	Chupinguaia, Parecis, Pimenta Bueno, Primavera de Rondônia, São Felipe D'Oeste, Vilhena

Source: IBGE [51].

For data processing, the SPSS statistical tool, version 23, was used as an instrument to calculate the crime and social vulnerability rates, idealized by the research, based on the technique of multifactorial analysis. The model in question follows the calculation reasoning proposed or applied by Reis, 2001[52];; Hair et al., [53]; Santana, [54];, Gama et al.,[55]; Santana, [56]; Cavalcante, [1]; Favero; Belfiore, [57].

3.1 Indicators raised by the survey

The indicators surveyed and which were part of the analysis of this work are listed in Table 2. For the crime indicator constructed in this study, it followed those presented in the atlas of violence in Brazil, prepared by IPEA. The social vulnerability indicator, named as it represents social factors that we believe are somehow related to factors that, in principle, have the potential to interfere with crime, were chosen based on available data, at the municipal level, by official bodies.

Table 2: Description of the crime and social vulnerability criteria used by the research

Index	Indicator	Year	Source
Crime	Rate of victims of traffic accidents (100,000 Inhabitants)	2017	IPEA (www.ipeadata.gov.br)
	Murder rate (100,000 Inhabitants)		
	Suicide rate (100,000 Inhabitants)		
	Proportion of traffic accidents as a cause of mortality		
	Proportion of traffic accidents as a cause of mortality among young people aged 15 to 29 years		
	Proportion of homicides as a cause of mortality		
	Proportion of homicides as a cause of mortality among young people aged 15 to 29 years		
	Proportion of suicides as a cause of mortality (2017)		
	Proportion of suicides as a cause of mortality among young people aged 15 to 29 years		
Social vulnerability	Proportion of people living in extreme poverty (%)	2018	National Confederation of Municipalities (https://www.cnm.org.br/municipios/registros/100111/todos)
	Mortality rate	2017	State Observatory for Regional Development (http://www.odr.ro.gov.br/home/municipioperfil#)
	Infant mortality (deaths per thousand live births)	2017	IBGE (https://cidades.ibge.gov.br/)
	Hospitalizations for diarrhea (hospitalizations per thousand inhabitants)	2016	
	Total population served with water supply	2017	National Sanitation Information System

	Total population served with sanitary sewage	2017	(http://app4.cidades.gov.br/serieHistorica/#)
	Total population served in the municipality with waste collection	2017	
	Illiteracy rate	2010	IBGE (Censo demográfico)
	School dropout - early years (1st to 5th year) (%)	2017	National Confederation of Municipalities (https://www.cnm.org.br/municipios/registros/100111/todos)
	School dropout - final years (6th to 9th grade) - base year 2017 (%)	2017	
	Percentage of employed population	2017	IBGE (https://cidades.ibge.gov.br/)
	Unemployment rate 16 years and+	2010	IBGE (demographic census)
	child labor rate	2010	IBGE (demographic census)

Source: Research data.

The scale adopted for analysis followed the following classification: Level 1: 0.000 to 0.100 (extremely low); Level 2: 0.101 to 0.200 (very low); Level 3: 0.201 to 0.300 (low); Level 4: 0.301 to 0.400 (medium to low); Level 5: 0.401 to 0.500 (average); Level 6: 0.501 to 0.600 (medium to high); Level 7: 0.601 to 0.700 (high); Level 8: above 0.701 (very high). Based on the two indices constructed in this study, they were related using the regression graphics of SPSS, version 23. For the calculations of correlations, they were made using the statistical package of Excel, version of Windows 10 Pro, version updated in 2020.

IV. DATA RESULTS AND DISCUSSION

When analyzing Table 3, we highlight only the performances considered "high" and "very high", that is, indexes above 0.600. In this sense, in relation to the crime rate, it was found that 9.62% of the municipalities in Rondônia were at this level, presenting performance either "high" or "very high". In relation to the social vulnerability index, 13.46% of the municipalities in the state presented performances at this level, in relation to the period of data collection used in this study. When analyzing based on the mesoregional scenario, it appears that 20% of the municipalities were concentrated in this same performance range, both for the crime rate and for the social vulnerability index. In the East Rondoniense mesoregion, this performance level was 7% and 14% of the municipalities, respectively.

But, when analyzing the performances above 0.500 ("medium to high" or higher) where it can represent an alert in terms of strategic vision on the subject, it appears that 19% of the municipalities in the State have crime rates in this range. In terms of social vulnerability, this percentage rises to half of the municipalities in Rondônia, which is still a concern.

From the mesoregional point of view, the situation is even more worrying, because in relation to the crime rate, where 30% of the municipalities in the Madeira-Mamoré mesoregion are in this range. In relation to the social vulnerability index, this percentage rises to 70% of the municipalities. In the East Rondoniense mesoregion, the result is milder, where 17% of the municipalities had a crime rate in this performance range and, in relation to the social vulnerability index, 45% of them are also in this range.

Table 3: Crime rate and social vulnerability in the municipalities of the state of Rondônia, by microregion.

MICROREGIONS	MUNICIPALITIES BY MICROREGION	Crime Index	Index Vulnerability
GUAJARÁ-MIRIM	Costa Marques	0,239	0,731
	Guajará-Mirim	0,268	0,584
	São Francisco do Guaporé	0,605	0,512
PORTO VELHO	Buritis	0,346	0,486
	Campo Novo de Rondônia	0,631	0,597
	Candeias do Jamari	0,528	0,600

	Cujubim	0,363	0,594
	Itapuã do Oeste	0,397	0,438
	Nova Mamoré	0,475	0,632
	Porto Velho	0,369	0,276
ALVORADA DO OESTE	Alvorada D'Oeste	0,199	0,498
	Nova Brasilândia D'Oeste	0,329	0,508
	São Miguel do Guaporé	0,462	0,421
	Seringueiras	0,374	0,382
ARIQUEMES	Alto Paraíso	0,517	0,606
	Ariquemes	0,475	0,258
	Cacaulândia	0,668	0,470
	Machadinho D'Oeste	0,442	0,480
	Monte Negro	0,446	0,424
	Rio Crespo	0,044	0,503
	Vale do Anari	0,330	0,629
CACOAL	Alta Floresta D'Oeste	0,432	0,504
	Alto Alegre dos Parecis	0,385	0,754
	Cacoal	0,287	0,212
	Castanheiras	0,161	0,462
	Espigão D'Oeste	0,360	0,390
	Ministro Andreazza	0,537	0,469
	Novo Horizonte do Oeste	0,664	0,523
	Rolim de Moura	0,423	0,313
	Santa Luzia D'Oeste	0,293	0,632
COLORADO DO OESTE	Cabixi	0,588	0,485
	Cerejeiras	0,387	0,415
	Colorado do Oeste	0,368	0,393
	Corumbiara	0,143	0,536
	Pimenteiras do Oeste	0,306	0,458
JI-PARANÁ	Governador Jorge Teixeira	0,386	0,709
	Jaru	0,460	0,287
	Ji-Paraná	0,337	0,232
	Mirante da Serra	0,545	0,556
	Nova União	0,239	0,582
	Ouro Preto do Oeste	0,334	0,305
	Presidente Médici	0,310	0,495
	Teixeirópolis	0,491	0,546
	Theobroma	0,466	0,586
	Urupá	0,358	0,546

	Vale do Paraíso	**0,156**	**0,581**
VILHENA	**Chupinguaia**	**0,677**	**0,395**
	Parecis	**0,347**	**0,673**
	Pimenta Bueno	**0,462**	**0,275**
	Primavera de Rondônia	**0,180**	**0,545**
	São Felipe D'Oeste	**0,342**	**0,539**
	Vilhena	**0,397**	**0,205**

Source: Research data.

Therefore, a worrying state scenario is evidenced in relation to the two indices shown in this study, to a lesser and/or greater degree, considering the microregions of the two mesoregions of the State. The question now is how these two indices relate to each other within a municipal context. It can be seen that the five municipalities with the highest crime rates, in descending order, were: Chupinguaia (0.677), Cacaulândia (0.668), Novo Horizonte do Oeste (0.664), Campo Novo de Rondônia (0.631) and São Francisco do Guaporé (0.605. And the five municipalities that had the lowest crime rates were: Rio Crespo (0.044), Corumbiara (0.143), Vale do Paraíso (0.156), Castanheiras (0.161) and Primavera de Rondônia (0.180).

Regarding the social vulnerability index, it appears that the five municipalities in Rondônia with the highest indexes were, in descending order: Alto Alegre dos Parecis (0.754), Costa Marques (0.731), Governador Jorge Teixeira (0.709), Nova Mamoré (0.632) and Santa Luzia do Oeste (0.632). When analyzing the five municipalities with the lowest rates of social vulnerability, the following sequence is obtained: Vilhena (0.205), Cacoal (0.212), Ji-Paraná (0.232), Pimenta Bueno (0.275) and Porto Velho (0.276). In general, it is possible to verify, based on the results presented so far, that a tendency of internalization of the problems of criminality and social vulnerability in the state of Rondônia, based on the indicators worked in this study and the time cut carried out, which concerns current data available from official sources.

This process of internalization has been pointed out by some researchers in different studies carried out in the country. In this sense, according to the Map of Violence [58], between 2000 and 2011, violence in Brazil underwent a process of dissemination and internalization due to having moved from large municipalities - above 100 thousand inhabitants - for small towns. For Waiselfisz [59] the growth of homicides in the 'inland' of the country did not occur homogeneously, but some states contributed more decisively to this increase. In 2008, this same author already pointed out that the increase in homicides in smaller municipalities was due to the fact that a process of relevant decentralization and deconcentration of economic development is underway in the country, with the emergence of new growth poles in the interior. And this new territorial dynamics of development would, therefore, also impact the geographic distribution of violence in the country [60].

Society, in general, seeks to curb criminal activities. For these activities to undergo a process of decline in a social structure, elements such as, for example, the structuring of police apparatus, educational training, job offer, planned urbanization and income distribution must emerge [61]. Battela; Diniz[62], in turn, state that the crime pattern in a region is linked to regional characteristics, such as location and concentration of wealth. It is noted that there are regions in Rondônia where the problem of violence is more striking, but in other municipalities, however, the issue of social vulnerability, although violence is noticeable, shows an equally important concern. Thus, the challenge for public security lies in devising interrelated strategies between “end” activities, which are actions aimed at reducing crime through institutional control, and “means” activities, which are actions aimed at to soften and create opportunities for social inclusion aiming at improving the quality of life.

In this sense, one should, for example, question the role of the public manager in stimulating the development of municipalities located in frontier strips based on the logic of economic, social, political-institutional and environmental integration, aiming at a more effective process in terms of regional development policies, along with the view that such border regions are also the focus of illicit trafficking, drug trafficking, income concentration, poverty, etc. terms of strategic vision. What is sought here is to expose exactly this aspect, where the basis of decision-making regarding the role of the State in conducting public policies, in the case portrayed here of public security, can find concomitant mechanisms of action, both in the scenario of "cause -effect", where police control of security to society is more active, as well as in

interdisciplinary actions of a more transversal nature, where public security can connect to other areas of public action aiming to minimize social vulnerability, through a strategic vision that permeates the generation of employment and income, leisure, education, health, in short, ways to satisfy the basic needs of the population, as already pointed out by the Maslow scale.

According to Batella; Diniz[62], variables such as wealth, income inequality, infrastructure, education and population structure have impacts on the occurrence of criminal acts. Shikida; Oliveira[63] states that despite there being a bilateral relationship between crime and development, there is evidence that socioeconomic factors are the cause of crime. According to these same authors, it is believed that as development indicators increase, the incidence of crimes tends to decrease. Therefore, given the context brought by the present research, which deals with the meso and micro-regional approach in Rondônia, and at this point inserting a fact considered relevant by the present research, where the environmental issue, within an institutional context, has been impacting more strongly the Madeira mesoregion -Guaporé in relation to East Rondoniense.

In the micro-regions of Porto Velho and Guajará-Mirim, the highest rates of crime and social vulnerability, respectively, were concentrated in the average of the observed municipal performances. The two highlighted microregions, as already demonstrated, are part of the Madeira-Guaporé mesoregion. This mesoregion in Rondônia has the highest environmental indices in the State, a fact that is intended to be a logical element of analysis in the work of building a vision for the establishment of a more effective public security strategic planning management for the State of Rondônia. Based on the indices constructed by the present study, correlations were made between them based on the groupings by microregions of Rondônia, which can be seen in Table 4, below.

Table 4: Correlations between crime rates and social vulnerability by microregions in Rondônia.

Mesoregions	microregions	Correlation
Madeira-Guaporé	Guajará-Mirim	**-0,7966**
	Porto Velho	**0,54363**
East Rondoniense	Alvorada do Oeste	**-0,66753**
	Ariquemes	**-0,18299**
	Cacoal	**0,126231**
	Ji-Paraná	**-0,02574**
	Vilhena	**-0,43071**

Source: Research data.

The result indicates a strong and negative correlation in the microregions of Guajará-Mirim (-0.80) and Alvorada do Oeste (-0.67). The Porto Velho micro-region presented a positive correlation of 0.54 and the other micro-regions surveyed showed a very insignificant correlation, indicating that there are other factors that can explain this behavior. In the case of the Guajará-Mirim micro-region, such values indicate that 80% of the violence can be explained by the behavior of social vulnerability and vice versa, in a negative way, that is, the higher one of the indices, the lower the other. This result indicates that more studies are needed on the subject, in order to bring new readings about this scenario that shows to be quite varied among the microregions surveyed in Rondônia. However, it is evident that the Madeira-Guaporé mesoregion presented, in microregional terms, performances that indicate a different scenario in relation to the other microregions of the State. Thus, this research suggests that Rondônia's public security policy should not be based only on a single indicator, as it can lead to a somewhat mistaken regional reading. Therefore, it is worth mentioning that this is done based on a set of indicators, through readings of constructed indices, from scientific techniques and instruments, in order to allow the micro-regional peculiarities to be perceived and that such a policy is appropriate for each of observed realities. With this, expanding the vision of abstraction of the problem of public security in Rondonia and, consequently, adjusting the strategic planning, in order to understand its regional inequalities.

V. FINAL CONSIDERATIONS

The first hypothesis built in this study is confirmed and valid, which says: "If the crime and social vulnerability rates identified by the research point to a scenario of greater impact in the micro-regions of Porto Velho and Guajará-Mirim, then the context of the approach brought by the research finds a foundation and makes logical and coherent the inequalities brought about in the mid-regional scope of Rondônia, which must be taken into account for the strategic planning of public security";

It is essential that the strategic planning of public security in Rondônia adopts technical, meso and micro-regional criteria, using quantitative and/or qualitative data, subject to comparative analysis, such as the one brought by the research, in order to facilitate the decision-making process decision-making to establish different strategies to be taken in relation to regions and their specificities that make them unique and specific, requiring different visions for different scenarios;

The results found for Rondônia in relation to crime and social vulnerability rates showed consistency with the theoretical and methodological foundations of the research, thus revealing its validation from a scientific point of view;

With this study, the internalization of violence in Rondônia is evidenced, which confirms the tendency of this scenario at the national level in relation to the studies shown here;

It becomes worrying and urgent the need to build a systematized and standardized database on the reality of Rondônia focused on the area of interest of public security in the State, where it is suggested the creation of a statistical department within the framework of the structure of the public security of the State, as has been observed in other regions of Brazil.

REFERENCES

[1] CAVALCANTE, F.R.C. Análise da desigualdade regional no estado de Rondônia à luz da teoria institucionalista de Douglass North. 2011. Tese (Doutorado). Núcleo de Altos Estudos Amazônicos, Universidade Federal do Pará, Belém-PA, 2011.

[2] CAVALCANTE, F.R.C.; SILVA, F. C. . Desenvolvimento e conservação no Estado de Rondônia: uma análise a partir do institucionalismo de Douglass North. **Papers do NAEA** (UFPA), v. 285, p. 3-29, 2011.

[3] CAVALCANTE, F.R.C.. Formação Institucional e Desenvolvimento Regional no Estado do Rondônia. In: SILVA, F.C. e RAVENA, N. (Org.). **Formação Institucional daAmazônia**. 1ed.Belém: Editora do NAEA, 2015, v. 1, p. 391-472

[4] PORTER, M. **Vantagem competitiva**: criando e sustentando um desempenho superior. Rio de Janeiro: Editora Campus, 2001.

[5] DE TONI, J. A retomada do planejamento estratégico governamental no Brasil. **Revista RBPO**, v. 4, n. 1, p. 4 – 20, 2014.

[6] PFEIFFER, P.. **Planejamento estratégico municipal no Brasil**: uma nova abordagem. Brasília: ENAP, 2000. 37 f. (Texto para discussão, 37).

[7] REZENDE, F. **Planejamento no Brasil**: auge, declínio e caminhos para a reconstrução. Brasília, DF: CEPAL; Escritório no Brasil/IPEA, 2010. (Texto para Discussão, n. 4). 69p.

[8] MATIAS-PEREIRA, José. Manual de Gestão Pública contemporânea. São Paulo: Editora Atlas, 2009.

[9] SANTOS, C. S. dos. **Introdução à gestão pública**. 2. ed. São Paulo: Saraiva, 2008.

[10] REZENDE, F. Planejamento no Brasil: auge, declínio e caminhos para a reconstrução. *In*: CARDOSO JR., J.C. (Org.). **A reinvenção do planejamento governamental no Brasil**. Brasília: Ipea, 2011, v.4, cap. 2, p. 177-238 (Diálogos para o Desenvolvimento).

[11] DE TONI, J. Em busca do planejamento governamental do século XXI − novos desenhos. *In*: REPETTO, F. et al. **Reflexões para Ibero−América**: Planejamento Estratégico. Brasília: ENAP, 2009, p.21-36. Disponível em: http://antigo.enap.gov.br/files/Caderno_EIAPP_Planejamento_Estrategico.pdf. Acesso em:. 6 dez 2019.

[12] LOPES, C. **Planejamento, Estado e Crescimento**. São Paulo: Livraria Pioneira Editora, 1990.

[13] CUNHA, C.G.S. da. **O plano plurianual como instrumento de planejamento e gestão**. 2011. 69 f. Trabalho de Conclusão de Curso (Especialização em Administração Pública) – Faculdade de Administração Pública Contemporânea, Universidade Federal do Rio Grande do Sul, Porto Alegre, 2011. Disponível em: <http://www.lume.ufrgs.br/handle/10183/70067>. Acesso em: 5 dez 2019.

[14] SOUZA, A. As trajetórias do planejamento governamental no Brasil: meio século de experiências na administração pública. **Revista do Serviço Público**, Ano 55, n. 4, p. 5-29, 2004.

[15] CARDOSO JR., J.C.; MELO, V. Papel e importância de planos nacionais de desenvolvimento. *In*: CARDOSO JR., J.C. (Org.). **A reinvenção do planejamento governamental no Brasil**. Brasília: Ipea, 2011, v.4, p. 9-29 (Diálogos para o Desenvolvimento).

[16] MELO, V. Planos nacionais de desenvolvimento: experiência brasileira e lições para o futuro. *In*: CARDOSO JR., J.C. (Org.). **A reinvenção do planejamento governamental no Brasil**. Brasília: Ipea, 2011, v.4, cap. 3, p. 239-286 (Diálogos para o Desenvolvimento).

[17] COSTA-FILHO, A. Estado-Nação e construção do futuro. *In*: CARDOSO JR., J.C. (Org.). **A reinvenção do planejamento governamental no Brasil**. Brasília: Ipea, 2011, v.4, cap. 4, p. 287-304 (Diálogos para o Desenvolvimento).

[18] PAULO, L.F.A.. O PPA como instrumento de planejamento e gestão estratégica. Brasília: **Revista do Serviço Público**, v. 61, n. 2, p. 171-187, 2010.

[19] SANTOS, E.A.V. dos. O confronto entre o planejamento

governamental e o PPA. *In*: CARDOSO JÚNIOR., J.C. (Org.). **A reinvenção do planejamento governamental no Brasil**. Brasília: Ipea, 2011, v.4, cap. 5, p. 307-336. (Diálogos para o Desenvolvimento).

[20] VAZ, G.C. A delicada disputa pelas cabeças na evolução do serviço público no Brasil pós-redemocratização. **Cadernos ENAP**, número especial, 2006.

[21] CUNHA, S.R.P.; NEVES, A.J. A experiência de Rondônia em planejamento. **Saber Científico**, Porto Velho, v. 1, n. 2, p. 156 - 177, 2008.

[22] GOVERNO DE RONDÔNIA. Decreto nº 23.698, de 27 de fevereiro de 2019. Aprova o Plano Estratégico da Segurança Pública, Defesa e Cidadania do Estado de Rondônia.

[23] BRASIL. Constituição da República Federativa do Brasil de 1988.

[24] KAHN, T.; ZANETIC, A. **O papel dos municípios na segurança pública**. Relatório final: concursos nacionais em pesquisas aplicadas em justiça criminal e segurança pública. Brasília: Senasp — Secretaria Nacional de Segurança Pública, 2005.

[25] SILVA JÚNIOR, E.L. da. **Política e segurança pública**: uma vontade de sujeição. Rio de Janeiro: Contraponto, 2009.

[26] BALLESTEROS, P.R. Gestão de políticas de segurança pública no Brasil: problemas, impasses e desafios. **Rev. bras. segur. pública**, São Paulo, v. 8, n. 1, p. 6-22, 2014.

[27] BRASIL. **Plano Nacional de Segurança Pública e Defesa Social 2018-2028**. Brasília: Secretaria Nacional de Segurança Pública/Ministério da segurança pública, 2018.

[28] CRUZ, G. B. A historicidade da segurança pública no Brasil e os desafios da participação popular. **Cadernos de Segurança Pública**, ano 5, n. 4, p. 1-9, 2013.

[29] LESSA, S.A.B.. **Planejamento Estratégico e Política de Segurança Pública**: Análise do Processo de Formulação das Políticas de Segurança Pública Implementadas pelo Estado de Rondônia no período de 2008 a 2017. 2018. 213 f. Tese (Doutorado em Ciência Política) - Instituto de Filosofia e Ciências Humanas, Universidade Federal do Rio Grande do Sul Porto Alegre, 2018.

[30] FERREIRA, N.J.C. Planejamento estratégico em segurança pública. Disponível em: http://www.institutoelo.org.br/site/files/publications/19e29602fb9f25c79df6dc450e6c25dc.pdf. Acesso em: 6 dez 2019

[31] SANTOS, M. J.; KASSOUF, A. L. Estudos Econômicos das causas da Criminalidade no Brasil: Evidências e Controvérsias. **Economia Aplicada**, v. 9, n. 2, p. 343-372, 2008.

[32] FÓRUM BRASILEIRO DE SEGURANÇA PÚBLICA. **O novo Sistema Único de Segurança Pública**: questões sobre financiamento da segurança pública. São Paulo: Fórum Brasileiro de Segurança Pública, 2019. 52 p.

[33] WAISELFISZ, J.J.. **Mapa da violência 2013**: acidentes de trânsito e motocicletas. Rio de Janeiro: CEBELA-FLACSO, 2013.

[34] CAMARA DOS DEPUTADOS. **Agenda de segurança cidadã** [recurso eletrônico]: por um novo paradigma. Brasília: Câmara dos Deputados, Edições Câmara, 2018. – (Série cadernos de trabalhos e debates; n. 2 E-book).

[35] UNODC, **Global Study on Homicide**: Homicide: extent, patterns, trends and criminal justice response. Vienna: UNODC, 2019.

[36] CGPES/DEPAID/SENASP/MJ. Diagnóstico dos homicídios no Brasil : subsídios para o Pacto Nacional pela Redução de Homicídios. Brasília: Ministério da Justiça, Secretaria Nacional de Segurança Pública, 2015. 271 p.

[37] JANUÁRIO, J.R.; NASCIMENTO, A.G.O.; FIORAVANTE, E.F.. Custo do bem-estar social de controle criminal na Amazônia Ocidental. **Rev. Cadernos de Campo**, Araraquara, n. 22, p. 221-243, 2017.

[38] IPEA/FBSP. **Atlas da violência 2019**. Brasília: Rio de Janeiro: São Paulo: Instituto de Pesquisa Econômica Aplicada; Fórum Brasileiro de Segurança Pública. 2019.

[39] RICCIO, V.; FRAGA, P.; ZOGAHIB, A.; AUFIERO, M. **Segurança Pública e Violência no Amazonas**: uma análise a partir da percepção da população e dos integrantes do sistema de justiça criminal. Disponível em: http://cesam.org.br/wp-content/uploads/2018/08/seguranca-publica-e-violencia-no-amazonas-uma-analise-a-partir-da-percepcao-da-populacao-e-dos-integrantes-do-sistema-de-justica-crimin.pdf. Acesso em: 6 dez 2019.

[40] NASCIMENTO, D.M.; CASTRO, J.L.G.; FERREIRA, A. dos S.; QUARESMA, E.S.; GUIMARÃES, S.G.Q. de A.. Criminalidade na Amazônia brasileira: motivação do crime na perspectiva do criminoso apenado em uma cidade média do Oeste do estado do Pará, Brasil. **Paper do NAEA** 313, Novembro de 2013.

[41] FRAGA, Paulo Cesar Pontes. A Geopolítica das drogas na América Latina. **Em Pauta**, v.10, n. 1, p. 83-105, 2007.

[42] DELUCHEY, J.F.Y.. Para além das desigualdades regionais na segurança pública: um olhar na região norte amazônica. *In*: ZIMERMAN, Artur (org.). **Políticas de segurança pública**. Santo André, SP: UFABC, 2017, cap. 1, p. 11-79. Disponível em: http://livroaberto.ufpa.br/jspui/handle/prefix/297. Acesso em:. 6 dez 2019.

[43] MACHADO, P.M.T. Violência e Cárcere em Rondônia. *In*: **Anuário Brasileiro de Segurança Pública 2014 a 2017**. São Paulo: FBSP, Edição especial 2018.

[44] LESSA, S. A. B.; SILVA, L. L. B. Os organismos de segurança pública do estado de Rondônia e o combate aos crimes transnacionais. In: SEMINÁRIO INTERNACIONAL DE CIÊNCIA POLÍTICA: ESTADO E DEMOCRACIA EM MUDANÇAS NO SÉCULO XXI, 1., 2015, Porto Alegre. **Anais...** Porto Alegre: Sicp, set. 2015.

[45] PEREIRA FILHO, O.A.; TANNURI-PIANTO, M.E.; SOUSA, M. da C.S. de. Medidas de custo-eficiência dos serviços subnacionais de segurança pública no Brasil: 2001-2006. **Economia Aplicada**, v. 14, n. 3, p. 313-338, 2010.

[46] JANCZURA, R. Risco ou vulnerabilidade social?. **Textos & Contextos**, Porto Alegre, v. 11, n. 2, p. 301 - 308, 2012.

[47] RUOTTI, C.; MASSA, V.C.; PERES, M.F.T. Vulnerability and violence: a new conception of risk for the study of youth homicides. **Interface - Comunic., Saude, Educ**., v.15, n.37, p.377-89, 2011.

[48] MONTEIRO, S. R. R. P. O marco conceitual da vulnerabilidade social. **Sociedade em Debate**, Pelotas, v.

17, n. 2, p. 29-40, 2011.

[49] ABRAMOVAY, M.; CASTRO, M. G., PINHEIRO, L.C.; LIMA, F.S.; MARTINELLI, C.C. da. **Juventude, violência e vulnerabilidade social na América Latina**: desafios para políticas públicas. Brasília: UNESCO/BID, 2002. 192 p.

[50] ABRAMOVAY, Miriam; FEFFERMANN, Marisa; RÉGNIER, Jean-Claude. Coesão social e vulnerabilidade no Brasil juventudes e violências. **Poiésis: Revista do Programa de Pós-Graduação em Educação**, número especial, p. 165-183, 2012. Disponível em: http://www.portaldeperiodicos.unisul.br/index.php/Poiesis/article/view/1172. Acesso em: 6 dez. 2019.

[51] IBGE. Divisão regional do Brasil em regiões geográficas imediatas e regiões geográficas intermediárias: 2017. Rio de Janeiro: IBGE, 2017. 82p.

[52] REIS, E. **Estatística multivariada aplicada**. 2. ed. Lisboa: Silabo, 2001.

[53] HAIR, J. F. et al. **Análise multivariada de dados**. 5. ed. Porto Alegre: Bookman, 2005. 730 p.

[54] SANTANA, A. **Elementos de economia, agronegócio e desenvolvimento local**. Belém: GTZ; TUD; UFRA, 2005.

[55] GAMA, Z. J. C. ; SANTANA, A. C. de. ; MENDES, F. A. T. ; KHAN, A. S. Índice de desempenho competitivo das empresas de móveis da região metropolitana de Belém. **Revista de economia e agronegócio**, v. 5, p. 127-159, 2007.

[56] SANTANA, A. Análise do desempenho competitivo das agroindústrias de polpas de frutas do Estado do Pará. **Revista de economia e sociologia rural**, v. 45, n. 3, Brasília, 2007.

[57] FÁVERO, L.P.; BELFIORE, P. **Manual de análise de dados**: estatística e modelagem multivariada com Excel, SPSS e Stata. 1º Ed. Rio de Janeiro: Elsevier, 2017.

[58] WAISELFISZ, J.J.. **Mapa da violência 2014**: os jovens do Brasil. Rio de Janeiro: FLACSO, 2014.

[59] WAISELFISZ, J.J.. **Mapa da violência 2012**: os novos padrões da violência homicida no Brasil. São Paulo: Instituto Sangari, 2012.

[60] WAISELFISZ, J. J. **Mapa da violência dos municípios Brasileiros**. Secretaria Nacional de Juventude. Brasília/DF, 2008.

[61] SHAEFER, G. J.; SHIKIDA, P. F. A.. Economia do crime: elementos teóricos e evidências empíricas. **Revista de Análise Econômica**, Porto Alegre, v.19, n. 36, p.195-217, 2001.

[62] BATELLA, W. B.; DINIZ, A. M. A.. Análise espacial dos condicionantes da criminalidade violenta no estado de Minas Gerais. **Sociedade & Natureza**, Uberlândia, v.22, n.1, p.151-163, 2010.

[63] SHIKIDA, P. F. A.; OLIVEIRA, H. V. N.. Crimes violentos e desenvolvimento socioeconômico: um estudo sobre a mesorregião Oeste do Paraná. **Revista Brasileira de Gestão e Desenvolvimento Regional**, Taubaté, v.8, n.3, p.99-114, 2012.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.2

Regional development of free trade areas in the context of the tax incentive policy of the Manaus free trade zone – Amazonas, Brazil

Fabio Robson Casara Cavalcante[1], Carlos Alberto Paraguassú-Chaves[2], Ana Maria Morais da Fonseca Cavalcante[3], Fabrício Moraes de Almeida[4], Lenita Rodrigues Moreira Dantas[5], Carla Dolezel Trindade[6], Simão Aznar Filho[7], Ruy Drummont Smith[8], Simão Dolezel Aznar[9], Márcia Maria Rodrigues Uchôa[10], Marcélio Rodrigues Uchôa[11]

[1]PhD in Sciences: Socio-environmental development - NAEA / UFPA. Associate Professor, Federal University of Rondônia – UNIR.
[2]PhD in Health Sciences -University of Brasília - UnB, Brazil; Post-Doctor in Health Sciences - UnB and Degli Studi D'Aquila University - Italy. Full Professor at the Rio de Janeiro Institute Faculty, Brazil
[3]Master in Agronomy from the Federal University of Pernambuco (UFPE), Brazil. Voluntary researcher at the Higher Institute of Health Sciences and the Environment of the Amazon – AICSA.
[4]PhD in Physics (UFC), with post-doctorate in Scientific Regional Development (DCR/CNPq). Researcher of the Doctoral and Master Program in Regional Development and Environment (PGDRA/UNIR).
[5]Geographer expert and lawyer. Researcher of the Institute of Health Sciences and the Amazon environment - AICSA.
[6]PhD in Law - Universidad Nacional de Lomas de Zamora (Argentina). Post-doctorate - Universita deli Studi di Messina (Italy). Full Professor at the University Institute of Rio de Janeiro - IURJ, Brazil.
[7]PhD in Law - Universidad Nacional de Lomas de Zamora (Argentina). Post-doctorate - Universita deli Studi di Messina (Italy). Full Professor at the University Institute of Rio de Janeiro - IURJ, Brazil.
[8]Master in Legal Sciences from the Autonomous University of Lisbon. Adjunct Professor at the Faculty Instituto Rio de Janeiro, Brazil.
[9]Graduated in Law. Master of Law Student, Specialist in Law. Professor at the University Institute of Rio de Janeiro, Brazil.
[10]PhD in Social Sciences from the Pontifical Catholic University (PUC/SP). Adjunct Professor at the Federal University of Rondônia, Brazil.
[11]PhD in Education from the Pontifical Catholic University of São Paulo (PUC/SP). Associate Professor at Faculdade Instituto Rio de Janeiro, Brazil.

Received: 05 Apr 2022,
Received in revised form: 27 Apr 2022,
Accepted: 03 May 2022,
Available online: 07 May 2022

Keywords*— *SUFRAMA, Regional development, Indicators, Indexes.

***Abstract*—** *The research brings in its scope the need to analyze the socioeconomic development of the municipalities of Tabatinga (Amazonas), Guajará-Mirim (Rondônia), Boa Vista and Bonfim (Roraima), Macapá and Santana (Amapá) and Brasiléia (Acre), with extension for the municipality of Epitaciolândia, and Cruzeiro do Sul (Acre), which are subject to the fiscal incentive policy, in the form of Free Trade Areas, linked to the Superintendence of the Manaus Free Trade Zone - SUFRAMA. The general objective of the research was to analyze the regional development of the nine cities covered by the SUFRAMA policy in comparison with other nine Amazonian municipalities not covered by this policy, in order to identify the municipal performances achieved in the face of the Brazilian Amazonian reality. The research method used was hypothetical-deductive. The research data were submitted to the multivariate factor model to extract the scores for the construction of the indices, using the SPSS statistical tool, version 22. The data were submitted to the necessary requirements for the sieve of*

factorial studies, through the tests of Bartlett's sphericity and the adequacy of the Kaiser-Meyer-Olkin (KMO) sample. In this way, it was possible to build socioeconomic development indexes and, with that, proceed with the due analysis intrinsic to the epistemological question of this work. The data showed adequacy to factor studies and allowed us to observe, in general, the low level of socioeconomic development of the surveyed municipalities, however, with a more favorable situation for the municipalities covered by the SUFRAMA policy.

I. INTRODUCTION

Understanding the Amazon and its multiple interrelationships requires objectivity and clarity that permeates the logic of delimiting the theme, space and temporality in which the phenomena to be observed can be seen and analyzed within a rational and scientific construction. Thus, the theme of regional development, from the perspective of economic and social development, within the context of free trade areas linked to the Manaus Free Trade Zone (SUFRAMA) policy, allows us to understand aspects of the Amazonian reality, its multiple forms and identities that portray the regional challenges in promoting actions aimed at institutional strengthening and their own trajectory resulting from choices and decision-making under the aegis of collective or even institutional behavior, from public policies directed to the region.

The Amazon development challenge is not new. Its socio-environmental complexity has always been the scene of discussions and often seen as an obstacle under the more orthodox logic of economic growth, where more conventional models, such as agricultural production, especially in the 1960s, 1970s and 1980s, were driven by colonization. Agriculture in some regions of northern Brazil, such as Pará and Rondônia, allowed the rapid process of consolidation of these activities as a standardized style of development marked by agricultural culture. On the other hand, the immense Amazon biome and the need to preserve these natural environments allowed us to think of more heterodox forms of development and for such models to take into account perspectives and values based on aspects of sustainable development, a vision that is institutionalized worldwide, the from the Brundtland Report or Our Common Future Report, which served as the basis for the second UN Conference on environment and development, held in Rio de Janeiro, in 1992. In this sense, it is worth highlighting the observations brought by José Eli da Veiga when pointing to the difficult measurement of sustainable development, when signaling that it is not a concept, as much as social justice, but a utopian expression that is here to stay [1].

According to the same author, GDP per capita has always been used as an indicator of economic growth, signaling a scenario whose interpretation points to the economic strength of a region, of a country, for example, where the term “development” has been used for a long time, was closely identified only with economic growth. When trying to illustrate this situation in a more routine and empirical way, José Eli da Veiga quotes Cambridge professor, economist Joan Robinson, who made the following statement “development is like the elephant, very difficult to define, but very easy to recognize” [1].Thus, according to this author, the rupture between growth and economic development would only be possible if an alternative indicator to GDP per capita emerged. A fact, according to him, occurred when the United Nations - UN, through one of its organizational structures, the UNDP - United Nations Development Program, organized an immense collective effort that culminated in the creation of the HDI (Development Index) Human), which combines per capita income with the best health and education indicators. In this sense, it is worth highlighting the work of the Nobel Prize winner, Amartya Sen, in his work entitled “Development as freedom”, in which he reveals that there is a distinction between income inequality and economic inequality [2].

According to Santos et. al[3] this work by Amartya Sen calls into question the simplistic view that analyzed development only from the perspective of income, with a predominant view in the interpretations of the various schools of economic thought. Building on these same authors, Amartya Sen particularly focuses on the roles and interrelationships between certain instrumental freedoms that he considers crucial, including economic opportunity, political freedoms, social facilities, guarantees of transparency, and protective security. It also highlights, among other things, the mismatches observed between income and longevity in several countries [3]. In this way, the vision of development and sustainable development, contextualized here, walk exactly in the perspective of the complexity that goes far beyond that brought by a certain and unique indicator as a universal explanation factor of the degree of development. However, this is not intended

to be a standard model to be followed. We only signal a scientific path to better understand the scenario object of the present research, from a quantitative approach.

In this context, the Amazon reality was chosen as the scenario of the present study because this is the main region of biodiversity in the world and that there is an international attention in relation to economic activities in the perspective of sustainable development, which requires the government to carry out technical studies that can serve as a subsidy for the strategies and actions of the federal executive in the elaboration of effective public policies, which, among others, are the result of research that can shed light on the understanding and interpretation of the Amazon as an element of national economic integration. Thus, faced with such a scenario, Brazil created the policy of the Superintendence of the Manaus Free Zone (SUFRAMA) as a strategy to boost economic growth and regional development, without giving up environmental preservation and social justice.

Some questions arise that need to be answered: a) how to determine the level of regional development of municipalities in the Amazon based on the reality of SUFRAMA? b) how to carry out a comparative study between them and between other municipalities without access to such a policy? c) which indicators should be taken into account for this study? Thus, the epistemological problem raised in this study focuses on questioning whether the municipalities, objects of the present research, inserted in the Free Trade Areas contemplated by the SUFRAMA policy, present satisfactory socioeconomic aspects in terms of regional development, in comparison with the economic indicators and social aspects of municipalities not covered by the SUFRAMA policy, based on the theory of endogenous development and regional development poles associated with the institutionalist theory of Douglass North.

The hypotheses raised by the work, in turn, aimed to allow the construction of epistemological beacons and assumptions that allow conducting this work within the academic and scientific rigor. Thus, two hypotheses were raised in this study, namely: **H0**: If the economic and social development indices achieved by the municipalities in the LAC present a satisfactory performance and/or superior to the municipalities not served by the aforementioned policy, then it is understandable that the fiscal incentive policy linked to SUFRAMA has been giving positive results and deserves to be stimulated as a strategic and sustainable development path for the Amazon region, not implying, therefore, the need for intervention measures and adjustments of said public policy. **H1**: If, on the other hand, the economic and social development indexes achieved by the LAC municipalities present an unsatisfactory performance and/or inferior to the municipalities not covered by the aforementioned policy, then the fiscal incentive policy linked to SUFRAMA deserves to be analyzed in a in loco, aiming to determine the bottlenecks and challenges inherent to the policy in question, indicating the need for adjustments and adaptations, in order to make it effective, effective and efficient.

Regarding the general objective, it consisted of analyzing, based on economic and social indicators, the degree of regional development of the 9 (nine) municipalities in the Amazon selected and covered by the tax incentives policy of the Manaus Free Trade Zone, linked to the Free Trade Areas , as well as other 9 (nine) municipalities in the western Amazon not covered by the aforementioned policy, based on quantitative data available from official sources, in order to understand the current situation of the regions selected in this study and discuss the effectiveness of this policy as a vector of regional development based on the theoretical foundations of the research.

Thus, given the context of economic globalization and the need to establish national policies to stimulate the development of regions with a significant presence of legally protected areas, such as the Brazilian Amazon and the Manaus Free Trade Zone policy, this work demonstrates its importance to the to analyze a regional context based on a vision of a pole of development inserted in a reality of economic freedom, which indicates the existence of an important paradox to be analyzed and discussed within science. With this, we seek to fill a fertile space in terms of analysis of regional economic development policies in the country, based on solid theoretical and methodological foundations capable of bringing light and contributions to the debates around this theme.

II. RESEARCH METHODOLOGY

2.1 TYPE OF SEARCH

This is a quantitative research of the experimental type, which will seek to raise indicators for later calculation of the index for purposes of comparison between the municipalities selected for this study.

2.2 UNIVERSE AND SAMPLE

Within the universe of 92 municipalities located on the border strip in the Brazilian Western Amazon [4],9 municipalities covered by the Free Trade Areas policy were surveyed, namely: Tabatinga (Amazonas), Guajará-Mirim (Rondônia), Boa Vista and Bonfim (Roraima),

Macapá and Santana (Amapá) and Brasiléia, with extension to the municipality of Epitaciolândia, and Cruzeiro do Sul (Acre) and 9 more municipalities, for comparison purposes, not covered by the aforementioned policy, namely: Feijó, Sena Madureira and Taraucá (Acre), Barcelos, Benjamin Constant and Boca do Acre (Amazonas) and Buritis, Nova Mamoré and Pimenta Bueno (Rondônia), totaling a sample of 18 municipalities along the border of the Western Amazon that participated in this study, with the years 2010 and 2018 being the two periods chosen for data collection. For this, the following acronyms of the municipalities selected in this work were adopted in order to facilitate the process of calculation and presentation of data, as follows: Tabatinga (TAB), Guajará-Mirim (GUA), Boa Vista (BOA), Bonfim (BOM), Macapá (MAC), Santana (SAN), Brasiléia (BRA), Epitaciolândia, (EPI), Cruzeiro do Sul (CRU), Feijó (FEI), Sena Madureira (SEN), Taraucá (TAR), Barcelos (BAR), Benjamin Constant (BEN), Boca do Acre (BOC) and Buritis (BUR), Nova Mamoré (NOV) and Pimenta Bueno (PIM).

2.3 DATA COLLECTION

The economic and social indicators collected from institutional sources are shown in Table 1 below.

Table 1: Initial survey of quantitative data for the preparation of the regional development index

THEME	INDICATORS	SOURCE
economic index	Gross Domestic Product per capita, at current prices (R$ 1.00)	IBGE (Statistics)
	Share of gross value added at current prices of agriculture in the gross value added at current prices of agriculture in the federation unit (%)	IBGE (Statistics)
	Share of gross value added at current industry prices in gross value added at current industry prices in the federation unit (%)	IBGE (Statistics)
	Share of gross value added at current prices of services, administration, defence, education and public health and social security, in added value	IBGE (Statistics)
	Share of gross value added at current prices total in gross value added at current prices total of the federation unit (%)	IBGE (Statistics)
	Gross Domestic Product, at current prices (R$ 1,000)	IBGE (Statistics)
	number of cattle	IBGE (Municipal livestock research)
	Rice production (% in relation to the state)	IBGE (municipal agricultural production)
	Coffee production (% in relation to the state)	IBGE (municipal agricultural production)
	Value of Production of Brazil Nuts (thousand BRL)	IBGE (Production of plant extraction and forestry)
	Value of the production of round wood (Thousand BRL)	IBGE (Production of plant extraction and forestry)
social index	Population served with water supply (%)	IBGE (demographic census)
	Unit No. Health (per thousand inhabitants)	DATASUS
	Number of beds (per thousand inhabitants)	DATASUS
	Number of doctors (per thousand inhabitants)	DATASUS
	IFDM Consolidated	Firjan

	IFDM Employment & Income	Firjan
	IFDM Education	Firjan
	IFDM Health	Firjan
	IDEB - Elementary school (early years)	INEP
	IDEB - Elementary school (final years)	INEP

Source: Own elaboration

Table 2: Survey of quantitative data effectively worked on for the preparation of the regional development index of the present study

THEME	INDICATORS	SOURCE
economic index	Gross Domestic Product per capita, at current prices (R$ 1.00)	IBGE (Statistics)
	Share of gross value added at current prices of agriculture in the gross value added at current prices of agriculture in the federation unit (%)	IBGE (Statistics)
	Share of gross value added at current industry prices in gross value added at current prices of industry in the federation unit (%)	IBGE (Statistics)
	Share of gross value added at current prices of services, administration, defence, education and public health and social security, in added value	IBGE (Statistics)
	Participação do valor adicionado bruto a preços correntes total no valor adicionado bruto a preços correntes total da unidade da federação (%)	IBGE (Statistics)
	Gross Domestic Product, at current prices (R$ 1,000)	IBGE (Statistics)
	number of cattle	IBGE (Municipal livestock research)
	Coffee production (% in relation to the state)	IBGE (municipal agricultural production)
	Value of the production of round wood (Thousand BRL)	IBGE (Production of plant extraction and forestry)
social index	Population served with water supply (%)	IBGE (demographic census)
	Unit No. Health (per thousand inhabitants)	DATASUS
	Number of beds (per thousand inhabitants)	DATASUS
	Number of doctors (per thousand inhabitants)	DATASUS
	IFDM Consolidated	Firjan
	IFDM Employment & Income	Firjan
	IFDM Education	Firjan
	IFDM Health	Firjan
	IDEB - Elementary school (early years)	INEP

Source: Own elaboration

2.4 DATA PROCESSING

This is a factor analysis study. The model in question follows the calculation reasoning proposed or applied by Reis [5]; Hair et al [6]; Santana [7] and Santana [8]; Gama et al. [9]; Santana [10]; Fávaro and Belfiore [11].This model has already been tested and applied in other studies, such as Cavalcante [12], Paraguassu-Chaves

et.at [13]; Paraguassu-Chaves et.at [14]; Paraguassu-Chaves et.at [15]; Paraguassu-Chaves et.at [16]; Paraguassu-Chaves et.at [17]; Paraguassu-Chaves et.at [18], where it was possible to build indexes within this methodological perspective. According to Hair et.al [6] factor analysis is a generic name given to a class of multivariate statistical methods whose main purpose is to define the underlying structure in a data matrix. Complementing this reasoning, the aforementioned authors also reveal that when summarizing the data, the factor analysis obtains latent dimensions that, when interpreted and understood, describe the data in a much smaller number of concepts than the original individual variables. The logic of construction of the social and economic indices, proposed here, therefore follows this reasoning.

These authors reveal that although there is still much debate about which factor model is the most appropriate, empirical research has shown similar results in many cases. Continuing with this reasoning, the authors state that in most applications, both principal component analysis and common factor analysis arrive at essentially identical results if the number of variables exceeds 30, or if the commonalities exceed 0.60 for most of the variables.

Therefore, factor analysis can identify the structure of a set of variables, as well as provide a process for data reduction [6]. In this study, we adopted the same methodological procedures already experienced by the authors in other research experiences. Thus, the factor analysis model adopted here is very similar to the principal components model, according to Santana [7] and Santana [8]. Also according to this author, the principal components model with m components and *p* variables (q < p), can be written based on the description presented by Dillon; Goldstein (1984), in which the model is presented in matrix form (Equation 1):

$$CP_1 = Y_{11}X_1 + Y_{12}X_2 + \cdots + Y_{IP}X_P$$
$$CP_2 = Y_{21}X_1 + Y_{22}X_2 + \cdots + Y_{2P}X_P$$

Equation (1)

$$CP_q = Y_{m1}X_1 + Y_{m2}X_2 + \cdots + Y_{qp}X_p$$

On what:

CPi = are the i-th principal components (i = 1, 2, ..., q);

ij = are the coefficients related to each variable;

Xj = are the jth variables (j = 1, 2, ..., p).

On the other hand, the basic model of factor analysis, according to Santana [7] and Santana [8], expresses each variable in terms of common latent factors and a single factor or specific factor. The algebraic representation of the model is given by equation 2:

$$X_1 = \lambda_{11}FC_1 + \lambda_{12}FC_2 + \cdots + \lambda_{Iq}FC_q + \varepsilon_1$$
$$X_2 = \lambda_{21}FC_1 + \lambda_{22}FC_2 + \cdots + \lambda_{2q}FC_q + \varepsilon_2$$

Equation (2)

$$X_p = \lambda_{p1}FC_1 + \lambda_{p2}FC_2 + \cdots + \lambda_{p.q}FC_q + \varepsilon_{mp}$$

On what:

Xi = are the i-th variables (i = 1, 2, ..., p);

ij = are the coefficients related to each common factor;

FCj = are the jth common factors (j = 1, 2, ..., q);

i = are the i-th specific factors.

Thus, according to the author in question, the basic model of common factors is usually expressed in matrix form as in equation 3, according to Dillon; Goldstein [19]:

$$.X = \alpha F + \varepsilon$$ Equation (3)

Being,

X = the **p-dimensional**, vector transposed of the observable variables, denoted by $X = (x_1, x_2,..., x_p)$;

F = the **q-dimensional**, vector transposed of unobservable variables or latent variables called common factors, denoted by $F = (f_1, f_2,..., f_q)$, being that q < p;

ε = the **p-dimensional** vector transposed of random variables or single factors, denoted by $\varepsilon = (e_1, e_2,..., e_p)$;

α = the matrix (p,q) of unknown constants, called factor loadings.

In the factor analysis process, an important aspect to be submitted to the data is the rotation of factors, through a factorial rotation tool, according to Hair e.al [6]. In practice, according to the same authors, the objective of all rotation methods is to simplify the rows and columns of the factor matrix to facilitate interpretation. Thus, it is assumed that in the factor analysis model the specific factors are orthogonal to each other, with all the common factors, where it is normally adopted that: E (ε) = E (*F*) = 0 and Cov (ε, F) = 0, according to Gama et.al., 2007 and Santana, 2007a. According to these authors, the initial structure used to determine the factor loading matrix, in general, may not provide a significant pattern of variable loadings, thus indicating that there is not something that signals a definitive way for this to occur. Thus, the confirmation or not of this initial structure can be done through various methods of factor rotation, according to Dillon; Godstein [19]; Johnson and Wichern [20]. For the purpose of the present construction of the regional development performance index, the VARIMAX method was adopted, considered one of the most popular methods

of orthogonal rotation of factors [6]. The VARIMAX method is a process in which the reference axes of the factors are rotated around the origin until some other position is reached. The objective is to redistribute the variance from the first factors to the others and reach a simpler and theoretically more significant factor pattern (HAIR et al [6]; SANTANA [7] and SANTANA [8]; GAMA et al [9]; SANTANA [21]; SANTANA[22].

The choice of factors, in turn, is performed using the latent root technique. According to Hair et.al.[6]latent root is the column sum of factor loadings squared for a factor. Also called eigenvalue, it corresponds to the amount of variance explained by a factor. According to these authors, a factor is understood to be the linear combination (statistical variable) of the original variables. The factors also represent the latent dimensions (constructs) that summarize or explain the original set of observed variables. Thus, the factor loading matrix that measures the correlation between common factors and observable variables is determined through the correlation matrix, according to Dillon; Goldstein[19]. Therefore, to determine the performance indices of economic and social development, we used the matrix of factor scores estimated by the factorial orthogonal rotation process, as pointed out by Santana[21]. The factor score, by definition, places each observation in the space of common factors. For each factor f_j, extracted factor score is defined by F_{ij}, expressed as follows (equation 4) [19]:

$$F_{IJ} = b_1 x_{i1} + b_2 x_{i2} + b_p x_{ip}\text{Equation (4)}$$

Being that:

$\boldsymbol{b_i}$ = are the estimated regression coefficients for the $\boldsymbol{n}$ common factors scores;

$\boldsymbol{x_{ij}}$ = are the $\boldsymbol{n}$ observations of the $\boldsymbol{p}$ observable variables.

$\boldsymbol{i}$ = 1,2,...,n.

$\boldsymbol{j}$ = 1,2,...,p.

Gama et al [9] and Santana [22] show the evolutionary sequence of the formulas from the previous equation, which allows arriving at the equation that represents the regional development performance index of the municipalities object of the present study. Thus, according to the authors, it appears that although the variable F_{ij} is not observable, it can be estimated using factor analysis techniques, using the matrix of observations of the vector x of observable variables. In factorial notation, equation 5 becomes:

$$F_{(n,q)} = X_{(n,q)} b_{(p,q)}\text{Equation (5)}$$

According to Santana[22], in equation 5, F is the regression matrix estimated from the n factor scores, which can be affected both by the magnitude and by the measurement units of the x variables. To get around this type of problem, the variable x is replaced by the standardized variable w, (equation 6), given by the ratio between the deviation from the mean and the standard deviation of x, as follows:

$$w_{ij} = \text{Equation (6)}$$

With these values, equation 6 is modified making equation 7 possible, as follows:

$$F_{(n,q)} = w_{(n,q)} \beta_{(p,q)}\text{Equation (7)}$$

Based on equation 7, the beta weight matrix (β) with q standardized regression coefficients, replaces b, given that the variables are standardized on both sides of the equation. Pre-multiplying both sides of equation 6 by the value $\frac{1}{n}\boldsymbol{w'}$, where n is the number of observations and w' is the transposed matrix of w, makes it possible to arrive at equation 8 [22]:

$$\frac{1}{n} w'_{(p,n)} F_{(n,q)} = \frac{1}{n} w'_{(p,n)} w_{(n,p)} \beta_{(p,q)} = R_{(p,p)} \beta_{(p,q)}\text{Equation (8)}$$

According to Santana[22]the matrix $\frac{1}{n}\boldsymbol{w'w}$ it is constituted in the matrix of inter-correlated variables or matrix of correlation between the observations of the matrix x, designated by R. The matrix $\frac{1}{k} w'F$ represents the correlation between factor scores and the factors themselves, denoted by Λ. Thus, rewriting Equation 9, we have that:

$$\Lambda_{(p,q)} = R_{(p,p)} \beta_{(p,q)}\text{Equation (9)}$$

The same author continues revealing that if the matrix R is non-singular, one can pre-multiply both sides of equation 10 by the inverse of R, obtaining:

$$\beta = R^{-1} \Lambda\text{Equation (10)}$$

Thus, substituting the β vector in equation 4, we obtain the factor score associated with each observation (equation 11), as follows:

$$F_{(n,q)} = w_{(n,p)} R^{-1}_{(p,p)} \Lambda_{(p,q)}\text{Equation (11)}$$

Thus, the main formula for the socioeconomic performance index (IDSE) of the municipalities studied is arrived at, from the perspective of the perception of regional development, which is defined as a linear combination of these factor scores and the proportion of variance explained by each factor in relation to to the common variance. The mathematical expression is now represented by the following formula (equation 12), which was based on Santana[22]:

$$IDL_i = \sum_{j=1}^{q} \left(\frac{\lambda_j}{\sum_j \lambda_j} FP_{ij} \right)\text{Equation (12)}$$

Where,

i = 1,2,..., n.

λ = the variance explained by each factor;

∑ **λ** = the sum total of the variance explained by the set of common factors.

The factor score was standardized (FP) to obtain positive values from the original scores and allow the ranking of performances to be determined by the index in question, which ranges from 0 to 1. The formula that allows this hierarchy can be seen by equation 13:

FP_i =Equation (13)

It is thus seen that F_{min} e F_{max} are the maximum and minimum values observed for the factor scores associated with the performance of the socioeconomic development index (IDSE) from the perspective of the perception of regional development adopted for the present study.

With this, with multiple potential for use, due to the wide capillarity of studies linked to the interest in better understanding and analyzing, in practice, the theme of socioeconomic development and the scenarios of the local and regional reality around the Brazilian western Amazon region, which the analysis of economic and social indicators based on the multivariate method of data, using the technique of factor analysis and statistical tools from SPSS, allows the construction of a critical view of SUFRAMA's policy and its reflection in the perspective of regional development.

It is hoped, therefore, that this work can help in debates in terms of public policies for regional development, considering the economic and social focus as the axis of analysis. Thus, in the current scenario, where the issue of the Amazon has been more effectively demanded at the negotiation tables for the conclusion of bilateral or multilateral agreements in the spheres of economic and social integration, such as economic blocs, common markets, cooperation between countries, channel efforts to the field of academic debate, from the critical view applied to the process of understanding and interpreting the regional reality, its internal dynamics and the trend of its historical trajectory, thus allowing to build a clear and objective perception of the reality object of the present study, in order to bring new elements and new bases for discussion in the context of SUFRAMA's policy focused on aspects of economic and social development.

2.5 DATA ADEQUACY CRITERIA FOR FACTOR ANALYSIS

According to Santana[22], the two main tests that assess data adequacy for factor analysis are the Bartlett sphericity tests, which assess the general significance of the correlation matrix, that is, it tests the null hypothesis that the correlation matrix correlation is an identity matrix; and the Kaiser-Meyer-Olkin (KMO) test, which is based on the principle that the inverse of the correlation matrix approximates the diagonal matrix, in order to compare the correlations between the observable variables. Such models can be expressed in mathematical formulas. Said mathematical formulas of these tests are based on Dillon; Goldstein [19]; Reis [5], Santana [22].

a) Bartlett's test

According to Santana [22], in particular, the Bartlett test of sphericity tests the null hypothesis that the variables are independent, against the alternative hypothesis that the variables are correlated with each other, as can be represented as follows, according to the said author:

$H_0: R = IouH_0: \lambda, = \lambda_2 = \cdots = \lambda_P$, (Equation 14)

and is given by:

$X^2 = -\left[n - 1 - \frac{1}{6}(2p + 5)\right] . \in \left| R \right|$ (Equation 15)

ou

$X^2 = -\left[n - 1 - \frac{1}{6}(2p + 5)\right] . \sum_{i=1}^{p} . \in . \lambda_i$(Equation 16).

On what:

|**R**| is the determinant of the sample correlation matrix;

λ is the variance explained by each factor;

n is the number of observations; and

p is the number of variables.

The statistic has an asymptotic distribution of x^2 com [0,5.p.(p-1)] degrees of freedom.

b) Kaiser-Meyer-Olkin (KMO) test

The mathematical formulas for these tests were based on Dillon; Goldstein [19], Reis [5], according to Santana [22]:

$KMO = \frac{\Sigma i \Sigma j r_{ij}^2}{\Sigma i \Sigma j r_{ij}^2 + \Sigma i \Sigma j a_{ij}^2}$(Equation 17)

On what:

rij is the sample correlation coefficient between variables xi and xj;

aij is the partial correlation coefficient between the same variables that is, simultaneously, an estimate of the correlations between the factors, eliminating the effect of the other variables.

The **a**ij should assume values close to zero, since the factors are assumed to be orthogonal to each other. Values of this test below 0.5 are unacceptable [6].

c) Commonality

In addition to the two previous tests, there is also commonality as an important criterion for testing the suitability of data for factor analysis. In this sense, commonality is the proportion of common variance present in a given variable. Thus, on a scale of zero to one, a variable that does not present specific variance or error would have a commonality of 1, while a variable that does not share variance with any other variable would have a commonality of value 0. In general, the literature indicates a minimum value of 0.5 for commonality to be considered satisfactory. Therefore, for a variable to work well in a factor analysis, it needs to have a large proportion of common variance (HAIR et.al [6]; MATOS and RODRIGUES [23]). In the specific case of this study, the cumulativeness met the requirements for factor analysis.

2.6 SCALE ADOPTED FOR ANALYSIS OF SOCIAL AND ECONOMIC INDICES

Below is table 3, which illustrates the description of the scale adopted for this study.

Table 3: Index scale and description

Scale	Description
0.801 to 1.000	Very high
0,601 to 0,800	High
0,401 to 0,600	Regular
0,201 to 0,400	**Weak**
< 0,200	**Very weak**

Source: Authors

III. DATA ANALYSIS AND DISCUSSION

3.1 Determination of the economic index of municipalities with SUFRAMA: 2010 and 2018

The economic development index for the municipalities assisted by the SUFRAMA policy in 2010. The highest rates found corresponded to the municipalities of Macapá (0.717) and Boa Vista (0.652), capitals of the States of Amapá and Roraima, respectively. Next, the municipality of Brasiléia (Acre) presented an index of 0.307, followed by the municipality of Santana (Amapá) of 0.239. The other municipalities presented indexes below 0.200, which here was classified as having very low performance.

In 2018, the economic development index was higher in Boa Vista (Roraima) with an index of 0.713 and in Macapá (Amapá) with an index of 0.626, followed by Brasiléia (Acre) with 0.319, Bonfim (Roraima) with 0.243 and Epitaciolândia (Acre) with 0.224, and the other municipalities presented performances below 0.200. The municipality with the highest growth rate in the IDEC in the period in question were the municipalities of Bonfim (Roraima) with 57.3% growth, Epitaciolândia (Acre) with 35.4% and Guajará-Mirim (Rondônia) with 13.1%. The municipalities that presented the highest negative growth rates were: Santana (Amapá) with -21.3% and Macapá (Amapá) with -12.8%.

3.2 Determination of the social index of municipalities with SUFRAMA: 2010 and 2018

From the point of view of social development based on the year 2010, the two capitals continue to stand out in relation to the other municipalities assisted by the SUFRAMA policy, with Macapá (Amapá) reaching an index of 0.581 and Boa Vista (Roraima) of 0.580. Next, in descending order, come the municipalities of Santana (Amapá) and Brasiléia (Acre), which reached, respectively, social development indices of 0.402 and 0.388. Then, also in descending order, are the municipalities of Cruzeiro do Sul (Acre) with 0.319; Guajará-Mirim (Rondônia) with 0.310; Epitaciolândia (Acre) with 0.303; Bonfim (Roraima) with 0.258 and Tabatinga (Amazonas) with an index below 0.200.

According to the IDSO results for the year 2018 in relation to the municipalities assisted with the SUFRAMA policy, the highest IDSO was observed in the municipality of Boa Vista (Roraima) with a performance of 0.700. Next come the municipalities of Cruzeiro do Sul (Acre) with 0.508; Brasilândia (Acre) with 0.487; Macapá (Amapá) with 0.447; Guajará-Mirim (Rondônia) with 0.373; Epitaciolândia (Acre) with 0.342; Tabatinga (Amazonas) with 0.338; Bonfim (Roraima) with 0.322; Santana (Amapá) with 0.319.

From the point of view of growth in the analyzed period (IDSO-2010 and IDSO-2018), it appears that only 22.2% of the municipalities assisted by the SUFRAMA policy had negative growth rates and this reality was observed exclusively in the municipalities of Amapá participating in this study, where the municipality of Macapá presented a rate of -23.0% and Santana with -20.7% of growth in the period. The other municipalities showed positive growth rates, especially Tabatinga (Amazonas) which achieved the highest growth rate in the period (222.6%). The others showed the following growth rates, in descending order, Cruzeiro do Sul (Acre) = 59.3%, Bonfim (Roraima) = 35.1%, Boa Vista (Roraima) = 20.7%, Guajará-Mirim (Rondônia) = 20.6% and Epitaciolândia (Acre) = 12.9%.

3.3 Determination of the economic index of municipalities without SUFRAMA: 2010 and 2018

The IDEC of the municipalities that are not assisted by the SUFRAMA policy reached a performance considered “low” for 40% of them and “very low” for the other 60%. In descending order, the performance found follows the following sequence: Pimenta Bueno (Rondônia) = 0.329, Sena Madureira (Acre) = 0.229. The other municipalities presented results below 0.200.

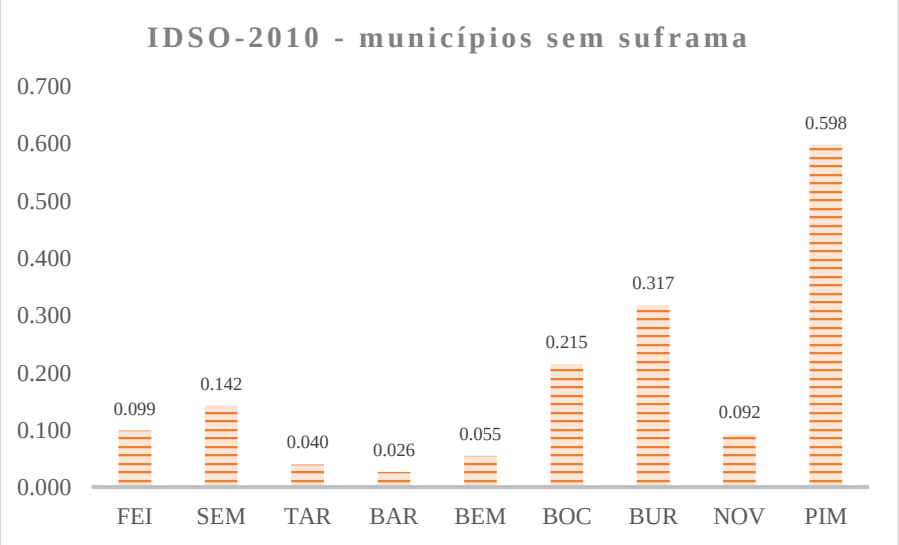
The distribution of performances in 2018 followed practically the same trends observed for 2010. Thus, in descending order, the performance of IDEC 2018 corresponded to the following sequence: Pimenta Bueno (Rondônia) = 0.326, Buritis (Rondônia) = 0.283, Nova Mamoré (Rondônia) = 0.248 and Sena Madureira (Acre) = 0.202. The other municipalities presented results below 0.200.

Thus, these results allow analyzing the growth rate in the period in question, that is, between 2010 and 2018, in relation to the IDEC. As a result, a negative growth rate was observed in 60% of the municipalities, namely: Barcelos (Amazonas) =-100%, Benjamin Constant (Amazonas) = -42.1%, Sena Madureira (Acre) = -11, 9%, Tarauacá (Acre) = -2.8% and Pimenta Bueno (Rondônia) = -0.9%. On the other hand, the other municipalities showed positive growth rates, namely: Boca do Acre (Acre) = 179.1%, Feijó (Acre) = 13.1%, Buritis (Rondônia) = 7.7% and Nova Mamoré (Rondonia) = 5.4%.

3.4 Determination of the social development index of municipalities without SUFRAMA: 2010 and 2018

Graph 1 illustrates the results of the IDSO-2010 for the municipalities without SUFRAMA surveyed.

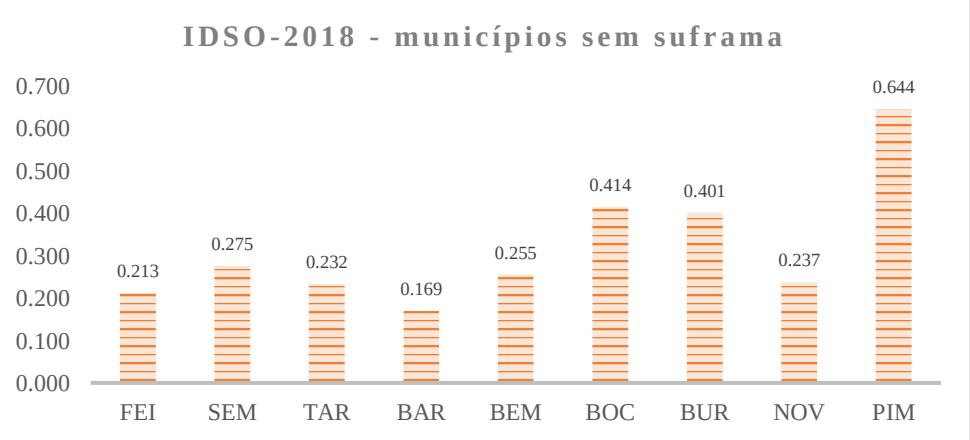
Graph 1: Social development index of municipalities without Suframa: 2010



Source: Determined by research.

The IDSO - 2010 for the municipalities without SUFRAMA, illustrated by graph 1, with the exception of the municipality of Pimenta Bueno (Rondônia) which achieved the highest performance among the other municipalities, however with a scale level classified as "regular" performance, when reaching the IDSO of 0.598, corresponding to approximately 10% of the representation of the municipalities, indicates a scenario of either very low performance, as was the case of almost all municipalities in this performance range, that is, approximately 70% of them, or of low performance , for the remaining 20% of the municipalities (Graph 2). Thus, the municipalities with low performance were: Buritis (Rondônia) = 0.317 and Boca do Acre (Amazonas) = 0.215. The municipalities with very low performance, in descending order, were: Sena Madureira (AC) = 0.142, Feijó (Acre) = 0.099, Nova Mamoré (Rondônia) = 0.092, Tarauacá (Acre) = 0.040 and Barcelos (Amazonas) = 0.026 . Graph 2 presents the results of the social development index for the year 2018 for the municipalities not covered by the SUFRAMA policy.

Graph 2: Social development index of municipalities without Suframa: 2018



Source: Determined by research.

Chart 2 shows a trend in the behavior of the results similar to that shown in the previous chart, which corresponded to 2010 data. Thus, in descending order, it is noted that the highest performance was achieved by the municipality of Pimenta Bueno (Rondônia) with 0.644, followed by the municipalities of Boca do Acre (Amazonas) with 0.414, Buritis (Rondônia) with 0.401, Sena Madureira (Acre) with 0.275, Benjamin Constant (AM) with 0.255, Nova Mamoré (Rondônia) with 0.237, Tarauacá (Acre) with 0.232 and Feijó (Acre) with 0.213. The municipality of Barcelos (Amazonas) was the only one to have a performance below 0.200 in this analysis.

Table 4 presents all the results found for the social and economic indices for the years 2010 and 2018, along with the respective growth rates observed in the period.

Table 4: Socioeconomic indices determined by the survey for the municipalities surveyed for the years 2010 and 2018 and the growth rates in the period.

Municipalities	IDSO-2010	IDSO-2018	Growth rate %	IDEC-2010	IDEC-2018	Growth rate
TAB	**0,105**	**0,338**	222,6	**0,024**	**0,023**	-4,8
GUA	**0,310**	**0,373**	20,6	**0,116**	**0,131**	13,1
BOA	**0,580**	**0,700**	20,7	**0,652**	**0,713**	9,3
BON	**0,238**	**0,322**	35,1	**0,154**	**0,243**	57,3
MAC	**0,581**	**0,447**	-23,0	**0,717**	**0,626**	-12,8
SAN	**0,402**	**0,319**	-20,7	**0,239**	**0,188**	-21,3
BRA	**0,388**	**0,487**	25,4	**0,307**	**0,319**	3,7
CRU	**0,319**	**0,508**	59,3	**0,169**	**0,166**	-2,1
EPI	**0,303**	**0,342**	12,9	**0,166**	**0,224**	35,4
FEI	**0,099**	**0,213**	115,7	**0,112**	**0,126**	13,1
SEN	**0,142**	**0,275**	93,5	**0,229**	**0,202**	-11,9
TAR	**0,040**	**0,232**	487,2	**0,125**	**0,121**	-2,8
BAR	**0,026**	**0,169**	542,9	**0,015**	**0,000**	-100
BEN	**0,055**	**0,255**	367,1	**0,023**	**0,013**	-42,1

BOC	**0,215**	**0,414**	92,9	**0,063**	**0,176**	179,1
BUR	**0,317**	**0,401**	26,3	**0,263**	**0,283**	7,7
NOV	**0,092**	**0,237**	157,7	**0,235**	**0,248**	5,4
PIM	**0,598**	**0,644**	7,7	**0,329**	**0,326**	-0,9

Source: Search result.. Subtitle:

	Municipalities WITH SUFRAMA
	Municipalities WITHOUT SUFRAMA

Based on this table, it was possible to organize the results found for the IDEC and IDSO indexes grouped in the two groups of municipalities studied in this study: with SUFRAMA and without SUFRAMA.

Thus, associating the respective indices with the scale adopted in this study, tables from 5 to 6 were prepared with the objective of distributing the results found by the cities surveyed according to the parameters adopted. Table 5, in turn, deals with the IDSO-2010 and IDSO-2018 for the municipalities assisted by the SUFRAMA policy.

Table 5: Classification of municipalities with SUFRAMA according to the scale of this research based on the social index.

Scale	Description	IDSO-2010	IDSO-2018
0,801 – 1,000	**Very high**	-	-
0,601 – 0800	**High**	-	BOA
0,401 – 0,600	**Regular**	BOA, MAC, SAN	MAC, BRA, CRU
0,201 – 0,400	**Weak**	GUA, BOM, BRA, CRU, EPI	TAB, GUA, BOM, SAN, EPI
<0,200	**Very weak**	TAB	-

Source: Search result.

The municipalities of Boa Vista (Roraima), Macapá (Amapá) and Santana (Amapá), in 2010, reached the same level of performance, classified as "regular". The municipalities of Guajará-Mirim (Rondônia), Bonfim (Roraima), Brasiléia (Acre), Cruzeiro do Sul (Acre) and Epitaciolândia (Acre) achieved a performance considered weak in this study. O pior desempenho foi registrado para o município de Tabatinga (Amazonas) que teve um desempenho muito ruim. In 2018, the situation improves for the municipality of Boa Vista (Roraima), which achieves a performance considered "high". The municipality of Macapá (Amapá) remains at the same performance level as it was in 2010, that is, it remains at the "regular" level of performance in 2018. The municipality of Santana (Amapá) also recorded a drop in the period from 2010 to 2018, going from a "regular" performance to a "poor" performance in the last year of analysis. With the exception of the municipality of Cruzeiro do Sul (Acre), which rose in the performance category in 2018, upon reaching the high performance scale, all other municipalities that had a "poor" performance in 2010 remained in the same performance range in the year 2018. Added to this list of municipalities with poor performance was the municipality of Tabatinga (Amazonas), which in the previous year had a performance considered very weak (Table 5).

Table 6 deals with the IDEC-2010 and IDEC-2018 for the municipalities covered by the SUFRAMA policy.

Table 6: Classification of municipalities with SUFRAMA according to the scale of this research based on the economic index.

Scale	Description	IDEC-2010	IDEC-2018
0,801 – 1,000	Very high	-	-
0,601 – 0800	High	BOA, MAC	BOA, MAC
0,401 – 0,600	Regular	-	-
0,201 – 0,400	Weak	SAN, BRA	BOM, BRA, EPI
<0,200	Very weak	TAB, GUA, BOM, CRU, EPI	TAB, GUA, SAN, CRU

Source: Search result.

From table 6 it is possible to observe that the municipalities of Boa Vista (Roraima) and Macapá (Amapá) remained in the same high performance category of the IDEC in both analyzed years, no municipality was observed in the category of very high or regular performance. In 2010, only the municipalities of Santana (Amapá) and Brasilândia (Acre) had regular performance. However, in 2018, only Brasilândia (Amapá) remains in this category, along with the municipalities of Bonfim (Roraima) and Epitaciolândia (Acre) that increased in performance, since in 2010 both municipalities were in the range of very poor performance. Thus, in 2018, the municipality of Santana (Amapá) falls into the range of very poor performance, in addition to the municipalities of Tabatinga (Amazonas), Guajará-Mirim (Rondônia) and Cruzeiro do Sul (Acre) that remained at this level of very poor performance in the period from 2010 to 2018.

Tables 7 and 8 refer to municipalities not covered by the SUFRAMA policy for IDS0 2010-2018 and IDEC 2010-2018, respectively.

Table 7: Classification of municipalities without SUFRAMA according to the scale of this research based on the social index.

Scale	Description	IDSO-2010	IDSO-2018
0,801 – 1,000	Very high	-	-
0,601 – 0800	High	-	PIM
0,401 – 0,600	Regular	PIM	BOC, BUR
0,201 – 0,400	Weak	BOC, BUR	FEI, SEM, TAR, BEM, NOV
<0,200	Very weak	FEI, SEM, TAR, BAR, BEM, NOV	BAR

Source: Search result.

In relation to table 7, it is possible to observe, with the exception of the municipality of Barcelos (Amazonas) which remained in the same category of very poor performance in the two years surveyed, the other municipalities rose in performance category in the period from 2010 to 2018. Thus, the municipality of Pimenta Bueno (Rondônia), which was in the regular performance range in 2010, moves to the high performance category in 2018. In the same way that the municipalities of Boca do Acre (Amazonas) and Buritis (Rondônia) that were in the low performance range in 2010 reach, in 2018, the regular performance range. And the municipalities of Feijó (Acre), Sena Madureira (Acre), Tarauacá (Acre), Benjamin Constant (Amazonas) and Nova Mamoré (Rondônia), which were in the range of very poor performance in 2010, moved up to the range of weak performance in 2018.

Table 8: Classification of municipalities without SUFRAMA according to the scale of this research based on the economic index.

Scale	Description	IDEC-2010	IDEC-2018
0,801 – 1,000	Very high	-	-
0,601 – 0800	High	-	-
0,401 – 0,600	Regular	-	-
0,201 – 0,400	Weak	SEM, NOV, PIM, BUR	SEM, NOV, PIM, BUR
<0,200	Very weak	FEI, TAR, BAR, BEM, BOC	FEI, TAR, BAR, BEM, BOC

Source: Search result.

Table 8, in turn, illustrates the result for the performance of the economic development index for the municipalities not covered by the SUFRAMA policy. Based on this table, it is possible to observe that the two scenarios inherent to the performance of IDEC-2010 and IDEC-2018, there was no change in the period. Thus, the municipalities of Sena Madureira (Acre), Nova Mamoré (Rondônia), Pimenta Bueno (Rondônia) and Buritis (Rondônia), which were in the low performance range in 2010, remained in the same range in 2018. Likewise, the municipalities of Feijó (Acre), Tarauacá (Acre), Barcelos (Amazonas), Benjamin Constant (Amazonas) and Boca do Acre (Amazonas) remained in the range of very poor performance for the two analyzed periods. In this way, it can be seen that there was a concentration of municipalities in the range of "weak" or "very weak" performance for the year 2010 and 2018, unchanged.

Municipalities of Macapá (Amapá) and Boa Vista (Roraima) compare themselves in comparison with other surveyed municipalities present the highest social and economic performances for the year 2010. Pimenta Bueno (Rondônia) also stands out for presenting a relatively high social index, the other municipalities surveyed had average performances with a tendency to weak or very poor performance for the two indexes surveyed, considering the scale adopted in this work.

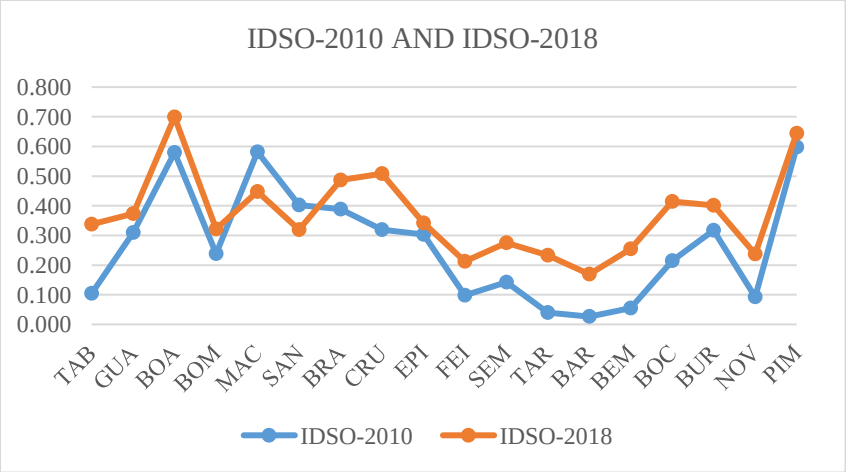
The results point to the high performance of the municipalities of Boa Vista (Roraima) and Macapá (Amapá) for the IDEC-2018 and the high performance of the IDSO-2018 for the municipalities of Boa Vista (Roraima) and Pimenta Bueno (Rondônia). In view of this context, the other municipalities were distributed in a range either with regular performance or with weak and very poor performance, in general.

Thus, analyzing the data presented so far, the complex reality of the Amazonian municipalities calls attention, which, not infrequently, tends to demonstrate a scenario that still lacks a regional development process that can in fact lead to a perspective of institutional change, according to North[24]and that, therefore, can lead them to new trajectories, to new scenarios, to new levels. However, what is evident in this work is that although there is a certain dynamic among the cities surveyed, in general, such dynamics are located at a critical level, where the signal is alarmed. This indicates that there is a need for greater attention from the government as an agent of change through public policies, within a context of endogenous or local development. However, there is another aspect that has not been researched, but that is essential for such a change to occur. It is about social capital as a collective mechanism for the convergence of forces, in order to enhance what there is of aptitude in the region, within an internal social perspective based on the context of endogenous development.

Such results indicate that development is still something difficult to be perceived within the Amazon regional context. Thinking about the Amazon with its peculiarities and complexities is the best way to go. However, in general terms, this is not what happens in practice. And the result ends up producing scenarios with multiple variables that end up interfering in some way in the local and regional dynamics. Understanding and interpreting such a complex reality is the challenge that continues to be projected in time and space, owing, even, to the economy, the challenge of contributing to the explanation of the phenomena that tend to have increasingly complex behaviors of reality. For this, it is necessary to find orthodox and/or heterodox economic forms of development capable of pulling up this scenario observed by the surveyed municipalities, which still tend to rest their dynamics on the lowest levels of development, with reflections, including, on the quality of local and regional life.

Graph 3, below, illustrates the results found for the IDSO-2010 and IDSO-2018 for all the municipalities surveyed. Based on it, it is possible to verify a certain improvement in the social development index, both for 2010 and 2018.

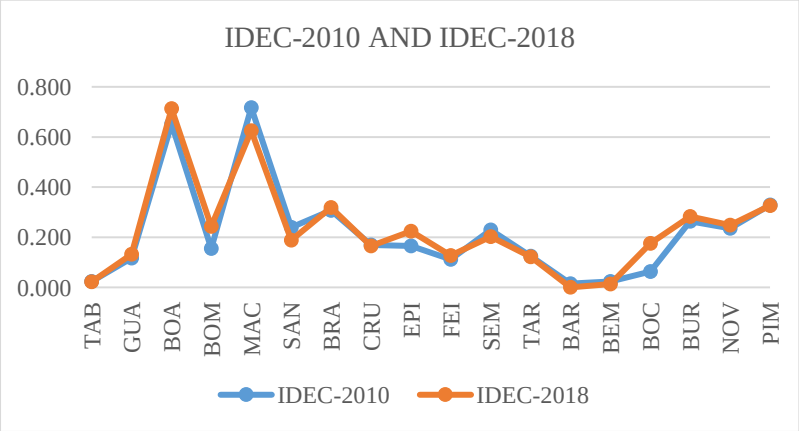
Graph 3: Social performance index of the surveyed municipalities.



Source: Search result.

Thus, it can be seen from graph 3 that 70% of the municipalities assisted by the SUFRAMA policy showed improvements in their performance from 2010 to 2018 and, in the same way, 100% of the municipalities not served by this policy had their rates improved from 2010 to 2018. Graph 4, in turn, concerns IDEC-2010 and IDEC-2018.

Graph 4: Economic performance index of the surveyed municipalities.



Source: Search result.

Based on this graph, it appears that there was almost no change in performance in the two years surveyed. However, 50% of the municipalities assisted by the SUFRAMA policy had a small and slight improvement in 2018 when compared to 2010. Regarding the municipalities without SUFRAMA, it was observed that approximately 30% of the municipalities had a slight improvement in performance. Aiming to obtain new perspectives of analysis, tables 9 and 10 were constructed that deal with the distribution and frequency of the indexes for a certain level of scale for the municipalities with SUFRAMA and without SUFRAMA, respectively. It can be observed that 66.7% of the municipalities served by SUFRAMA that participated in this research presented "weak" and "very weak" performance for the social development index for the year 2010. For 2018 this index was even higher, reaching 77.8% with low performance level.

Table 9: Distribution and relative frequency of the socioeconomic indices of the municipalities WITH SUFRAMA determined by the survey.

Scale	Description	IDSO-2010		IDSO-2018		IDEC-2010		IDEC-2018	
		qde	%	qde	%	Qde	%	qde	%
0,801 – 1,000	Very high	-	-	-	-	-	-	-	-
0,601 – 0,800	High	-	-	1	11,1	2	22,2	2	22,2
0,401 – 0,600	Regular	3	33,3	3	33,3	-	-	-	-
0,201 – 0,400	Weak	5	55.6	5	55,6	2	22,2	3	33,3
➢ 0,200	Very weak	1	11,1	-	-	5	55,6	4	44,5
Total	-	9	100%	9	100%	9	100%	9	100%

Source: Search result.

Although the SUFRAMA policy is a reality for these municipalities, it is noticeable from the data and indices analyzed that such a scenario could be even worse if such a policy did not exist. This allows us to point out that it is not simply a matter of denying the importance of the aforementioned regional development policy, but of stating that there is a need to redirect the strategic focus so that SUFRAMA's policy can be felt more strongly by society in general, especially those residing in local level

In this sense, it is worth noting, in general, the fact that the taxes generated by economic activities in these municipalities assisted by the policy of influence of the Manaus Free Trade Zone are normally directed to the federal government treasury, with no possibility of part of this amount being applied in the region covered by the said policy. Thus, the return of part of these values transferred to the treasury to be applied in local public policies seems to us to be a fair measure for strategic planning in favor of local and endogenous development. Thus, strengthening the internal social capital and the natural vocation of these regions that could focus their planning in favor of actions that aim to guarantee greater investments in infrastructure, health, education, etc. In relation to the municipalities unassisted by the SUFRAMA policy, the result was even worse. (Table 10).

Table 10: Distribution and relative frequency of socioeconomic indices of municipalities WITHOUT SUFRAMA determined by the survey.

Scale	Description	IDSO-2010		IDSO-2018		ÍDEC-2010		ÍDEC-2018	
		qde	%	qde	%	qde	%	qde	%
0,801 – 1,000	Very high	-	-	-	-	-	-	-	-
0,601 – 0,800	High	-	-	1	11,1	-	-	-	-
0,401 – 0,600	Regular	1	11,1	2	22,2	-	-	-	-
0,201 – 0,400	Weak	2	22,2	5	56,6	4	44,4	4	44,4
➢ 0,200	Very weak	6	66,7	1	11,1	5	55,6	5	55,6
Total	-	9	100%	9	100%	9	100%	9	100%

Source: Search result.

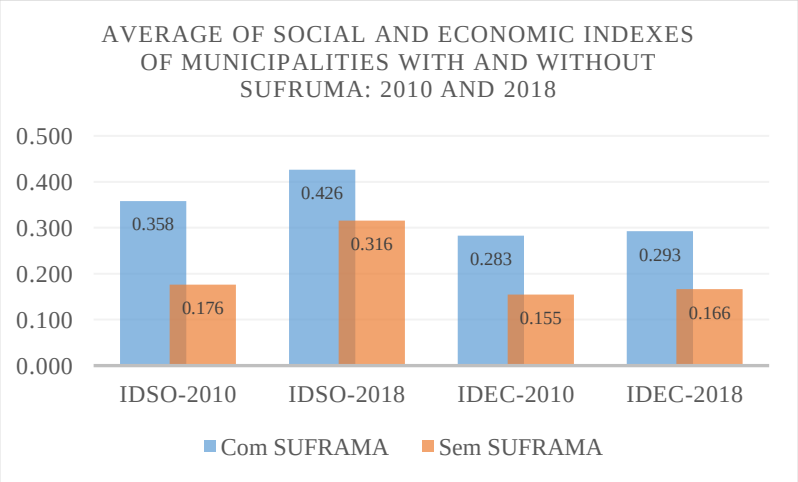
In this sense, 88.9% of these municipalities were at the “weak” and “very weak” level of development, both in 2010 and 2018. Regarding the economic development index for the year 2010, it was observed that 100% of the municipalities presented “weak” and “very weak” performances for both 2010 and 2018.

Although these results have been reached, further research and deeper analysis is necessary due to the multiple variables that may be acting and interfering in the

dynamics observed in this study. Anyway, the present study signals a worrying scenario in terms of regional development, seen here based on economic and social indices, which allows new abstractions regarding the Brazilian Amazon region. By taking the average of the indexes between the municipalities with SUFRAMA and without SUFRAMA, with the objective of verifying, in a comparative way, the two samples of municipalities surveyed, we arrive at graph 5.

From this graph, it is possible to notice that in all scenarios the average of the indices presented by the municipalities with SUFRAMA exceed the average of the municipalities without SUFRAMA. The fact that the capitals of Roraima and Amapá are participating in this sample of municipalities, in some way, may have contributed to this scenario. However, this does not preclude the results found, which showed some coherence with the reality in question. This observation serves so that future studies can analyze this aspect in order to corroborate or not with the results achieved here.

Graph 5: Average of social and economic indices of municipalities with and without SUFRAMA: 2010 and 2018.



Source: Search result.

This analysis is important because it demonstrates that the economic issue is reflected in the social issue and vice versa. This analysis is in line with the thought of North[24], where social culture, built on the basis of a historical perspective, has a strong relationship with the development process of a region. Putnam[25] demonstrated this aspect when studying the reality of Italy for 20 years and found the power of social capital and its reflection on citizenship and the degree of development of Italian regions that occurred differently due to differences in traditions and culture. This aspect in the Amazon was worked on by Cavalcante[12] where he found that in Rondônia there are two historical scenarios that produced two very different societies in Rondônia, with different cultures and that this has influenced the dynamics of regional development to the point of demonstrating that social capital it is a factor that has interfered with intensity for the status quo of these regions in a differentiated way, each one in its dynamics and in its rhythm.

Thus, the starting point for a better understanding of this dynamic is the historical-economic formation of these regions, in order to allow a better critical analysis of the culture and its respective processes of endogenous development. Corroborating with the thought of North[24] where the social is the basis for understanding the dynamics or stagnation of an economy, that is, the economic is not the cause but a consequence of a certain institutional arrangement built by the social force of the place, it allows to trace new future perspectives of studies in the field of social capital as a means to understand, from the historical trajectory, the present scenario and, from it, the future of the region. In view of this, studies in this direction prove to be quite fertile to understand the Amazon scenario and its peculiarities materialized in its multiple variables that normally escape the context of the everyday national scenario of large urban-industrial centers. Understanding such dynamics involves expertise and requires methodological instruments capable of dealing with a complex reality such as, in general, the regions inserted in the Brazilian Amazon context.

IV. FINAL CONSIDERATIONS

The research brought as a challenge to analyze the reality of Amazonian municipalities based on economic

and social indicators in order to determine the regional development index and, from there, analyze the degree of performance achieved by the municipalities assisted with the regional development policy linked to the context of the SUFRAMA policy in comparison with municipalities that were not contemplated with the aforementioned public policy in order to analyze its effect from the perspective of economic and social development.

The use of the quantitative method with the use of factor analysis allowed the impartial character of the research, since all the procedures performed in this work strictly followed the methodological procedures, thus avoiding any possibility of imposing or influencing a trend in the behavior of the data. Only after the construction of the indices and procedures that led to their systematization that make it possible to have the necessary conditions to analyze the results found.

In general, a low level of economic and social development of the surveyed municipalities was evidenced, indicating a reality that goes through challenges that need to be overcome and focused on the local reality in an integrated way to the national context such as logistics, infrastructure, health, education and aspects economic and socio-environmental issues as the main axis of strategic vision to overcome such a regional challenge. Such results can, in the first place, serve as a counterpoint to the main reason for maintaining the SUFRAMA policy in the region. However, the fact that this scenario of weak or very weak regional development observed in the municipalities that participated in this study, including the municipalities that are not assisted by the SUFRAMA policy, allows us to conclude, therefore, that this is a reality faced in the Amazon region as a whole, and that, therefore, should be the object of future research, in order to determine which factors contribute to this scenario, which may require other statistical methods used in the multivariate analysis of data, such as multiple regression, among other available models and applicable to specific cross-sectional data sets or time series or a combination of both.

On the other hand, based on the *ceteris paribus* concept, an analysis can be made from the endogenous point of view of SUFRAMA's regional development policy based on the indices and results found in this study. In this way, it was evident that even with performances, in general, depressing in terms of the performance of IDEC and IDSO, especially in the municipalities assisted by the aforementioned policy, even so it is still necessary for the development of the region, in view of many of these municipalities, characterized by being significantly limited by nature conservation units and indigenous lands that end up, in some way, limiting productive areas, which strengthens the maintenance of the SUFRAMA policy as an alternative strategic action in search of sustainable development of these regions, in particular, and the Western Amazon more generally. In addition, it was shown that even with low levels of economic and social development in this study, the municipalities covered by the SUFRAMA policy presented a slightly better scenario compared to those not covered by this federal government policy, showing some type of influence of this policy in the local reality.

From the point of view of the growth pole theory and the economic development pole brought by Perroux, it is clear that it was not possible to observe the effects of this reality in the municipalities covered by the SUFRAMA policy and which participated in this study. Even so, it is clear that the scenario could be more serious if such a policy did not exist in the respective regions. Perhaps therein lies the biggest problem of this policy in not having yet managed to produce a prosperous and autonomous environment of endogenous development, which seems to impact the way of seeing the aforementioned policy not as an element of change in the local and regional reality, but as a welfare policy. generating behavior dependent on government actions that ends up contributing in some way to low social capital, human capital and, consequently, the impact of this behavior on the culture of the place. Although it is an aspect perceived in this study in an abstract way, there is a need for further studies within this perspective. Within a view of contributing to greater effectiveness of SUFRAMA's policy, the issue of distribution of resources collected from taxes generated by the economic activities of the place can be mentioned. This is because the current model indicates that all resources from taxes paid by companies installed and collected by the government basically present a one-way path, with a one-way path to the national treasury coffers and not in a two-way context, with a sense also back to the municipal coffers. In this sense, an observation is made on this aspect that, in our view, could positively impact the development of these regions covered by the aforementioned policy.

REFERENCES

[1] VEIGA, J.E.da. **Do global ao local**. Campinas, SP: Armazém Ipê (autores associados), 2005.

[2] SEN, Amartya. **Desenvolvimento como Liberdade**. Tradução de Laura Teixeira Motta. São Paulo: Companhia das Letras, 2000.

[3] SANTOS, N.B.; FARIA, A.M.M.; DALLEMOLE, D.; MANSO, J.R.P. Desenvolvimento econômico das macrorregiões de Mato Grosso nos anos de 2005 a 2013.

Interações, Campo Grande, MS, v.18, n.3, p.169-182, jul./set.2017.

[4] IBGE. Municípios da faixa de fronteira. Disponível em: https://www.ibge.gov.br/geociencias/organizacao-do-territorio/estrutura-territorial/24073-municipios-da-faixa-de-fronteira.html?=&t=acesso-ao-produto. Acesso em: 28/05/2021.

[5] REIS, E. **Estatística multivariada aplicada**.2. ed. Lisboa: Silabo, 2001.

[6] HAIR, J. F. et al. **Análise multivariada de dados**. 5. ed. Porto Alegre: Bookman, 2005. 730 p.

[7] SANTANA, A.C. de. **Métodos quantitativos em economia**: elementos e aplicações. Belém: UFRA, 2005a.

[8] SANTANA, A.C. de. **Elementos de economia, agronegócio e desenvolvimento local**. Belém: GTZ; TUD; UFRA, 2005b.

[9] GAMA, Z. J. C. ; SANTANA, A. C. de. ; MENDES, F. A. T. ; KHAN, A. S. Índice de desempenho competitivo das empresas de móveis da região metropolitana de Belém. **Revista de economia e agronegócio**, v. 5, p. 127-159, 2007.

[10] SANTANA, A.C. de. Análise do desempenho competitivo das agroindústrias de polpas de frutas do Estado do Pará. **Revista de economia e sociologia rural**, v. 45, n. 3, Brasília, jul/set. 2007a.

[11] FÁVERO, L.P; BELFIORE, P. **Manual de análise de dados**. 1ª ed. Rio de Janeiro: Elsevier, 2017.

[12] CAVALCANTE, F.R.C. **Análise da desigualdade regional no Estado de Rondônia á luz da teoria institucionalista de Douglass North**. Tese (Doutorado) - Universidade Federal do Pará, Núcleo de Altos Estudos Amazônicos, Programa de Pós-Graduação em Desenvolvimento Sustentável do Tropico Úmido. Belém-PA, 2011, 464 p.

[13] PARAGUASSU-CHAVES, C.A.; CAVALCANTE, F.R.C.; CLARO, P.C. G.; FISCHER, M.D.; OLIVEIRA, P. DE T. C. DE ; SILVA, I. R.R.P. E ; NETO, Z. DE O.; CALDERARO, I.F.N.; ALMEIDA, F.M. DE . Environmental Education Perception Index (IPEA) headed for sustainable development: A study in Elementary Schools in the city of Guajará-Mirim, Rondônia (Brazil). **INTERNATIONAL JOURNAL OF ADVANCED ENGINEERING RESEARCH AND SCIENCE**, v. 5, p. 38-50, 2018a.

[14] PARAGUASSU-CHAVES, C.A.; CAVALCANTE, F.R.C.; ALMEIDA, F.M. DE; NETO, L.S. DA L.; SOUZA, L.V. DE; UCHOA, M. R.; CALDERARO, I.F.N.; OLIVEIRA, P. DE T.C. DE; CLARO, P. C. G.; DANTAS, L. R.M.. Factor Analysis and the Social Capital Index: A Study at the Brazil / Bolivia Border. **INTERNATIONAL JOURNAL OF ADVANCED ENGINEERING RESEARCH AND SCIENCE**, v. 5, p. 41-51, 2018b.

[15] PARAGUASSU-CHAVES, C.A.; CAVALCANTE, F.R.C.; DANTAS, L.R.M.; ALMEIDA, F.M. DE; CAVALCANTE, A.M.M. DA F.; SOUZA, J. S. Índice de desempenho da condição de saúde (IDCS) nos municípios de fronteira do Arco Norte e Central do Brasil. **InterScience Place**, v. 14, p. 170-219, 2019.

[16] PARAGUASSU-CHAVES, C.A.; CAVALCANTE, F.R.C.; BARROS FILHO, A. K.D.; CAVALCANTE, A.M.M. DA F.; DUARTE, J.C.; ALMEIDA, F.M. DE; MOREIRA DANTAS, L.R.; CARVALHO, C.D.; FONSECA NETO, J.V. Quantitative methods and study of the parth dependence effect of Douglass North from the cocoa production index (CPI) in RondÃ´nia, Brazil. **INTERNATIONAL JOURNAL FOR INNOVATION EDUCATION AND RESEARCH,** v. 8, p. 469-493, 2020a.

[17] PARAGUASSU-CHAVES, C.A.; CAVALCANTE, F.R.C.; BARROS FILHO, A.K.D.; ALMEIDA, F. M. DE; DANTAS, L.R.M.; MACIEIRA, C. DE A.; NETO, J.V.F.; BARATA, C. DA S.; SIQUEIRA, S.M.M.; CAVALCANTE, A.M.M. DA F.; NETTO, E.M. Factor Analysis Applied in the Construction of the Socio-Environmental Performance Index (IDRSA) in the Guajará-Mirim Free Trade Area, Brazil / Bolivia Border. **INTERNATIONAL JOURNAL OF ADVANCED ENGINEERING RESEARCH AND SCIENCE**, v. 7, p. 312-324, 2020b.

[18] PARAGUASSU-CHAVES, C.A.; CAVALCANTE, F.R.C.; BARROS FILHO, A.K.D.; ALMEIDA, F. M. DE; DANTAS, L.R.M.; GOES, S.B. DE ; NETO, J.V.F.; CAVALCANTE, A.M.M. DA F.; BARATA, C. DA S.; NETTO, E.M.; ANJOS, O. DOS . Factor analysis as a tool for building the sustainable development index of river basins in Rondônia, Western Amazon. **INTERNATIONAL JOURNAL OF ADVANCED ENGINEERING RESEARCH AND SCIENCE**, v. 7, p. 220-237, 2020c.

[19] DILLON, W. R.; GOLDSTEIN, M. **Multivariate analisys**: methods and applications. New York: Wiley, 1984.

[20] JOHNSON, Richard A.; WICHERN, Dean W.**Applied Multivariate Statistical Analysis**. 2nd Edition. **ISBN 10: 0130411469 / ISBN 13: 9780130411464**

[21] SANTANA, A.C. de. Análise do desempenho competitivo das agroindústrias de frutas do Estado do Pará. In: CONGRESSO BRASILEIRO DE ECONOMIA E SOCIOLOGIA RURAL, 44., 2006, Fortaleza,CE. **Anais...** Brasília, DF: Sober, 2006. p. 1-20

[22] SANTANA, A.C. de. Índice de desempenho competitivo das empresas de polpas de frutas do Estado do Pará. **RER**, Rio de Janeiro, v.45, n.03, p.749-775, jul./set. 2007b.

[23] MATOS, D.A.S. e RODRIGUES, E.C. **Análise Fatorial**. Brasília, DF: ENAP, 2019.

[24] NORTH, D. **Institutions, Institutional Change and Economic performance.** Cambridge University Press, Cambridge, 1990.

[25] PUTNAM, R.D. **Comunidade e democracia: a experiência da Itália moderna**/ Robert D. Putnam, com Robert Leonardi e Raffaela Y. Nanetti; tradução Luiz Alberto Monjardim – 5ª ed – Rio de Janeiro: Editora FGV, 2006.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.3

Performance Analysis of a Photovoltaic System installed in the Northeast of Brazil

Lya Serpa Claudio dos Santos[1], Lutero Carmo de Lima[2], Elissandro Monteiro do Sacramento[3], Raylla Silveira Souto[4]

[1]Centro de Ciências e Tecnologia Universidade Estadual do Ceara´ Fortaleza, CE, Brazil
E-mail: serpa.santos@aluno.uece.br
[2] Centro de Ciências e Tecnologia Universidade Estadual do Ceara´ Fortaleza, CE, Brazil
E-mail: lutero.lima@uece.br
[3] Instituto Federal de, Educação Ciência e Tecnologia-IFCE Fortaleza, CE, Brazil
E-mail: elissandro.monteiro@ifce.edu.br
[4] Centro de Ciências e Tecnologia Universidade Estadual do Ceara´ Fortaleza, CE, Brazil
E-mail: raylla.souto@aluno.uece.br

Received: 08 Apr 2022,

Received in revised form: 26 Apr 2022,

Accepted: 01 May 2022,

Available online: 09 May 2022

***Keywords*— Diversity management, diversity, Identity, Stereotype.**

***Abstract*—** *This article shows the study about the photovoltaic solar power plant installed in Messejana, Fortaleza, Ceará, Brasil (latitude 3° 49'57",7" S and longitude 38°29'58",3'' W) with an installed capacity of 19.2 kWp. It aims to punctuate the good practices for correct sizing of a grid connected photovoltaic power system, in microgeneration, and evaluate the system performance. The monitoring of the system was between March and September 2021. During this measuring period, the energy delivered to the power grid was 18197.15 kWh. the average reference, array, and final yields were 5.45 kWh/kWp, 4.33 kWh/kW, and 4.26 kWh/kW, respectively. The annual loss of the array and the system were 0.81 kWh/kW and 0.07 kWh/kWp, respectively, and the annual average of array and system efficiencies were 15.13% and 14.88%, respectively. The performance rate and capacity factor were 81.85% and 18.05%, respectively. Those numbers highlight the relatively good performance of photovoltaic systems installed in the Northeast region of Brazil.*

I. INTRODUCTION

Given the current scenario of electric energy consumption and considering the fact that energy is a fundamental subsidy for human activities and is used in different fields and spatialities, the use of renewable energy sources is increasing and gaining strength in the global energetic scenario. The advantage of energy generation through renewable sources is mainly the minimum impact on the environment (Jung, 2015).

The use of solar radiation for energy generation has advantages compared to the other sources since it receives economic incentives, has low maintenance costs, and is an inexhaustible resource. Based on this, it is necessary to invest in research and innovation in the Photovoltaic Energy sector and seek improvements in the modules and system performance.

Besides the previously mentioned advantages, the consumer has the possibility to lower the energy bill. This occurs when the amount of energy generated by the system is equal to or higher than the energy consumed in the same period. This way, the consumer receives credits that can be used later. According to the laws of the National Electric Energy Agency (Agência Nacional

de Energia Elétrica - ANEEL), the credits are valid for 60 months and can be used to reduce the consumption of consuming units belonging to the same owner but located in a different area, as long as the said area is inside the attendance area of the same distributor. This type of use is what the agency calls "remote self-consumption" (ANEEL, 2015).

According to CRESESB (2008), every year the Earth receives solar energy equivalent to 10 thousand times the global energetic consumption in the same period. Great regions in Brazil receive more than 2200 hours of insolation per year, which is equivalent to 32 thousand times the electricity consumed nationally in 2015 (WANDERLEY, 2016). Considering these numbers and information, it is possible to conclude that the use of photovoltaic energy in Brasil is very viable.

The performance evaluation of photovoltaic systems is the best way to determine the potential of photovoltaic energy production in an area. Normally, the performance of photovoltaic modules refers to the standard test conditions (STC), which do not always represent the real module operation (LIMA, et al, 2017).

There is a possibility of loss in the power generation of the solar system by different factors, such as loss due to shadowing, inclination, misdirection or poor location, lack of cleaning of the panels, or maintenance of the cables and inverter, among others.

All the mentioned factors might damage or shorten the lifespan of the system or cause it to have performance below expected. That being said, it is necessary to take specific measurements to avoid possible losses and, thus, preserve the system.

The system connected to the power grid

The panels used were from DAH Sola, model HCM72X9-400W, made of monocrystalline silicon with nominal power of 400 Wp, providing energy for two Growatt inverters model 8000MTL-S that, together, had a nominal power of 16 kWp. These pieces of equipment are in a commercial building in Messejana, Fortaleza-CE, coordinates 3°49′57,7″ latitude south and 38°29′58,3″ longitude west. It is a system connected to a power grid that started operating in January 2021.

The panels point to the geographic north, as recommended for installations located on the south of the Equator line, and with an inclination that follows the roof of the building. The recommendation for maximum production throughout the year is to install the panels with an inclination similar to the latitude of the place. The grid-connected photovoltaic power system (GCPVS) has 6 strings of 8 panels each, with a total of 48 photovoltaic panels with an installed power of 19,2 kWp and a total area equals 105.6 m². The calculated area of unit power (kWp) was 5.5 m².

Fig.1: Image of the 19.2 kwp Solar System

Source: Author.

Performance Analysis of the Photovoltaic Systems

The performance evaluation of a grid-connected photovoltaic power system normally uses as a reference the IEC 61724:1998 pattern and ABNT NBR 16274/2014 norm. The evaluated indicators are Total Energy, the yield of the photovoltaic system (of reference, PV array, and final), losses of system energy and of the system itself, system efficiency (set efficiency, system efficiency, and inverter efficiency), Performance rate, and Capacity factor (LIMA et al., 2017).

Total Energy

The total energy is the amount of alternated potency generated by the system for a certain amount of time. The total, daily, and monthly hourly energy produced might be determined respectively by:

$$E_{CA,h} = \sum_{t=1}^{60} E_{CA,t} \quad (1)$$

$$E_{CA,d} = \sum_{h=1}^{24} E_{CA,h} \quad (2)$$

$$E_{CA,m} = \sum_{d=1}^{N} E_{CA,d} \quad (3)$$

In which, E_{ACt} is the total AC energy at t time (in minutes), E_{ACh} is the hourly total AC energy (in hours), $E_{AC,d}$ is the daily total AC energy, $E_{AC,m}$ is the monthly total AC energy, and N is the number of days on the month.

Photovoltaic system yield

The photovoltaic system productions are represented by the letter "Y" and classified in three types: reference yield (Y_R), PV array yield (Y_{PV}), and final yield (Y_F). It represents the energy generated by the system, in kWh, for each KW_P of installed power. The used unit is kWh/KW_P in day or hours/day. When expressed in hours/day, it represents the time that the system should

operate in its nominal power to generate the same amount of energy on the same given period of time (MORAIS, 2017).

The yields indicate the real operation of the photovoltaic panels and the photovoltaic array in relation to its nominal power (MORAIS, 2017).

The PV array yield (Y_{PV}) is given by equation 4, in which de E_{DC} is the total energy (in kWh) produced by the photovoltaic array:

$$Y_{FV} = \frac{E_{cc}}{E_{cc.nom}} \left(\frac{kWh}{kW_P \,.\, dia}\right) \quad (4)$$

The final yield Y_F is given by equation 5, in which E_{AC} is the total AC energy:

$$Y_F = \frac{E_{CA}}{P_{FV.nom}} \left(\frac{kWh}{kW_P \,.\, dia}\right) \quad (5)$$

The reference yield Y_R is the total irradiation on the level or global horizontal irradiation (H_T) on the level divided by the reference irradiation (H_R) in standard temperature and pressure conditions are equal to 1 kWh/m^2. This is a theoretical energy measurement available in a specific place during a specific period of time (MORAIS, 2017). The reference performance can be calculated by equation 6:

$$Y_R = \frac{H_T}{H_R} \left(\frac{kWh}{kW_P \,.\, dia}\right) \quad (6)$$

According to equations 4, 5, and 6, we will reach values that theoretically express a mathematical relation between the productivities, it is possible to affirm that:

$$Y_R \geq Y_{FV} \geq Y_F \quad (7)$$

Losses

Captures losses of the photovoltaic array (L_{PV}) represent the losses due to the operation that highlight the incapacity of the photovoltaic array in fully using the available irradiation. The calculation of the PV array capture loss is the difference between the reference production of the photovoltaic panels (MORAIS, 2017). It is given by equation 8:

$$L_{FV} = Y_R - Y_F \ \left(\frac{kWh}{kW_P}\right) \quad (8)$$

The losses of photovoltaic system (L_S) are due to the losses on the conversion of direct current output (E_{DC}) to alternating current (E_{AC}) by the inverter, it is the subtraction of the PV array yield by the final yield. It is also necessary to consider the losses by the Joule effect. Equation 9 below shows it:

$$L_S = Y_{FV} - Y_F \ \left(\frac{kWh}{kW_P}\right) \quad (9)$$

The total PV system losses (L_T) are the sum of the capture loss of the PV array (L_{PV}) with the PV system losses (L_S), given by equation 10 below:

$$L_T = L_{FV} + L_S \ \left(\frac{kWh}{kW_P}\right) \quad (10)$$

Photovoltaic system efficiencies

There are three classifications for the photovoltaic system efficiency: photovoltaic array efficiency, system efficiency, and inverter efficiency. Depending on the available data and the level of desired resolution, these efficiencies might be determined in instant, hourly, daily, monthly and annual basis, expressed in percentages (MORAIS, 2017).

The PV array efficiency is the output of DC energy while the system efficiency is a function of the output of AC energy. The PV array efficiency (η_{PV}) represents the average efficiency of the energy conversion of the photovoltaic array, which is the ratio between the daily production of DC energy and the product of total daily irradiation on the level and the area of the PV array (LIMA *et al.*, 2017). The PV array efficiency is calculated by equation 11, the system efficiency by equation 12, and the inverter efficiency by equation 13. Considering A_{PV} as the total area of the photovoltaic array in m^2:

$$\eta_{FV} = \frac{100 \, x \, E_{CC}}{H_T \, x \, A_{FV}} \ (\%) \quad (11)$$

$$\eta_{SYS} = \frac{100 \, x \, E_{CA}}{H_T \, x \, A_{FV}} \ (\%) \quad (12)$$

$$\eta_{INV} = \frac{100 \, x \, E_{CA}}{E_{CC}} \ (\%) \quad (13)$$

Capacity factor X "Performace ratio"

Capacity factor

The capacity factor is the "capacity that a system would have of producing energy if it operated in its full nominal power for the 24 hours of the day". The following equation shows the calculation of the annual capacity (SECUNDE, 2015):

$$FC \ (\%) = \frac{Eg(kWh)}{P_n \, (kWh) \, x \, 24h \, x \, 365} x100 \quad (14)$$

In which:

FC = System capacity factor;

Eg = energy produced by the system in a year;

P_n = nominal power of the photovoltaic system.

Performance Ratio – PR

Performance ratio (PR) is one of the most important variables when evaluating the efficiency of a GCPVS. In this analysis, it is possible to find the quality factor for the system. PR, indicated in percentage (%) shows

the relationship between the real and theoretical outputs of the GCPVS, showing the percentage of available energy to inject on the grid after the deduction of the energy losses (related to the temperature of the operation of the PV modules, wiring, DC/AC energy conversion on the inverter, shadowing, among others) and the energy consumption for the operation.

The closer to 100% the PR is, the lower the system losses are, but it is not possible to reach a 100% PR level in practice, since there are inevitable losses during the operation of a PV system.

Equation y shows the calculation of the PR:

$$PR = \frac{YF}{\frac{\int_{t1}^{t2} Icol\, dt}{I_R}} \quad (15)$$

In which:

Icol = global irradiation received on the collector level;

IR = reference irradiation;

YF = system yield.

For a certain time interval, the calculation of the system yield is the relation between the average value of energy delivered to the load and the nominal power of the photovoltaic generator. The equation below shows how to calculate the system yield (SECUNDE, 2015).

$$YF = \frac{\int_{t1}^{t2} P_{Saida} \times dt}{P_{FV}^{0}} \quad (16)$$

In which YF is in kWh/kWp, or per hour. Therefore, though having more than one mechanism to evaluate the performance of photovoltaic systems, PR is, among other, the most commonly used for performance evaluation.

(Theoretical) energy production of a GCPVS

According to Morais (2017), it is possible to calculate the theoretic value of the energy produced by a GCPVS (E_{TCA}) following equation 17.

$$E_{CAT} = P_{FV,nom}\, x\, \frac{H_T}{H_R}\, x\, FS\, x\, PR\, x\, \eta_{INV} \quad (17)$$

In which E_{TAC} is the theoretical AC in kWh, $P_{PV,nom}$ is the GCPVS installed potency, H_T is the global irradiance (monthly or annual total), H_R is the reference irradiance in standard temperature and pressure conditions and are equal to 1 kW/m^2, *SF* is the shadowing factor, *PR* is the theoretical performance relation for the system and η_{INV} is the inverter efficiency. The *SF* varies from zero (0) to a total shadowing to one (1) when there is no shadowing.

II. RESULTS

The analysis used data from the datalogger of the Growatt inverter and pyranometer (PDC/FUNCEME). After extracting and compiling the data on an Excel sheet, it was possible to analyze the statistical data and produce the charts to enable comprehension and discussion. The data included on the inverter screen include DC power, DC tension, DC potency, AC power, AC tension, AC potency, and energy sent to the grid while the ShinePhone application shows potency and energy. The data are stored on a webserver or SD card every 30 minutes and, from this data, it was possible to determine the daily, monthly, and annual indicators. FUNCEME provides the irradiance data on an Excel sheet.

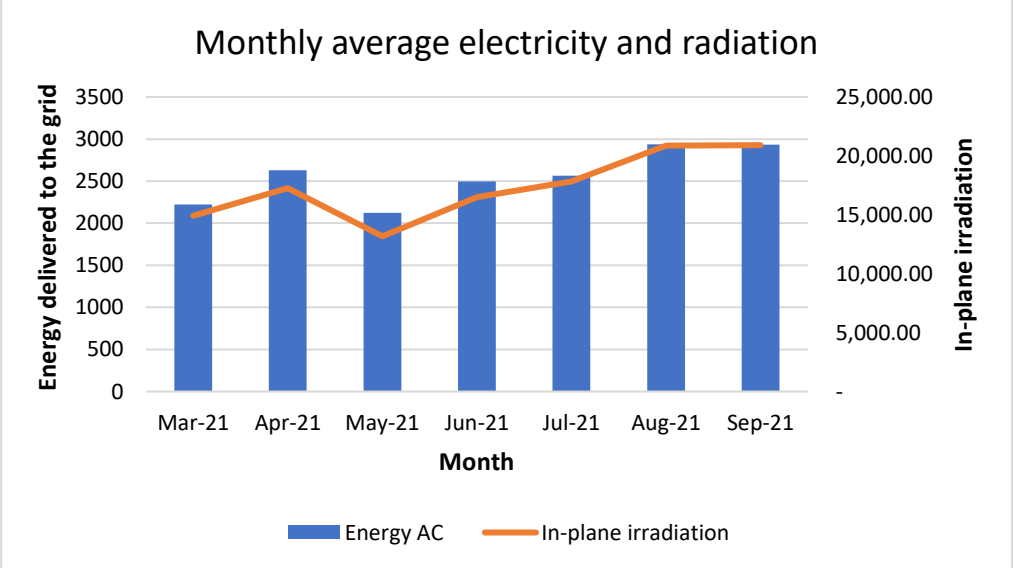


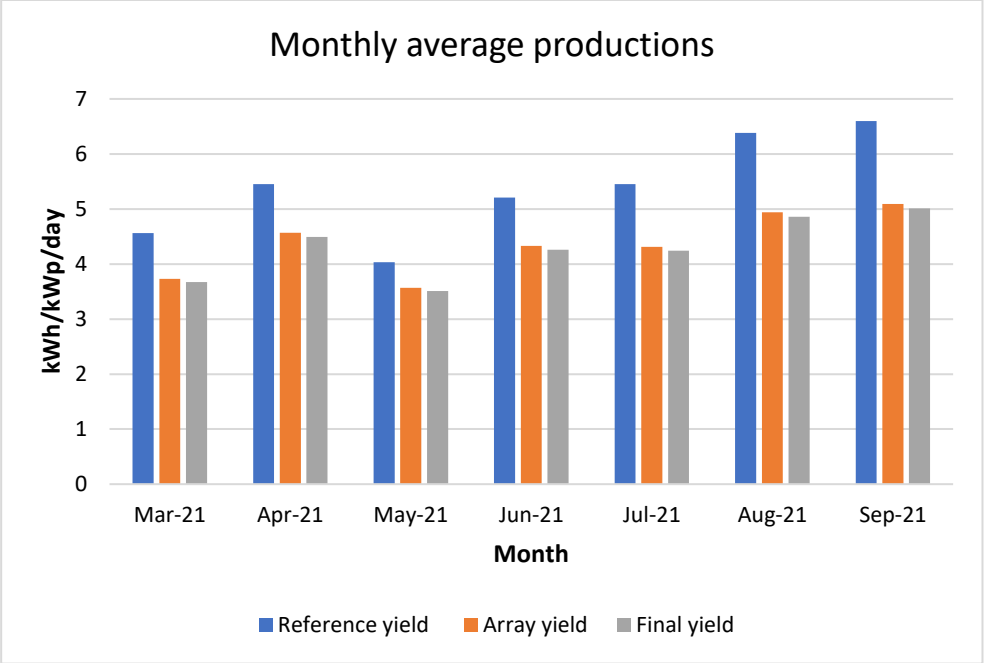
Fig.2 – Energy produced by the photovoltaic system and radiation on the horizontal level

Source: author

The analysis of the photovoltaic systems in this study covers the period from March to September 2021. According to the chart in Figure 2, the total energy sent to the grid from March 1, 2021, to September 30, 2021, was 18197 MWh with a monthly average of 2605.6 kWh. The maximum value of energy sent was in August/2021 (2986,89 kWh) and the lowest was in May/2021 (2157.82 kWh). For comparison purposes with the energy sent to the grid, we converted the irradiation measured in em kWh/m2 by direct rule of three with the total area of the photovoltaic panels (105.6 m²) to obtain the daily and monthly kWh values.

The highest solar irradiation value was in September/2021, during the dry season, without rain. In March/2021 and May/2021, there was a reduction in irradiation value with registered numbers of 14.921 kWh and 13.176 kWh, respectively.

The energy productions are in Figure 3. The daily annual average reference yield (YR), PV array yield (YPV), and final yield (YF) were 5.45 kWh/kWp.day; 4.33 kWh/kWp.day; 4.26 kWh/kWp.day, respectively.



Source: author.

The monthly average efficiencies for the photovoltaic system are in Figure 4. The inverter efficiency, found on the technical file by the manufacturer Growatt, is 98%.

The average efficiency from March/2021 to September/2021 of the photovoltaic array during the collection period was 15.13%, varying from 14,26% in September/2021 to 16.38% in May/2021. This article did not intend to analyze the degree of soiling on the PV modules, but it is possible to preliminarily conclude that the highest efficiency value of the array was during the period with more precipitation, which washed the panels.

The monthly average capacity factor (CF) varied between 14.86% (May/2021) and 21.22% (September/2021) and measures the average percentage in which the GCPVS worked at full capacity. The performance ratio (PR) varied between 77.15% in September/2021 to 88.63% in May/2021. The performance ratio (PR) measures the global effect of the losses over the nominal power of the GCPVS due to factors such as inefficiency of the inverters and losses on the conversion from DC to AC, soiling of the panels and failure of the components of the system, and lack of electric energy from the distributor (ENEL) which avoids the binding of the GCPVS. Figure 5 shows the monthly average CF and PR data.

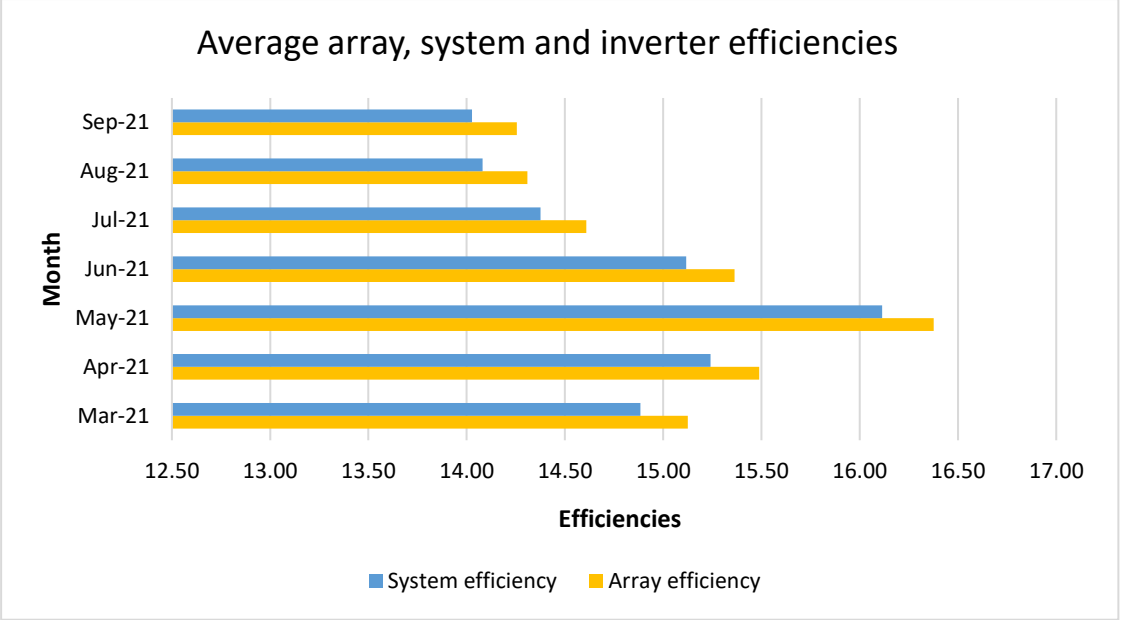


Fig.4 – Monthly average efficiencies

Source: author.

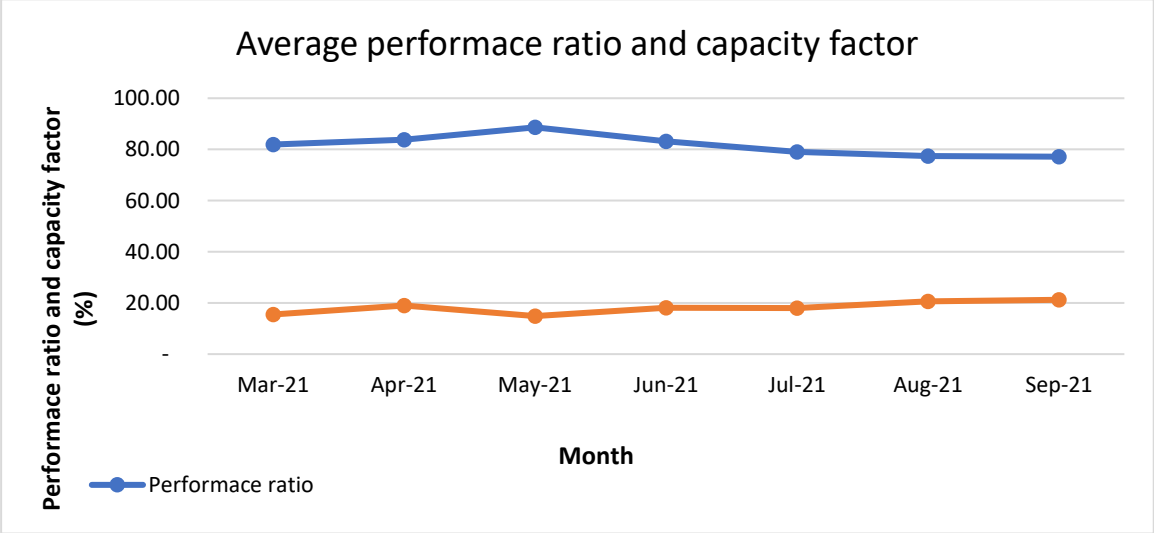


Fig.5 – Monthly averages: CF and PR

Source: author.

Figure 6 shows the relative losses of the analyzed GCPVS. The month with the highest loss was September/2021, with a value of 1.5 kWh/kWp.day, and the lowest was in May/202, 0.45 kWh/kWp.day. In all the months analyzed in this study, the PV array surpassed the system losses. According to Pinho and Galdino (2014), there is an optimization of the annual energy production of GCPVS with a fixed array when it points to the geographic north (azimuth 0) and has an inclination similar to the installation site. The annual average total loss for the GCPVS was 0.88 kWh/kWp.day.

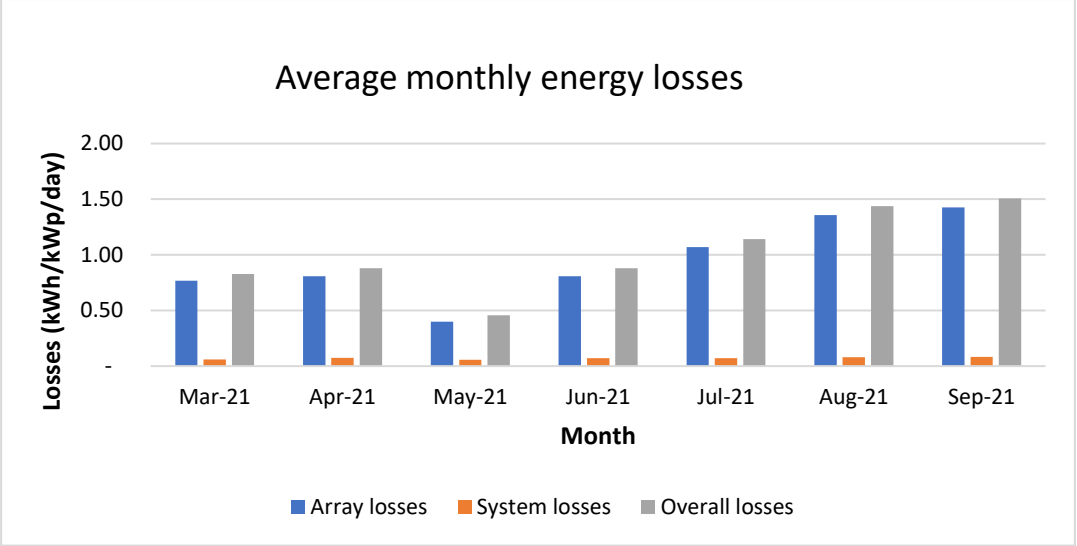


Fig.6 – Relative losses

Source: author.

III. CLOSING REMARKS

In this study, we analyzed a photovoltaic system connected to a 19.2 kWp grid installed in Messejana, Fortaleza, Ceará – Brasil from March 2021 to September 2021. The average energy delivered generated by the photovoltaic array in this period is 2563.6 kWh. The average reference, array, and final yields are 5.45, 4.33, and 4.26, respectively. The average array and system efficiencies are 15.13% and 14.88%, respectively, while the capacity factor and performance ratio averages are 18.05% e 81.85%, respectively. The total losses of the system are average 0.88 kWh/kWp/day. These results show a great performance of the analyzed system, indicating a good energetic potential of solar energy in Ceará - Brasil and also indicating that the localization of the system is in a shadowing-free environment and its installation project followed the proper guidelines.

REFERENCES

[1] AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA. **Iformações técnicas:** Geração Distribuida. 2015. Disponivel em: http://www.aneel.gov.br/informacoes-tecnicas/-/asset_publisher/CegkWaVJWF5E/content/geracao-distribuida-introduc-1/656827?inheritRedirect=false&redirect=http%3A%2F%2Fwww.aneel.gov.br%2Finformacoes-tecnicas%3Fp_p_id%3D101_INSTANCE_CegkWaVJWF5E%26p_p_lifecy. Acesso em: 5 jul. 2021.

[2] CENTRO DE REFERÊNCIA PARA ENERGIAS SOLAR E EÓLICA. **Radiação Solar.** 2008. Disponivel em: http://cresesb.cepel.br/index.php?section=com_content&cid=301. Acesso em: 5 jul. 2021.

[3] JUNG, R. M. Energia eólica no brasil: uma análise das vantagens e desvantagenS. In: CONGRESSO NACIONAL DE EXCELÊNCIA EM GESTÃO, 11., 2015. [S.l.]. **Anais...** [S.l.:s.n.], 2015.

[4] LIMA, L. C. de et al. Performance analysis of a grid connected photovoltaic system in northeastern Brazil. **Energy for Sustainable Development.,** v. 37, p. 79– 85, 2017.

[5] MORAIS, Francisco Hedler Barreto de Lima. **Análise de desempenho de um sistema fotovoltaico de 5,2 kwp conectado à rede instalado na UECE**. 2017. 96 f. Dissertação (Mestrado em Ciências Físicas Aplicadas, Universidade Estadual do Ceará, Fortaleza, 2017.

[6] SECUNDE, U. U. **Procedimentos e normativas para instalação de centrais fotovoltaicas conectadas à rede elétrica em média tensão.** 2015. 140f. Dissertação (mestrado em Tecnologia Energéticas e Nucleares) - Universidade Federal De Pernambuco, Recife, 2015.

[7] WANDERLEY, P. A. C. F. **Porque usar a energia solar?** Brasilia/DF: [s.n.]. 2016

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.4

Comparisons of Cephalometric image analysis by Information Technology (IT) in the treatment of Dentomaxillofacial Changes

Eliano da Fonseca Reis; Nathanael Attilas Aleva; Lucas de Morais Barros; Hércules Henrique Onibene Castro; Daniel Rodrigues Silva and Juscélio Clemente de Abreu

Received: 08 Apr 2022,

Received in revised form: 26 Apr 2022,

Accepted: 01 May 2022,

Available online: 09 May 2022

***Keywords*— Cephalometry, Cephalometric Analysis, Information Technology, Cefanalisys ®.**

***Abstract*—** *Cephalometry is one of the most important complementary exams in the diagnosis and planning of orthodontic, surgical, speech therapy, otorhinolaryngology and facial orthopedic treatments. The lateral cephalogram used for cephalometry can also assess the maturation of the cervical vertebrae to complement the diagnosis of bone age, orofacial dysfunction and changes in the Upper Airway (UAS). Due to the technological evolution for obtaining and interpreting images and with the emergence of software that are auxiliary in the diagnosis of orofacial alterations, the objective of this work was to develop diagnostic hypotheses and suggestions for treatments of dentomaxillofacial alterations , from comparisons of IT data. four commonly used cephalometric techniques. The software used for the analysis of the images was Cefanalis ® and the parameters Cephalometric measurements were obtained using the techniques of Jarabak , McNamara , Ricketts and USP. The advantage of having four analyzes gathered in a single software and the possibility of making cephalometric tracings of each of these techniques in combination allows the orthodontist to perform the entire procedure in his own office. More than the cephalometric tracing itself, it is possible to elaborate diagnostic hypotheses for each of the listed measures and treatment proposals for each of the changes in normality. The findings of this study made it possible to complement the data for an accurate diagnosis performed by professionals who use CCom .*

I. INTRODUCTION

The study of interventions in orofacial function and aesthetics requires clinical and technological resources for a complete evaluation. The ability of orthodontists and surgeons to recognize a symmetrical face is innate, and translating it into objective therapeutic goals becomes an arduous task.

With the advancement and popularity of orthognathic surgeries ,the search for craniofacial balance received more attention. Facial cephalometric tracings , based on lateral cephalometric radiographs, made using information technology (IT) are, today, one of the best semiotechnical options for a correct diagnosis, in addition to establishing treatment options, which provide linear dimensions. and appropriate angles of the structures of the oral and maxillofacial complex .

Therefore, the use of a clinical pattern, as well as adequate complementary exams are fundamental for the formal analysis of facial aesthetics.

In Brazil, as in other countries around the world, numerous facial cephalometric analyzes are used as complementary tests for the diagnosis of oral and maxillofacial alterations .

The different courses of Dentistry, undergraduate and graduate, usually determine one or two cephalometric analyzes as a standard to be taught to their students. However, these analyzes are not complete, that is, none is able to evaluate all the oral, maxillofacial , dental and soft tissue characteristics of a patient.

For an accurate diagnosis, the use of only a cephalometric analysis is not indicated . Therefore, the combination of several analyzes makes it possible to use a greater number of linear and angular measurements, which will allow a broader and more accurate assessment.

In order to increase the use of bioinformatics in dentistry and facilitate the practice of specialties such as orthodontics, functional maxillary orthopedics (OFM) and oral and maxillofacial surgery (CBMF), the objective of this work was to propose diagnostic hypotheses and suggestions for treatment of dentomaxillofacial alterations , from comparisons of IT data from four commonly employed cephalometric techniques, Jarabak , McNamara , Ricketts and USP.

II. MATERIALS AND METHODS

CEPHALOMETRIC MEASUREMENTS

The longitudinal assessment of craniofacial growth and development was performed using cephalometric techniques that are more widely disseminated, known and used in Brazil: Jarabak , McNamara , Ricketts and USP.

Tables 1, 2, 3, and 4 organize the measures selected and used in each of the four techniques adopted.

Table 1: Jarabak 's cephalometric analysis

MEASUREMENTS	NORMALITY
Saddle angle or skull base deflection angle	123* ± 5*
joint angle	143* ± 6*
gonial angle	130* ± 7*
superior gonial angle	52* to 55*
lower gonial angle	70* to 75*

Source: Jarabak, 1972

Table 2: Cephalometric analysis of USP

MEASUREMENTS	NORMALITY
NAP	0
SNA	82*
SNB	80*
ANB	two*
SND	76*
NS.Gn	67*
SN.PLO	14*
GoGn.PLO	18*
SN.GoGn	32*
1.1	130*
1.NA	22*
1-NA	4 mm
1.NB	25*
1-NB	4mm
1-ORBITA	5mm

1-LINE I	0
H.NB (Soft Profile)	9*-11*
H-NOSE	9 to 11mm
P-NB	4mm
FMA	25*
FMIA	68*
IMPA	87*
WITS	M- 0.0 +-1
	H- -1.5mm+1

Source: Interlandi, 1971

Table 3: McNamara 's Cephalometric Analysis

MEASUREMENTS	NORMALITY
Mandibular Plane Angle	Mixed Dentures: 25*
	Permanent Denture: 32*
Point A- (N-PERP or McNAMARA Vertical)	Mixed Denture: Point A coincident with N-PRSP
	Permanent Denture: Point A 1 mm forward N-PERP
Nasolabial Angle	110*
Upper Lip Tilt	14*± 8*
Pog (N-PERP)	Mixed Dentures: -8 to -6mm behind N-PERP
	Permanent Denture: -4 to 0mm behind
	N-PERP (up to +2mm in men)
Effective jaw length (Co-A)	Mixed Denture: 85mm
	Adult women: 94mm
	Adult men: 100mm
Effective Jaw Length (Co-Gn)	Mixed Dentures: 105 to 108mm
	Adult women: 121 to 124mm
	Adult men: 130 to 133mm
Maxillomandibular relationship	Mixed Dentures: 20 to 23mm
	Adult women: 27 to 30mm
	Adult men: 30 to 33mm
Lower Anterior Facial Height (AFAI)	Mixed Dentures: 60 to 62mm
	Adult women: 66 to 67mm
	Adult men: 70 to 74mm
(Ba-Na).(Pt-Gn)	90* ± 3.5*
(Ricketts Cephalometric Analysis)	Â - 90*= X (negative X = vertical growth)
	(Positive X = horizontal growth)
Anteroposteriorly Line A-1	4 to 6mm
Vertically 1-Ls	2 to 3mm

anteroposteriorly	1 to 3 mm ahead of the A-Pog Line
Vertically	2 to 3mm
nasopharynx	1.3 mm above the Functional Occlusal Plane
	Mixed denture: 12 mm
oropharynx	Permanent Denture: 17.4 mm
	10 to 12 mm for all ages

Source: MacNamara, 1984

Table 4 : Ricketts Cephalometric Analysis

MEASUREMENTS (Dentoskeletal)	NORMALITY
Tilt of the Occlusal Plane	22*+-4* up to the age of 8 years. Increases 0.5* per year
1.APO	22* ± 4*
1 .PO	28* ±4*
1-APO	1mm ± 2mm
1 - APO	3.5mm ± 2.5mm
Occlusal Plane to the Branch (Xi)	0mm+-3mm at 9 years and 6 months. Decreases 0.5mm per year in relation to point Xi
A6-PTV	Age +3mm ± 3mm
A6-B6 (in the Occlusal Plane)	Class I = -3mm
	Class II ≥ 0
	Class III ≤ -6mm
	Clinical Deviation ± 3mm
Canine Relationship (in the Occlusal Plane)	Class I = -2mm
	Class II ≥ +1mm or more
	Class III ≤ -5mm
	Clinical Deviation = ± 3mm
A1-B1 (Horizontal Overjet, Overjet)	2.5mm ± 2.5mm
A1-B1 (Overbite, perpendicular to the Occlusal Plane , Overbite)	2.5mm ± 2mm
B1-(B1-B6) Incisive Extrusion	1.25mm ± 2mm
interincisors	130* ± 10*
Point A convexity	2mm ± 2mm at 8 years and 6 months, decreases by 0.2 mm per year
Lower Facial Height	47*± 4*
Lip Position	-2mm ± 2mm up to the age of 8 years and 6 months, decreases by 0.2 per year
Upper Lip Length (ENA- Stm)	24mm ± 2mm at 8 years and 6 months

Union Point (Stomium -Stm) - Occlusal Plane	-3.5mm ± 2mm at 8 years and 6 months, decreases by 0.1mm per year in relation to the Occlusal Plane
Facial Depth	87* ± 3* at age 9, increases by 0.33* per year
facial axis	90* ± 3.5*
facial cone	68* ± 3.5*
Mandibular Plane Angle	26* ± 4.5* at 9 years old, decreases by 0.33* per year
Maxillary Depth	90* ± 3*
jaw height	53* ± 3* at age 9, increases by 0.4*per year
Angle formed by the Palatine Plan and the Frankfurt Plan	1* ± 3.5*
Total Face Height	60* ± 3*
Cranial Deflection	27* ± 3*
Anterior Cranial Length	55mm ± 2.5mm up to age 8.5 years, increases 0.8mm per year
Posterior Facial Height	55mm ± 3.3mm at 8.5 years, increases 0.8mm per year
Branch Position	76* ± 3*
Porium Position	-39mm ± 2.2mm at 9 years old, increases 0.5mm per year
Mandibular Arch	26* ± 4* at age 8.5 years, increases by 0.5*per year
Mandibular Body Length	65mm ± 2.7mm at age 8.5 years, increases by 1.6mm per year

Source: Ricketts, 1957

Table 5: Diagnosis and treatment parameters from Jarabak's cephalometric analysis for the Cefanalisys ® Software

MEASUREMENTS	NORMALITY	DIAGNOSIS	TREATMENT SUGGESTIONS
Saddle Angle or Skull Base Deflection Angle - formed by the NS and S-Ar lines	123* ± 5*	> 128* Posterior skull base - absorbs more mandibular growth; leads to mandibular retrognathia (Skeletal Class II)	Protrude Mandible and/or Speech Therapy
		< 118* Posterior skull base propels mandible; leads to mandibular protrusion (Skeletal Class III)	Retracting Mandible and/or Speech Therapy Isolated interpreted compensations
Articular Angle - formed by the S-	143* ± 6*	> 149* Tooth extrusion (accentuates vertical-dolichofacial growth tendency)	Flexible wires (Nitinol) Control vertical growth and mandibular retrognathism

Ar and Ar-Go lines		< 137* Tooth Intrusion (accentuates horizontal-brachyfacial growth tendency)	Rigid Wires (Steel) Control horizontal growth and mandibular prognathism
Goniac Angle - formed by the Ar-Go and Go-Me lines	130* ± 7*	> 137* Vertical growth trend	Controlling Vertical Growth and Open Bite
		< 123* Horizontal growth trend	Control horizontal growth and Deep Bite
Gonical Angle - formed by the Ar-Go and Go-N Lines	52* to 55*	> 55* Increases sagittal growth (horizontal chin projection)	Control horizontal growth
		< 52* Greater vertical growth (vertical chin growth)	Control vertical growth
Goniac Angle - formed by the N-Go and Go-Me lines	70* to 75*	> 75* Vertical growth trend (open bite) - unfavorable prognosis (surgical)	Controlling Vertical Growth and Open Bite
		< 70* Horizontal growth tendency (deep bite) - unfavorable prognosis (surgical)	Control horizontal growth and Deep Bite

Table 6: Diagnostic and Treatment Parameters from USP Cephalometric Analysis for Cefanalisys ® Software

MEASUREMENTS	NORMALITY	DIAGNOSIS	TREATMENT SUGGESTIONS
NAP	0	> 0 - convex profile	Advance mandible - Retract maxilla
		< 0 - concave profile	Retract mandible - Advance maxilla
SNA	82*	> 82* Protruded jaw	retract jaw
		< 82* Retracted jaw	protrude jaw
SNB	80*	> 80* Protruded jaw	retract jaw
		< 80* Retruded jaw	protrude jaw
ANB	two*	> 2* Maxilla in front of the mandible - skeletal class II	Advance mandible - Retract maxilla
		< 2* Mandible in front of Skeletal Class III Maxilla	Retract mandible - Advance maxilla

SND	76*	> 76* Mandible protruded in relation to the base of the skull	retract jaw
		< 76* Mandible retruded in relation to the base of the skull	protrude jaw
NSGn	67*	> 67* Vertical growth trend (Open bite)	Rotate jaw counterclockwise
		< 67* Horizontal growth tendency (Deep bite)	Rotate jaw clockwise
SNPLO	14*	> 14* Vertical growth trend (Open bite)	Rotate jaw counterclockwise
		< 14* Horizontal growth tendency (Deep bite)	Rotate jaw clockwise
GoGnPLO	18*	> 18* Vertical growth trend (Open bite)	Rotate jaw counterclockwise
		< 18* Horizontal growth tendency (Deep bite)	Rotate jaw clockwise
SNGoGn	32*	> 32* Vertical growth trend (Open bite)	Rotate jaw counterclockwise
		< 32* Horizontal growth tendency (Deep bite)	Rotate jaw clockwise
11	130*	> 130* Lingualized incisors	Vestibular incisors
		< 130* Factualized incisors	Lingualize incisors
1NA	22*	> 22* maxillary incisors proclined	Lingualize upper incisors
		< 22* lingual maxillary incisors	Vestibular superior incisors
1-NA	4 mm	> 4mm - Protruded upper incisors	Retract maxillary incisors
		< 4mm - Retruded maxillary incisors	Protrude upper incisors

1NB	25*	> 25* Facing lower incisors	Lingualize lower incisors
		< 25* Lingualized lower incisors	Vestibularize lower incisors
1-NB	4mm	> 4mm - Protruded lower incisors	Retract lower incisors
		< 4mm - Retruded lower incisors	Protrude lower incisors
1-ORBITA	5mm	> 5mm - Upper incisor behind the orbit, incisors proclined	Lingualize maxillary incisor
		< 5mm - Upper incisor in front of orbit, incisors lingual	Vestibular superior incisor
1-LINE I	0	Retruded lower incisor	protrude lower incisor
		< 0 - Protruded lower incisor	retract lower incisor
HNB (Soft Profile)	9*-11*	> 11* Convex profile, H-NOSE decreases	advance jaw
		< 9* Concave profile, H-NOSE increases	retract jaw
H-NOSE	9 to 11mm	> 11mm - Nose ahead of the H line (concave profile)	retract jaw
		< 9mm - Nose behind the H line (convex profile)	protrude jaw
P-NB	4mm	> 4mm - Protruded chin	retract _
		< 4mm - Petrified chin	protrude chin
FMA	25*	>25* Vertical growth trend (dolichofacial)	Decrease FMA
		<25* Horizontal growth trend (brachyfacial)	Increase FMA
		> 68* Lingualized lower incisors	Vestibularize lower incisors
		< 68* Facing lower incisors	Lingualize lower incisors

IMPA	87*	> 87* Factualized incisor	Lingualize Lower Incisors
		< 87* Lingualized incisor	Vestibular Lower Incisors

Table 7: Diagnosis and Treatment Parameters Based on McNamara 's Cephalometric Analysis for the Cefanalisys ® Software

MEASUREMENTS	NORMALITY	DIAGNOSIS	TREATMENT SUGGESTIONS
Mandibular plane angle	Mixed Dentures: 25*	> 25* Vertical growth trend (Open bite)	Rotate jaw counterclockwise
		< 25* Horizontal growth tendency (Deep bite)	Rotate jaw clockwise
	Permanent denture: 32*	>32* Vertical growth trend (Open bite)	Rotate jaw counterclockwise
		<32* Horizontal growth trend (deep bite)	Rotate jaw clockwise
RELATIONSHIP OF THE MAXILLA WITH THE BASE OF THE SKULL	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Point A	mixed denture	Point A > 0 - Protruded maxilla	retract jaw
		Point A < 0 - Retruded jaw	protrude jaw
	permanent denture	Point A > 1mm - N-PRSP Protruded maxilla	retract jaw
		Point A < 1mm - N-PRSP Retracted maxilla	protrude jaw
SOFT TISSUE EVALUATION	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
nasolabial angle	110*	> 110* Maxillary retrusion	protrude jaw
		< 110* Maxillary protrusion	retract jaw
Upper lip tilt	14* ± 8*	> 22* Protruded upper lip	Retract maxilla and anterior maxillary teeth
		Retruded upper lip	Protrude maxilla and anterior superior teeth
RELATIONSHIP OF THE JAW WITH THE BASE OF THE SKULL	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Pog -(N-PERP)	mixed denture	> 6mm - Protruded jaw	retract jaw

		< 8mm - Retruded jaw	protrude jaw
	Permanent Denture	> 0mm - Protruded jaw	retract jaw
		< 4mm - Retruded jaw	protrude jaw
RELATIONSHIP BETWEEN MAXILLA AND JAW	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Effective length of the maxilla (Co-A)	Mixed Denture: 85mm	> 85mm - Large jaw	Decrease jaw length
		< 85mm - Small jaw	increase jaw length
	Adult women: 94mm	> 94mm - Large jaw	Decrease jaw length
		< 94mm - Small jaw	increase jaw length
	Adult men: 100mm	> 100mm - Large jaw	Decrease jaw length
		< 100mm - Small jaw	increase jaw length
Effective jaw length (Co-Gn)	Mixed denture: 105 to 108mm	> 108mm - Large jaw	Decrease jaw length
		< 105mm - Small jaw	increase jaw length
	Adult women: 121 to 124mm	> 124mm - Large jaw	Decrease jaw length
		< 121mm - Small jaw	increase jaw length
	Adult men: 130 to 133mm	> 133mm - Large jaw	Decrease jaw length
		< 130mm - Small jaw	increase jaw length
maxillomandibular relationship	Mixed Dentures: 20 to 23mm	Compare the results with McNamara 's table	McNamara table
	Adult women: 27 to 30mm		
	Adult men: 30 to 33mm		
ANTERO-LOWER FACIAL HEIGHT	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Lower anterior facial height (AFAI)	Mixed Dentures: 60 to 62mm	> 62mm larger AFAI, retruded jaw	Treat open bite and/or mandibular class II
		< 60mm - Smaller AFAI, Protruded or well positioned jaw	Treat mandibular deep bite and/or Class III

	Adult women: 66 to 67mm	> 67mm - Larger AFAI, Retruded Jaw	Treat open bite and/or Class II mandibular
		< 66mm - Smaller AFAI , Jaw protruded or well positioned	Treat mandibular deep bite and/or Class III
	Adult men: 70 to 74mm	> 74mm - Larger AFAI, Retruded Jaw	Treat open bite and/or Class II mandibular
		< 70mm - Smaller AFAI, Protruded or well positioned jaw	Treat mandibular deep bite and/or Class III
FACIAL AXIS ANGLE	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
(Ba - Na)(Pt-Gn)	90* ± 3.5*	> 93.5* Horizontal growth trend	Control horizontal growth
(Ricketts Cephalometric Analysis)	Â - 90* = X	< 86.5* Vertical growth trend	Control vertical growth
RATIO OF THE UPPER INcisor TO THE MAXILLA	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Anteroposteriorly Line A- 1	4 to 6mm	> 6mm - maxillary incisors proclined	Lingualize upper incisors
		< 4mm - lingual maxillary incisors	Vestibular maxillary incisors
Vertically 1 -Ls	2 to 3mm	> 3mm - Extruded upper incisors	Intrude maxillary incisors
		< 2mm - Intruded maxillary incisors	Extrude maxillary incisors
LOWER INCISOR TO JAW RELATIONSHIP	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
anteroposteriorly	1 to 3 mm ahead of the A-Pog Line	> 3mm - Protruded lower incisor	Lower Incisor
		< 1mm - Retruded lower incisor	Protrude Lower Incisor
Vertically	1.3 mm above the functional occlusal plane	> 1.3 mm Extruded Lower Incisor	Lower Incisor
		< 1.3 mm Intruded Lower Incisor	Lower Incisor
AIRWAYS ANALYSIS	**NORMALITY**	**DIAGNOSIS**	**TREATMENT**
nasopharynx	Mixed denture: 12 mm	> 12 mm - Enlarged nasopharyngeal space	No need to treat
		< 12 mm - Decreased nasopharyngeal space	Treat lip incompetence, underdevelopment of nostrils, maxillary atresia and Posterior Crossbite (MCP), and mandibular retrognathism

	Permanent Denture: 17.4 mm	> 17.4 mm - Enlarged nasopharyngeal space	No need to treat
		< 17.4 mm - Decreased nasopharyngeal space	Treat lip incompetence, underdevelopment of nostrils, maxillary atresia and Posterior Crossbite
oropharynx	10 to 12 mm for all ages	> 12 mm - Forward positioning of the tongue	Treat lip incompetence, underdevelopment of nostrils, maxillary atresia and Posterior Crossbite (MCP), and mandibular retrognathia Speech Therapy Tonsillectomy
		< 10 mm Irrelevant	

Table 8: Diagnosis and Treatment Parameters Based on Ricketts Cephalometric Analysis for Cefanalisys ® Software

SKELETAL DENTAL	NORMALITY	DIAGNOSIS	TREATMENT SUGGESTIONS
Tilt of the occlusal plane	22*± 4* up to the age of 8 years. Increases 0.5* per year	> 26* Open bite tendency	control open bite
		< 18* Deep bite tendency	control deep bite
1.APO	22* ± 4*	> 26* Facing lower incisors	Lingualize lower incisors
		< 18* Lingualized lower incisors	Vestibularize lower incisors
1. APO	28*± 4*	> 32* maxillary incisors proclined	Lingualize upper incisors
		< 24* lingual maxillary incisors	Vestibular maxillary incisors
1-APO	1mm ± 2mm	> 3mm - Protruded lower incisors	Retract lower incisors
		< -1mm - Retruded lower incisors	Protrude lower incisors
1 - APO	3.5mm ± 2.5mm	> 6mm - Protruded upper incisors	Retract maxillary incisors
		< 1mm - Retruded maxillary incisors	Protrude upper incisors
Occlusal Plane to the Branch (Xi)	0mm ± 3mm	> 3mm - Class II	Retract maxilla - protrude mandible
		< 3mm - Class III	Protrude maxilla - retract mandible

A6-PTV	3mm ± 3mm	> age + 6mm	Distalize maxillary molar
		< age + 0mm - Distalized upper molar	Mesialize maxillary molar
DENTAL	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
A6-B6	Class I = - 3mm Class II ≥ 0 Class III ≤ - 6mm	> 0 Class II	Mesialize mandibular molar - distalize maxillary molar
		< - 6 mm Class III	Distalize maxillary molar - mesialize maxillary molar
Canine Relationship	Class I = - 2mm Class II ≥ +1mm or more Class III ≤ -5mm	> 1 mm Class II	Mesialize lower canine - distalize upper canine
		< -5mm Class III	Distalize lower canine - mesialize upper canine
A1-B1 - Overjet	2.5mm ± 2.5mm	> 5 mm - Severe overjet (Class II) Deleterious habits (bottle bottle, finger sucking)	Decrease overjet - remove harmful habits
		< 0 - Decreased Overjet (Class III) - Crossbite	Increase or maintain overjet (uncross bite)
A1-B1 - Overbite	2.5mm ± 2mm	> 4.5mm - Open bite	treat open bite
		< 0.5mm - Closed bite (greater joint damage)	treat closed bite
B1-(B1-B6) Incisive Extrusion	1.25mm ± 2mm	> 3.25mm - Lower incisor overburden	Intrude lower incisor
		< - 0.75mm - Lower Incisor Infrairruption	Extrude lower incisor
interincisors	130* ± 10*	> 140* lingual maxillary incisors	Vestibular maxillary incisors
		< 120* proclined maxillary incisors	Lingualize upper incisors
MAXILLO-MANDIBULAR RELATIONSHIP	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Point A convexity	2mm ± 2mm at 8 years and 6 months	> 4mm - Class II - maxillary skeletal	retract jaw
		< 0 - Class III - maxillary skeletal	protrude jaw

Lower Facial Height	47* ± 4*	> 51* Skeletal open bite	treat open bite
		< 43* Skeletal deep bite	treat deep bite
AESTHETICS	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Lip Position	- 2mm ± 2mm up to the age of 8 years and 6 months, decreases by 0.2 per year	> 0 - protruded lower lip	Retract lower lip if it interferes with the aesthetic plan
		< - 4mm - Retruded Lower Lip	Protrude lower lip if it interferes with the aesthetic plan
Upper Lip Length (ENA-Stm)	24mm ± 2mm at 8 years and 6 months	> 26mm - Long Lip	Speech-language pathology techniques of oral motricity to treat perioral muscles
		< 22mm - Short Lip	orthognathic surgery , Speech-language pathology techniques of oral motricity to treat perioral muscles functional jaw orthopedics
Interlabial Union Point (Stomium-Stm)	- 3.5mm ± 2mm at 8 years and 6 months	> - 1.5mm - "Hidden" teeth	Effective treatment so that the occlusal plane is below the interlabial junction point
		< - 5.5mm Short lip with gummy smile	Orthognathic surgery , speech therapy techniques of oral motricity to treat perioral musculature functional jaw orthopedics
CRANIOFACIAL RELATIONSHIP	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Facial Depth	87* ± 3* at 9 years old	> 90* Class III - concave profile	retract jaw
		< 84* Class II - convex profile	protrude jaw
facial axis	90* ± 3.5*	> 93.5* - Class III - mandibular	Control of mandibular horizontal growth, with mandibular retrusion
		< 86.5* - Class II - mandibular	Control of the vertical growth of the mandible, with mandibular protrusion
facial cone	68* ± 3.5*	> 71.5* - Class III - jaw	retract jaw
		< 64.5* - Class II - jaw	protrude jaw

Mandibular Plane Angle	26* ± 4.5* at 9 years old	> 30.5* - Class II - with convex profile	Control of vertical growth and open bite
		< 21.5 - Class III - with straight or concave profile	Control of horizontal growth and deep bite
Maxillary Depth	90* ± 3*	> 93* Maxillary protrusion - Maxillary Class II	retract jaw
		< 87* Maxillary Retrusion - Maxillary Class III	protrude jaw
jaw height	53* ± 3* at 9 years old	> 56* Increased middle third of the face	Maxilla intrusion - botulinum toxin
		< 50* Decreased middle third of the face	treat open bite
Angle formed by the Palatine Plan and the Frankfurt Plan	1* ± 3.5*	>4.5* Dental or skeletal open bite, with high probability of mouth breathing habits	Treating open bite and mouth breathing habits
		< -2.5* Dental or skeletal deep bite	treat deep bite
Total Face Height	60* ± 3*	> 63* Vertical growth trend - Class II mandibular	Protrude jaw and control vertical growth
		< 57* Horizontal growth tendency - Class III mandibular	Retract jaw and control horizontal growth
INTERNAL STRUCTURES	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Cranial Deflection	27* ± 3*	> 30* Excessive vertical and mandibular growth pattern - Class III	Control of vertical and mandibular growth, with mandibular retrusion
		< 24* Retrognathism tendency - Class II with micrognathia	mandibular advancement
Anterior Cranial Length	55mm +-2.5mm up to the age of 8.5 years	> 57.5mm - Class II - skeletal	Advance mandible - retract maxilla
		< 52.5mm - Class III - skeletal	Retract mandible - advance maxilla
Posterior Facial Height	55mm +-3.3mm at 8.5 years	> 58.3mm - Large mandibular ramus - horizontal growth	Control horizontal growth
		< 51.7mm - Short mandibular branch - vertical growth	Control vertical growth

Branch Position	76* ± 3*	> 79* Class III pattern - mandibular	retract jaw
		< 73* Class II pattern - mandibular	advance jaw
Porium position	- 39mm ± 2.2mm at 9 years	> - 36.8mm - Class III -skeletal tendency	Class III Control
		< - 41.2mm - Class II Tendency - Skeletal	Class II Control
Mandibular Arch	26* ± 4* at age 8.5 years	> 30* Mandibular prognathism - Class III	Retract mandible, control and treat deep bite, Advance Mandible
		< 22* Mandibular retrognathism - Class II	Control and treat open bite
Mandibular Body Length	65mm ± 2.7mm at age 8.5 years	> 67.7mm - Mandibular prognathism tendency	retract jaw
		< 62.3mm - Tendency of mandibular retrognathism	advance jaw

Index Vert : (EF)+(PF)+(PM)+(AFAI)+(AM) = X

Note : Norm minus the measurement obtained, divided by the standard deviation 5

Vertical growth trend (hourly) = negative value (dolichocephalic)

Horizontal growth trend (counterclockwise) = positive value (brachycephalic)

Dolic = -2.0; Dolic = -1.9 to -1.0; Light Dolic = -0.9 to -0.5"; Meso = -0.4 to +0.4

Brachy = +0.5 to +0.9; Braqui Severo = +1.0

USE OF THE ANALYSIS SOFTWARE

The *Cefanalisys ® software* was chosen because it has the ability to integrate and analyze the parameters of the four cephalometric techniques used in this work.

After analysis, the software issues a report with all linear and angular measurements of each of the chosen analyses, or a combination of all of them, based on the normality criteria adopted in each measurement.

From the joint analysis of the parameters studied, diagnostic hypotheses and one or more treatment suggestions for each analyzed measure were presented.

DIAGNOSTIC HYPOTHESES

The diagnostic hypotheses established for each of the measures of the cephalometric analyzes were constructed by evaluating the standard of normality adopted by the authors, establishing a diagnostic hypothesis for the quantities that are found to be smaller than the standard measure (or smaller than the minimum value of the interval considered as the standard of normality) and another diagnostic hypothesis for quantities that are found to be greater than the standard measurement (or greater than the maximum value of the interval considered as the standard of normality).

For each established diagnostic hypothesis, a treatment suggestion was constructed. These treatment suggestions were established based on the principle of existing maneuvers so that the analyzed structure assumes the normality standards indicated by the authors.

The maneuvers are limited to suggesting what should be done and not the therapeutic method that should be used to achieve the goal, that is, we point the goal to be achieved for normality, but not the method to be used to achieve this goal. .

Therapeutic methods can be orthodontic, orthopedic, surgical, all of them or different combinations of these or even others that can be adopted by the responsible professional or indicated by him.

III. RESULTS AND DISCUSSION

The parameters used in each linear and angular measurement of the cephalometric analyzes used in the *software* on screen were determined, which determined, based on the normality criteria adopted in each measurement, by their authors, at least one diagnostic hypothesis.

Based on these diagnostic hypotheses, one or more treatment suggestions were presented for each analyzed measure (**TABLES** 5, 6, 7 and 8).

Bioinformatics covers aspects of biology, acquisition, processing, storage, distribution, analysis and interpretation of data, combined with the techniques of mathematics and computing. It aims to understand the significance of biological data . Not only does it have databases and instruments to help researchers, but it can also be fully responsible for the analysis of highly complex information, which can only be evaluated by automated equipment, according to Andrade & Sander (1997); Gibas & Jambeck (2001) and Laine *et al* ., (2013).

Information systems are also applied to health. In Dentistry, the creation of *software* for the elaboration of cephalometric analyses, based on teleradiography of the patient's facial profile, has facilitated and made more efficient tools available for orthodontists, surgeons and other professionals who use this complementary exam to exercise their specialties (SCHLEYER & SPALLEK, 2001; JOHNSON, 2003).

According to Pereira; worldstock ; Berthold . (2014) Orthodontics consecrated the era of radiographic cephalometry based on the historic work of Broadbent, who developed techniques for obtaining standardized radiographs of the head. Lateral cephalometric radiography is an instrument of great value in the diagnosis, prognosis, planning and evaluation of treatment, as well as in studies of growth and development of the dentocraniofacial complex.

It is not possible to study a case in orthodontics, in its entirety, without the aid of cephalometry. Many points, lines and angles are plotted on these radiographic images according to Ricketts (1972).

The advent of cephalometry marked the end of one era and the beginning of another, allowing us to identify and measure a large number of variables that remained hidden. Since then, the diagnosis of orthodontic cases comprises two distinct aspects: clinical and cephalometric, suggested by Ramirez & Fernández (2012).

The evolution of Orthodontics, over time and due to the diversification of philosophies, techniques and orthodontic mechanics used, has contributed to reestablish, in the patient, occlusal balance and facial esthetics. Therefore, radiographic cephalometry provides many elements to professionals in their fields, whether in research or in clinical practice, providing them with information about occlusion, the relationship of bone bases of the maxilla and mandible - in a longitudinal sense - and the relationship of the positioning of the teeth.

Cephalometry is one of the most important auxiliary elements in the diagnosis and planning of orthodontic treatment, since only the Angle classification, used until the advent of cephalometry and which is clinical, is not complete.Because they understand this, several authors have proposed their analysis, such as Ricketts in 1957, Interlandi 1971, Jarabak in 1972 and McNamara in 1984.

The evolution in the diagnosis of dental occlusion alterations has gained an excellent ally: IT. With the use of dental programs, it was possible to maximize and define with some accuracy the diagnosis, treatment plan and prognosis of the patient, whatever the malocclusion. With this, it facilitated the work of the dentist, guaranteeing him greater safety (SCHLEYER; SPALLEK, 2001).

Cephalometric radiographs are used for diagnosis, treatment planning, and prognosis of soft and hard tissue responses to treatments. Normative cephalometric values have been identified as guides in diagnostic decisions, bone and tooth movements. Cephalometric analysis is used as a norm due to its ease of obtaining, measuring and comparing (superimposing) hard tissue structures and the belief that, in the case of hard tissue cephalometric norms, this results in a pleasant face.

These continuing advantages of cephalometric analysis have led to strong reliance on cephalometrics in all aspects of orthodontic, surgical and other facial interventions (SUGUINO *et al* ., 1996; BIANCHINI 2002; MORESCA *et al* ., 2002; SANTOS et al., 2002; SANTOS *et al* ., 2005; REIS *et al.* , 2006; RAMIREZ & FERNÁNDEZ 2012; PEREIRA *et al.* , 2014).

Cephalometric tracings can be performed by manual and/or computerized methods. For a long time, the manual method was the only one used to perform cephalometric tracings and obtain angular and linear measurements, but it became inconvenient due to the increasing demand and accessibility of patients to clinical and specialized dental treatment (Orthodontics/ Orthopedics/Surgery), making it impossible for the dental professional to perform so many manual tracings.

The evaluation of soft tissues is essential when looking for balance and facial aesthetics, according to Sant'ana *et al.*, 2009. The face can become more or less

aesthetically acceptable and, for this reason, cephalometric analysis is not used in isolation. It is important to analyze facial esthetics for diagnosis, planning and orthodontic and/or surgical treatment. Professionals can count on digital alternatives, in addition to radiographs, plaster models, photographs according to Schols (2003); *scanners* to capture images (VAN DER STELT, 2005); 3D printers and *scanners* intraoral according to Hurt in 2012 and the emergence of CT according to reports by Silva & Sant'Anna, 2013.

The use of CCom has grown remarkably in recent years, and it can be said that it reaches almost all cephalometric studies in clinics around the world. Ricketts (1972) led this research internationally. He himself started in 1957 defining the position of the chin in space, using basal and cranial references; oriented the maxilla (point A) in the profile , in ideal harmony for the individual and created a new A- Pogonio plane , which served as a parameter for positioning the arch. He also considered, theoretically, that the lower point A, the more lingually it would be related to the Lower Incisor and defined the values for the Lower Incisors as 1mm±1.5mm.

ricketts *et al.,* (1972) described the Summary Analysis or Analysis of the 11 factors, with angular and linear measures studied in American Caucasian subjects with normal occlusion, at the age of 9 years; this is a synthesized analysis with some of its main measurements taken from the original analysis of the 33 factors mentioned by him in 1957. The determination of facial type through cephalometry was based on the calculation of the VERT index (vertical skeletal pattern of the face) Ricketts measure , based on five cephalometric measurements (Facial Axis Angle, Facial Depth, Mandibular Plane Angle, Lower Facial Height and Mandibular Arch).

According to Pereira; worldstock ; Berthold . (2014) since the introduction of cephalometry by Broadbent in 1931, several different analyzes have been carried out. Those of Downs (1948, 1956), Steiner (1953), Tweed (1953) and Ricketts (1960, 1972) gained the most acceptance. The Wits assessment (1975, 1976) and analyzes by Jarabak(1972), Coben(1955), Wylie(1947, 1952), Sassouni(1969, 1970) are less used but well known.

McNamara (1984) stated that most of the available analyzes were conceived during the period between 1940 and 1970, when significant changes in craniofacial structural relationships were considered impossible. However, at that time, clinical Orthodontics experienced the advent of numerous orthognathic surgery procedures that allowed the repositioning of the three dimensions of almost all bone structures in the facial region and treatment by means of a Functional Orthopedic Appliance (AOF) that presented new possibilities. in the treatment of skeletal discrepancies.

For this reason, a need has arisen for new cephalometric analyzes that are sensitive not only to the position of the teeth in relation to the bone bases (maxilla and mandible), but also the relationship of the bone bases to each other.

Cephalometric tracings can be performed manually or digitally using *software* such as: *VisualBasic*® and *PorDiosW*® according to Gotfredsen, Kragskov, Wenzel (1999); *VistaDent 2.1 AT® and Jiffy Orthodontic Evaluation® (JOE) cited by Celiket al.,* (2009); *Orthometric*® cited by Sommer *et al.,* (2009) *; Dolphin Imaging 3D® and InVivo® reported by Silva and Sant'Anna* (2013 *);* among others, which provide efficiency in obtaining diagnosis, as well as help in image storage. bonilla *et al.* ;(2011) highlighted that digital cephalometry allows correcting errors generated in manual tracing and presented *Cephapoin* t ®, which allows the location of points on a computer monitor directly with the cursor, in a digital image.

cephalometric tracings are therefore used for diagnosis according to Suguino *et al* ., (1996); to assess facial growth according to Bianchini (2002) and Ramirez & Fernández (2012); to determine the facial type according to Moresca *et al* ., (2002); to plan the treatment cited by Santos *et al.,* (2005) and by Pereira *et al* ., (2014) and are important to evaluate the soft tissues cited by Sant'ana *et al* ., (2009).

In addition to being used as a complementary exam in the elaboration of the diagnosis, cephalometric analyzes are widely used in the evaluation of treatments performed and in the evolution of these treatments. Orthodontic treatments can be evaluated by cephalometric tracings according to Tien *et al* ., (2008) and Huang *et al.,* (2016); treatments with OFM as well, as stated by Araújo *et al.,* (2011) and Ko *et al* ., (2011); as well as facial surgical treatments, as assured by Filho *et al* ., (2007).

Among the cephalometric analyzes selected in this article, it can be seen that there are measures in certain analyzes that are not found in others. As an example, we cite, in the analysis of USP (1968), the Interlandi line related to the position of the Lower Incisors and the Wits index (University of Witwatersrand), defined as a linear measure and not an analysis itself. In addition to these, we also have the Tweed triangle formed by the angles FMA (*Frankfurt Mandibular Plane Angle*), IMPA (Incisor Mandibular Plane Angle) and FMIA (*Frankfurt Mandibular Incisor Angle*).

McNamara 's analysis , there are measures that allow professionals to obtain cephalometric measurements of the upper airways and the buccopharynx, which

facilitates the diagnosis and treatment of adenoids and hypertrophied tonsils.

In the analysis of Ricketts (1957) there is the VERT index of facial growth that allows the professional to determine the facial typology of the patient in: Dolichofacial (long face, tendency of vertical growth with open bite); Mesofacial (balanced and harmonious face in the facial thirds) and Brachyfacial (short face, tendency of horizontal growth with deep bite). Finally, Jarabak 's analysis (1972) provided us with important measures of the Superior, Inferior and Total Gonical Angle , which are also determinant in facial typology.

With all the measurements of the four cephalometric analyzes and with the diagnostic hypotheses and treatment options gathered in a single *software*, the clinical and/or academic daily life of the professional becomes easier and more practical. This meeting of four cephalometric analyzes is important since no cephalometric analysis alone is complete and this joint presentation brings a necessary complement to the professional for the correct diagnosis, treatment and prognosis.

The *software* and the established parameters provide the linear and angular measurements of the patient and, comparing with the standardized measurements, issues a report with diagnostic hypotheses and treatment options for each angular and/or linear measurement. This is innovative because what happens nowadays is only the offer of, at the end of the cephalometric measurements , a summary and general report for the referred analysis.

Therefore, it is evident that the professional who works with cephalometric analysis has clear and easy to interpret data, at the same time safe and faithful for the establishment of the diagnosis, treatment plan and prognosis, in a single *software* : *Cefanalysis* **®.**

IV. FINAL CONSIDERATIONS

Within the limits of this study, it can be seen that the use of Bioinformatics is increasing in Brazilian and worldwide Dentistry. It is essential to encourage research involving computational technology, expanding this science and taking knowledge to undergraduate and graduate courses, integrating students and their practices with the tools of bioinformatics.

The advantage of having four analyzes gathered in a single software and the possibility of making cephalometric tracings of each of these techniques in combination allows the orthodontist to perform the entire procedure in his own office. More than the cephalometric tracing itself, it is possible to elaborate diagnostic hypotheses for each of the listed measures and treatment proposals for each of the changes in normality. The findings of this study made it possible to complement the data for an accurate diagnosis performed by professionals who use CCom .

It is extremely important that the orthodontist and other professionals who use cephalometry as a complementary exam for diagnosis, planning, treatment and follow-up are always updated on the evolution of techniques for obtaining, interpreting and treating images, as well as all the technology made available by bioinformatics. so that all these tools are strong allies for the success of your patients' treatments.

REFERENCES

[1] ANDRADE MA; SANDER C. Bioinformatics : from genome data to biological knowledge . curr opinion Biotechnol . 8(6):675-83. 1997.

[2] ARAÚJO EM, MATOSO RM, DIÓGENES A. MN ; LIMA KC Cephalometric evaluation of the effects of the joint use of a mandibular protraction appliance (MPA) and a fixed orthodontic appliance on the skeletal structures of patients with Angle Class II, division 1 malocclusion .Dental Press J Orthod . May-June;16(3):113-24. 2011.

[3] BIANCHINI. EMG Cephalometry in oral myofunctional alterations : diagnosis and speech therapy. 5.ed. Carapicuíba: Pro -Fono ; 2002.

[4] BONILLA M; BARRERA J; GUTIÉRREZ D; WALLS M; PUENTES J. Comparison del error in there location of points cephalometric measurements between a direct and a conventional digital image . Scientific Journal Sociedad Colombiana de Ortodoncia ; 18(17): 63-71. 2011.

[5] CELIK, E ; POLAT-OZSOY, O ; TOYGAR MEMIKOGLU, YOU . Comparison of cephalometric measurements with digital versus conventional cephalometric analysis. Eur J Orthod . June 31(3):241-6. 2009

[6] FALTIN JR., K. Functional Orthodontics of the Jaws. In: PETRELLI, E. Contemporary Orthodontics. Sao Paulo: Sarvier . for. 211-246, 1988.

[7] SON, VAP; JEREMIAS, F; TEDESCHI, L; SOUZA, RF Cephalometric evaluation of the posterior airspace in patients with Class II occlusion undergoing orthognathic surgery . R Dental Press Ortodon Maringá Facial Ortop , v.12. n.5. p.119-125, Sep./Oct.2007 .

[8] FRANCHI, L.; BACETTI, T.; McNAMARA JR., JA Mandibular growth as relatedto cervical vertebral maturationandbodyheight . love J. Orthod . DentofacialOrthop ., St. Louis, v. 118, no. 3, p. 335-340 , Sept. 2000

[9] GIBAS, C; JAMBECK, P. Developing Bioinformatics: Software Tools for Applications in Biology. Rio de Janeiro. Ed. Campus, 2001.

[10] GOTFREDSEN, E ; KRAGSKOV, J ; WENZEL, A. Development of a system for craniofacial analysis from monitor-displayed digital images. DentomaxillofacRadiol . Mar;28(2):123-6. 1999

[11] HUANG, JQ; LIU, SY; JIANG, JH; BEIJING, XB Therapeutic evaluation of the correction of the severe bi-maxillary protrusion cases by Tweed-Merrifield technique. Jun 18;48(3):555-61.2016.
[12] HURT, AJ *Digital technology in the orthodontic laboratory* . Am J OrthoddentofacialOrthop . Feb;141(2):245-7. 2012
[13] INTERLANDI, S. Line "I" in Morphodifferential Analysis for Orthodontic Diagnosis. Rev. Fac. Odontol ., São Paulo, v. 9, p. 289-309, 1971.
[14] JARABAK, JR; FIZZELL, JA Technique and treatment with light-wire edgewise appliance. ed. 2, St. Louis. The CV Mosby Company. 1972.
[15] JOHNSON, LA Biomedical informatics training for dental researchers. Adv Dent Res.;17(1):29-33. 2003.
[16] KO, EW; HSU, SS; HSIEH, HY; WANG, YC; HUANG, CS; CHEN, YR Comparison of progressive cephalometric changes and postsurgical stability of skeletal Class III correction with and without presurgical orthodontic treatment. J Oral Maxillofac Surg. May;69(5):1469-77. 2011.
[17] LAINE, ML; MUSTAKIS, V; KOUMAKIS, L; POTAMIAS, G; LOOS, BG Modeling susceptibility to periodontitis. J Dent Res.92(1):45-50. 2013.
[18] McNAMARA Jr. JA A method of cephalometric evaluation. love J. Orthod ., 86. Dec. 1984.
[19] MORESCA, R; KINGS SAB; VIGORIT JW; SCANAVINI MA Comparative cephalometric -radiographic study of the facial pattern in Angle class II, 1st malocclusion , using the cephalometric analyzes of Ricketts and Siriwat & Jarabak . J Bras Ortodon Facial Ortho .; 7(42):520-5. 2002.
[20] WALLS, V; GANDIA, JL; CIBRIÁN, R. Digital diagnosis records in orthodontics. An overview. Med Oral Patol Oral Cir Bucal.11. E.88-93. 2006.
[21] PEREIRA, CB; MUNDSTOCK, C .A; BERTHOLD,TB Introduction to Radiographic Cephalometry. Ed. AcBO Virtual Magazine . 5th Ed., 2014.
[22] RAMÍREZ, CJ A; FERNÁNDEZ, LN Studio cephalometric of la stability of the intracranial Frankfurt plane during the growth and development process craniofacial . Rev. chil. Orthod ., 29(2):71-81, 2012.
[23] REIS, SAB; ABRAO, J; CAPELOZZA FILHO, L; CLARO, CAA Subjective facial analysis. Dental Press Ortodon Facial Ortho . 11(5):159-72. 2006.
[24] RICKETTS, RM Planning treatment on the basis of the facial pattern and an estimate of its growth. Am J Orthod , St. Louis, v. 27, no. 1, 1957.
[25] RICKETTS, RM; BENCH, RW; HILGERS, JJ; SCHULHOF, R. An overview of computerized cephalometrics . AM JORTHOD 61: 1-28, 1972.
[26] SANT'ANA, E; KURIKI, EU; ARNETT, W; LAUTENSCHLÄGER, GAC; YAEDU, RYF Comparative evaluation of the normality pattern of the facial profile in Caucasian Brazilian and North American patients. Dental Press Ortodon Facial Ortho .; 14(1):80-9. 2009
[27] SANTOS, SH; MORAES, LC; DOCTOR, SON E; CASTILHO, JCM; MORAES, MEL Application of the linear and geometric method using lateral cephalometric radiographs , to differentiate and identify the divine proportion in three facial types. science odontol _ Bras.8(3):10-21. 2005.
[28] SARVER, DM; JOHNSTON, MW Orthognathic surgery and aesthetics: planning treatment to achieve functional and aesthetic goals.Br J Orthod . May;20(2):93-100. 2006.
[29] SCHLEYER, T; SPALLEK, H. Dental informatics. A cornerstone of dental practice. J Am Dent Assoc.;132(5):605-13. 2001.
[30] SCHOLS, JG Digitalizing in the orthodontic practice. Ned Tijdschr Tandheelkd . Jan;110(1):25-30. 2003.
[31] SILVA, MB G; SANT'ANNA , EF The evolution of cephalometric diagnosis in Orthodontics. Dental Press J Orthod . May-June;18(3):63-71. 2013.
[32] SOMMER, T ; CIESIELSKI, R ; ERBERSDOBLER, J. ORTHUBER, W ; FISCHER-BRANDIES, H. Precision of cephalometric analysis via fully and semiautomatic evaluation of digital lateral cephalographs . Dentomaxillofac Radiol. Sep;38(6):401-6. 2009
[33] SUGUINO, R; RAMOS, AL; TERADA, H; FURQUIM, LZ; MAEDA; L; SILVA FILHO, OG Facial analysis. Dental Press Orthod Maxillary Ortho. 1(1):86-107.1996.
[34] TIEN, LA; CUOGHI, OA; MENDONÇA, MR; BERTOZ, FA The effect of anterior teeth retraction on point A in patients undergoing corrective orthodontic treatment. R Dental Press Ortodon Ortop Facial Maringá, v.13,n. 2, p.115-123, Mar/Apr.2008.
[35] VAN DER STELT, PF Filmless imaging: the uses of digital radiography in dental practice. J Am Dent Assoc.136(10):1379-87. 2005.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.5

Changes in the Tragic daily Life of those who Experience Intimate Partner Violence: A Collective Discourse of Women

Jeany Freire de Oliveira[1], Margaret Olinda de Souza Carvalho e Lira[2], Lucia Marisy Souza Ribeiro de Oliveira[3], Vanda Palmarella Rodrigues[4], Rafaella Ayanne Alves dos Santos Ribeiro[5]

[1]Federal University of Vale do São Francisco, Petrolina, Brazil.
Email: jeanyfroliv@hotmail.com
[2]Federal University of Vale do São Francisco, Petrolina, Brazil.
Email: olindalira@gmail.com
[3]Federal University of Vale do São Francisco, Petrolina, Brazil.
Email: lucia.oliveira@univasf.edu.br
[4]State University of Southwest Bahia, Jequié, Brazil.
Email: vprodrigues@uesb.edu.br
[5]Federal University of Vale do São Francisco, Petrolina, Brazil.
Email: rafaayanne@hotmail.com

Received: 18 Apr 2022,
Received in revised form: 03 May 2022,
Accepted: 08 May 2022,
Available online: 12 May 2022

***Keywords*—Abused Women, Intimate Partner Violence, Daily Activities, Women's Health.**

Abstract*—*Intimate partner violence is a complex problem that harms the lifestyle with profound changes in women's daily lives. This is an interdisciplinary research, with a qualitative approach, developed between July 2019 and February 2020, in a Reference Center for Women's Care in the city of Petrolina, Pernambuco, Brazil, with data collected through semi-structured interviews, applied to twelve women who experienced intimate partner violence. The results were systematized by the Collective Subject Discourse method and interpreted by methodological theoretical resources of Comprehensive Sociology and Everyday Life in Michel Maffesoli's sociological thought. The collective subject was between 32 and 56 years old, Black and Brown, low income, evangelical religion and complete higher school level. The content of the narratives originated three central synthesis ideas that comprised three collective discourses about the daily life of women before violence, daily life during violence and daily life after partner violence. The discourses describe daily transformations resulting from the tragic represented in childhood and adolescence by intrafamily violence and adulthood by intimate partner violence that resulted in the loss of freedom, autonomy, individuality, social relationships and material goods and gave rise to needs that transcend traditional care.

I. INTRODUCTION

The life of a woman who experiences Intimate Partner Violence (IPV) changes dramatically with losses that extend in different areas of her daily life (Soares and Lopes, 2018). This type of violence is a tragic and recurrent event affecting women worldwide, with an

estimated 27% of them in 154 countries suffering IPV (World Health Organization [WHO], 2021).

Women who suffer IPV live in a domestic environment that is disharmonious and harmful to health, favorable to the triggering of physical and psychological symptoms, whose exposure to repetitive physical aggression, humiliation or removal from their belonging groups, emotionally wears down the woman who, due to marital discussions, does not have time for themselves (work and leisure) and these, predictors of long-term health damage (Carneiro et al., 2021).

Thus, it is possible to observe that IPV is a complex problem that compromises quality of life and well-being, implying changes in daily life with risk behaviors, reduced productivity, negative effects on physical and psychological health, or destruction of life by feminicide (Lucena, Vianna, Nascimento, Campos and Oliveira, 2017). These are profound effects that can extend to perpetrators, family members and social context (Stewart and Vigod, 2017; Frazão et al., 2020).

From this brief panorama, it is considered relevant to discuss this type of violence that affects women worldwide, with repercussions on lifestyle and profound changes in daily living. In view of this, the question emerged: how does the day-to-day life of a woman who experiences IPV? This study aimed to describe changes that occurred in the daily life of women in situations of Intimate Partner Violence. This research has social relevance for contributing to the understanding of the harmful effects of traumatic IPV experience on the daily lives of women and families, reinforcing the need to use strategies to control this type of violence against women. The results will boost interdisciplinary reflections and the development of comprehensive care practices for women and their family groups.

II. METHOD

The present work is an example of the master's thesis entitled "Daily life of women experiencing intimate partner violence: contributions to interdisciplinary care", which integrates the anchor project "Violence against women: implications and basic human needs affected" approved by the Research Ethics Committee of UNIVASF under Opinion N 2,615,442 and Amendment N 3,350,005 of May 27, 2019.

This is a qualitative research that is part of the field of interdisciplinarity and was developed between July 2019 and February 2020 at the Valdete Cezar Reference Center for Women's Care (CEAM) in the city of Petrolina – PE, Brazil.

Data were collected through semi-structured interviews, applied to 12 women over 18, experiencing Violence by partner or ex-intimate partner, who to ensure confidentiality and confidentiality about the information, were identified by the fictitious names of Hydrangea, Gardenia, Dahlia, Rose, Acacia, Angelica, Iris, Magnolia, Daisy, Yasmin, Melissa and Lily.

After transliteration, the potential of narratives was systematized by the Collective Subject Discourse (CSD) method of data organization, based on the grouping of similar key expressions (KEP) that represent the same Central Synthesis Idea (CSI) and which compose a discourse synthesis of the qualitative sum of individual discourses (Marinho, 2015). After formulated, the Collective Discourses (CD) were interpreted by Comprehensive Sociology and Everyday Life, under the sociological perspective of Michel Maffesoli who uses sensitivity in his theoretical concepts and assumptions to perceive minutiae and understand people's daily lives. Among the assumptions, "the form" was selected by proposing the description of daily life without judgment of values and considering that things are not static and can change at a given time. The author presents the formism, neologism used by him, to explain a mode of presentation of everyday life from the "contours of within" by using imaginary modulations to apprehend subjectivity and capture the nuances of people's underground centrality (Maffesoli, 2010).

For this research, presenteeism modulations, forms of passive resistance and sense of limit were explored. Presenteeism is the valorization of the present time, made of ephemeral moments in which what matters is what exists and what is done and not what will be done. Thus, the future ceases to be the focus and by worrying about living the instant attention is focused on the beauty of the world and things, to the pleasure and affront of fate (Maffesoli, 2010).

Forms of passive resistance are indirect opposition strategies used in situations of domination or oppression, organized in the categories of analysis: acceptance of life or destiny, silence, cunning, double play and organic solidarity (Maffesoli, 1987). As for the sense of the limit, it can be said that it is between tolerance and consciousness in the face of the tragic in daily living, which concerns events capable of modifying daily life and for which it is necessary to find ways to deal and adapt (Maffesoli, 2009).

The collective subject invited to collaborate with the research signed the Free and Informed Consent (TCLE) and answered questions about their experience of IPV through individual interviews with an average duration of

60 minutes, recorded with their authorization. The closure of data collection was not defined by saturation criterion, but by the quality of the content of the collected data when contemplating the research object and meeting its objective.

III. RESULTS

Characterization of the collective subject

The collective subject was composed of 12 women aged between 32 and 56, black and brown (9), evangelical religion (7), married marital status (3), single (3) or divorced (3), with higher education complete higher education (4), low income with total or partial dependence on the partner or family (8), beneficiaries of the Brazil Aid Program (4), which constituted single-parent female families (4), nuclear families (4) and extensive families (4). They had time living with their partner between five and 36 and simultaneous experience of two to four forms of violence: physical violence (11), sexual (2), moral (9), psychological (11) and patrimonial violence (5). There was involvement with alcohol and marijuana used by the collective subject and alcohol used by the partner.

Composition of the Collective Discourse

Three CSI stems were identified that gave rise to discourses about the daily life and the effects of the tragic experience. The CSI "my childhood and adolescence were difficult, but I had freedom before I met him", CD generated: living daily life of the woman before IPV.

> My childhood was not good, I was raised in a disstructured family, I was ignored by everyone and the only person I still have contact with is my ex-stepfather, only he has tried to sexually abuse me. I suffered violence from my mother, beat me, treated me badly and said I was the ugliest of brothers, never put me in school and abandoned me young. My father loved to change women and kept changing towns, once he gave each of us to a different person. Also, he was an executioner, he did not let study, it was only to work, only to leave one day Sunday if it was for a prayer, many things he did not let use, such as a lipstick, enamel, then when I got married [crying]. My head is very full of negative things from my childhood and adolescence. But before I met him I was more daring, more independent, worked and made money, always went out, always had a lot of fun. I felt happy, I was free, I traveled a lot, alone or with friends. My life before him was normal, I wouldn't go to the police station, and I wouldn't take the guardianship council at the door. (Hydrangea, Gardenia, Dahlia, Rose, Acacia, Angelica, Iris, Magnolia, Daisy, Yasmin, Lily).

The CSI "my life changed after I married him" composed the CD: living every day during IPV.

> After I met him my life changed, he got in the way of doing everything, suffocated me, I didn't give an opinion or what to eat and only worked with what he left. He only liked a boy man and when he saw that I would have a girl started assaulting me, he put me as the worst of women and pushed me out of bed when we were sleeping. It was a coexistence of abuse, aggression, manipulation, lack of respect and threats. He was possessively jealous, he didn't want me to leave the house, he had a time to get here, he wouldn't let me be friends, he called me a slut, and he wondered if I had anyone. When I went out to study, he'd break things up at home and punch me in the chest when I got back from a course. Then came other violence, made me sell the things I had achieved, used my name as a company and soiled my name, to this day I keep paying the price. My sex life was always active because it required sex every other day, so I had to do it and to get a perfect husband because everything I heard from him left me without pleasure. Because I was evangelical, I didn't think I could deny myself to my husband. I was hungry with my kids, too, because he didn't do a fair, I'd open the closet and start crying and he'd laugh in my face. I was fighting with him, and once I hit him, i pushed him and slapped him. (Hydrangea, Gardenia, Dahlia, Rose, Acacia, Angelica, Daisy, Yasmin, Lily).

The CSI "today I live a life I would not like" composed the CD: the daily life of women after IPV.

> My day to day was bad, unbearable, changed everything, peace is over, today I live a life I would not like. After my marriage went apart, I had to get used to it, I had a home and even the way It was, I could bear it, I could be happy even with the problems. It's kind of a prison, I feel suffocated and besides, it left me in a tough situation with very high debts, besides my daughter being in a foster home because of him. Now I have to supply all the needs of the house, I have to work twice, besides my normal job I have to sell candy, sell jewelry, do ceremonial, because the money he gives me does not even pay my son's school. He left a lot of debt on my credit card, so the financial side is weighing a lot on me, and it shakes me because I don't have the emotional structure for debt. And even though they were separated five years ago, he still raped me. So, today I feel in the middle of nowhere, lost, forsawed, sustained by one and the other. That's when I decided to get help. (Gardenia, Dahlia, Acacia, Angelica, Magnolia).

IV. DISCUSSION

Active and sensitive listening, without prejudice or judgment, contributed to the collective subject letting emerge the underground centrality that concealed feelings everyday changes resulting from the experience of IPV.

Still in childhood and adolescence, the tragic experience of intrafamily violence in their expressions of neglect, abandonment, sexual, physical and psychological abuse experienced by the collective subject is remarkable, occurrences commonly found in life histories of women in IPV situations, which is a significant factor for the occurrence of violence in intimate relationships in adulthood, sexual and physical abuse (Yan and Karatzias, 2020).

Thus, the effects of child abuse tend to interfere with daily living throughout existence, associated with depression and posttraumatic stress disorder with severe symptoms, psychological functioning problems and low levels of stress dominance (Yang Li, Herbell, Bloom, Sharps and Bullock, 2020; Yan and Karatzias, 2020; Alvarez, Perrin, Lameiras-Fernandez, Rodriguez and Glass, 2019). This draws attention to the influence of the relational patterns of the family of origin on the dynamics of the couple because they are often naturalized, they constitute a reference. Thus, many conflicts are reflections of the relational patterns learned in childhood that are repeated transgenerationally (Colossi and Falcke, 2018; Costa, Costa, Mosmann and Falcke, 2018).

It is noted that the collective subject describes a day-to-day violation of the right to freedom that denotes the small daily deaths present in the restrictions of choices, opinions, tastes, work activities, leisure, study and relationships. He, Collective Subject, renounced, annulled himself and invalidated his own feelings and desires, skills, dreams, relationships and activities that are sources of pleasure and joy, and the renunciation extended to the domain of one's own body, because it eventually gave in to sex, even against the will (Parada and Murta, 2020; Maffesoli, 2010; Netto, Moura, Queiroz, Leite and Silva, 2017; Goes, 2019).

As can be seen, male domination nullifies the inner power of women, this force that uniformizes the multidimensionality of being, polymorphic potentialities, creativity, vitality and dynamism (Maffesoli, 1984), and it is common that in Situations of IPV, there is a personal demotion of women with destruction of her self-esteem and the vision she has of herself (Moulding, Franzway, Wendt, Zufferey and Chung, 2020), because the relationship that women have with values, social life, death, sex, work, housing and clothing, that is, everything that concerns the art of living or the ways of life, constitutes its "core of identity" (Maffesoli, 1984). So that, with the annulment of herself, there is a loss of identity, freedom, work, relationships, individual property and financial autonomy (Goes, 2019).

Thus, it is necessary to consider the plural being in its singularities of feelings that it needs to express, so that boredom does not assole the woman who suffers IPV and that coertion tries to institute (Maffesoli, 2010; Maffesoli, 2012). Thus, when they no longer endure a daily routine of oppression, they have the sense of the limit provoked and no longer tolerating suffer, tend to react by attacking the partner, or rescuing the strength of wanting to live and break with the relationship. This is how the collective subject overcame tolerance and allowed the sense of the woman's limit to emerge that is aware of the traumatic experience of IPV and the changes triggered by it.

Therefore, to demonstrate their exhaustion in the face of IPV, the collective subject used masks and emotion to stage, express restlessness, through feelings of anger, fear, repentance, sadness, anguish, and hope. Through crying he staged and compared his daily life before the tragic of IPV, emphasizing that his lifestyle changed in a way that despite rescuing the inner strength and breaking with the relationship, the negative effects persisted modifying his life.

Every mutation and transmutation arouses fear, and this is how changes in daily post-separation have frightened them (Maffesoli, 2010). After the break of the conjugal bond, the collective subject found himself in a transformed and distant daily life, in order to perceive life as undesirable. The separation generated a dissatisfaction because it resulted in the disaggregation of the family, which in the collective imaginary, should be constituted by parents and children in union, as well as, because the home was undone as a place of residence, since the financial situation after IPV did not allow to supply expenses in separate places.

With the rupture of affective bonds, the collective subject felt helpless and lonely because he had to deal alone with the effects of social isolation and property violence suffered. Mainly, because after leaving the relationship, it is common to face financial difficulties, especially due to debts, when the partner forces them to sell their assets and have their names used for lending. Therefore, IPV accentuates economic insecurity and material difficulties by limiting work activities, negatively impacting health, increasing stress and decreasing physical and psychological well-being, which can also affect the ability to manage available resources (O'Connor and Nepomnyaschy, 2019).

In these situations, there is an existential emptiness, given the rupture of social bonds and women's autonomy. The obligation to do this or that, of conjugal duty, to attend to the partner's orders together with domestic care and the education of children transforms the somewhat illusory freedom that once existed in real slavery (Maffesoli, 2003). Therefore, one must count on the otherness of people, because social life is the expression of feelings of belonging, of cooperage, of being a member, of being part, of corresponding to a group (Maffesoli, 2003; Maffesoli, 2012).

The study presented as limitations the brief period of data collection, due to the social isolation imposed by the pandemic of the new coronavirus (Covid-19) that interrupted the application of face-to-face interviews. In addition, the data may be subject to memory bias because they are past feelings and experiences and there was no longitudinal follow-up of daily changes during and after IPV, which can be considered in recent studies.

V. CONCLUSION

The collective discourses expressed the underground centrality of women composed of life stories, feelings, thoughts, images, beliefs, inner strength and resistance in the face of the daily transformations they experienced throughout their lives during childhood, in living with the aggressor partner and after breaking away from the abusive relationship.

The underground centrality reveals a daily life in which all the rituals of daily life were demarcated by the tragic, that is, the imposition of the limit, exercised, first by the father figure and then by the partner. Living in this family context required several times, annulling to survive and even if violence was already part of daily life, the practice practiced by the partner was more invasive resulting in the loss of freedom, autonomy, individuality, social relationships and material goods.

Thus, women who have experienced IPV have adverse life histories since childhood and experience changes in daily life that disturb feelings, thoughts, identity, rituals and daily practices, future expectations, social relationships and quality of life, requiring comprehensive care and interdisciplinary care that transcends socio-legal and physical and psychological health demands.

In view of these changes, needs arise that transcend what is already offered by the traditional attention of the support services available. A sensitive and resolutive care to the needs of women who have experienced IPV requires an interdisciplinary look that encompasses problems in all areas of life, not only in the present, but considering the past in a transversal and longitudinal perspective.

REFERENCES

[1] ALVAREZ, Carmen. PERRIN, Nancy. LAMEIRAS-FERNANDEZ, Maria. RODRIGUEZ, Rebecca. GLASS, Nancy. Adverse childhood experiences among Latina women and its association with mastery of stress and health. Child Abuse & Neglect, v. 93; 2019, p. 139–148. DOI: https://doi.org/10.1016/j.chiabu.2019.05.004

[2] ARAÚJO, Bianca Fonseca de. PEREIRA, Felipe Matheus Felix. FREITAS, Pedro Vinicius Lacerda de. SATURNINO, Vitória Souza. SANTOS, Everson Vagner de Lucena. Análise da prevalência dos tipos de violência contra a mulhernaregiãonordeste. Journal of Medicine and Health Promotion, v. 4, n. 1, 2019; p. 1086-1095.

[3] AZEVEDO, Milena Nogueira. ALVES, Paula Rúbia Oliveira do Vale. Permanência de mulheresemsituação de violência: compreensões de umaequipemultidisciplinar. Revista EPOS, v.7, n. 2, 2016.

[4] CARNEIRO, J. S. SILIO, L. F. ANTUNEZ, B. F. SILVA, O. G. RODRIGUES, M. A. M. OLIVEIRA, J. R. L. OLIVEIRA, H. F. R. PEREIRA, A. A. LIMA, B. N. FILENI, Carlos H. P. MARTINS, G. C. CAMARGO, L. B. CARVALHO, A. F. PASSOS, R. P. JUNIOR, G. B. V. GONÇALVES, L. G. de O. Qualidade de vida de mulheresvítimas de violênciadoméstica. Revista do Centro de PesquisasAvançadasemQualidade de Vida, v.13, n. 1, 2021. DOI: http://dx.doi.org/10.36692/v13n1-9

[5] COLOSSI, P. M. FALCKE, D. Intimate partner violence and family of origin: Discriminant profile of partners who commit and do not commit infidelity. Psico, v. 49, n. 4, 2018, p. 328–338. DOI: https://doi.org/10.15448/1980-8623.2018.4.26272

[6] COSTA, Ramona Daniela Bernardo. COSTA, Crístofer Batista da. MOSMANN, Clarisse Pereira. FALCKE, Denise. Experiênciasnafamília de origem que repercutem no clima familiar dos descendentes. Estudos e PesquisasemPsicologia, v. 18, n. 2; 2018, p. 408-425.

[7] FRAZÃO, Maria Cristina Lins Oliveira. VIANA, Lia Raquel de Carvalho. PIMENTA, CláudiaJeane Lopes. SILVA, Cleane Rose Ribeiro da. BEZERRA, Thaíse Alves. FERREIRA, Gerlania Rodrigues Salviano. COSTA, Tatiana Ferreira da. COSTA, KátiaNeyla de Freitas Macedo. Violênciapraticadaporparceirosíntimos a mulheres com depressão. RevistaMineira de Enfermagem, v. 24, 2020. DOI: 10.5935/1415-2762.20200061

[8] GOES, Eva Dayane Almeida de. A vergonha social e o medo: obstáculos para a superação da violênciadoméstica contra a mulher. Brazilian Journal of Development, v. 5, n. 11; 2019, p. 23627-23645.

[9] JANUÁRIO, Iara de Souza. MEDEIROS, Priscilla Brandão de. Como a gentelida?: A atuação da Estratégia de Saúde da Famíliaemsituações de violência conjugal. Temporalis, v. 18, n. 35; 2018.

[10] LUCENA, Kerle Dayana Tavares de. VIANNA, Rodrigo Pinheiro de Toledo. NASCIMENTO, João Agnaldo do. CAMPOS, Hemílio Fernandes Coelho. OLIVEIRA, Elaine Cristina Tôrres. Associação entre a violênciadoméstica e a qualidade de vida das mulheres. Revista Latino-Americana de Enfermagem, v. 25; 2017. DOI: 10.1590/1518-8345.1535.2901

[11] MAFFESOLI, Michel. A conquista do presente. Rio de Janeiro: Rocco, 1984.168 p.

[12] MAFFESOLI, M. Dinâmica da violência. São Paulo: Revista dos Tribunais, 1987, 162p.

[13] MAFFESOLI, M. O InstanteEterno: o retorno do trágiconassociedadespós-modernas. São Paulo: Zouk, 2003.

[14] MAFFESOLI, Michel. O tempo das tribos: o declínio do individualismonassociedades de massa. 5ª ed. Rio de Janeiro: ForenseUniversitária; 2014.

[15] MAFFESOLI, M. O Tempo retorna: formaselementares da pós-modernidade. Rio de Janeiro: ForenseUniversitária, 2012.114p.

[16] MAFFESOLI, M. Saturação. São Paulo (SP): Iluminuras Ltda.; 2010.

[17] MAFFESOLI, M. O mistério da conjunção: ensaiossobrecomunicação, corpo e socialidade. Porto Alegre (RS): Sulinas, 2009. 102 p

[18] MARINHO, Mary Lucia Costa. O Discurso do SujeitoColetivo: Uma AbordagemQualiquantitativa para a Pesquisa Social. Trabajo Social Global, v. 5, n.8; 2015, p. 90-115.

[19] MASCARENHAS, MárcioDênis Medeiros. TOMAZ, Gabriela Rodrigues. MENESES, Gabriel Medina Sobreira de. RODRIGUES, Malvina Thais Pacheco. PEREIRA, Vinícius Oliveira de Moura. CORASSA, Rafael Bello. Análise das notificações de violênciaporparceiroíntimo contra mulheres, Brasil, 2011–2017. RevistaBrasileira de Epidemiologia, v. 23, supl. 1, 2020.

[20] MOULDING, Nicole. FRANZWAY, Suzanne. WENDT, Sarah. ZUFFEREY, Carole. CHUNG, Donna. Rethinking Women's Mental Health After Intimate Partner Violence. Violence Against Women, v. 27, issue 8; 2020. DOI: 10.1177/1077801220921937

[21] NETTO, Leônidas de Albuquerque. MOURA, Maria Aparecida Vasconcelos. QUEIROZ, Ana Beatriz Azevedo. LEITE, FrancièleMaraboti Costa. SILVA, Giuliana Fernandes e. Isolamento de mulheresemsituação de violênciapeloparceiroíntimo: umacondiçãoem redes sociais. Escola Anna Nery, v. 21, n. 1, 2017.

[22] NICOLAU, KarineWlasenko. ESCALDA, Patrícia Maria Fonseca. FURLAN, Paula Giovana. Método do Discurso do SujeitoColetivo e Usabilidade dos SoftwaresQualiquantisoft e DSCsoftnaPesquisaQualiquantitativaemSaúde. Fronteiras: Journal of Social, Technological and Environmental Science, v.4, n.3; 2015, p.87-101.

[23] O'CONNOR, Julia. NEPOMNYASCHY, Lenna. Intimate Partner Violence and Material Hardship Among Urban Mothers. Violence Against Women, v. 26, n. 9; 2019. DOI: 10.1177/1077801219854539

[24] PARADA, Priscila de Oliveira. MURTA, Sheila Giardini. Brazilian women's transition to new relationships after ending a violent one: a case study. Psicologia USP, v. 31; 2020.

[25] SANTOS, Ione Barbosa dos. LEITE, FranciéleMarabotti Costa. AMORIM, Maria Helena Costa. MACIEL, Paulete Maria Ambrósio. GIGANTE, Denise Petrucci. Violência contra a mulhernavida: estudo entre usuárias da AtençãoPrimária. Ciência&SaúdeColetiva, v. 25, n.5, 2020.

[26] SILVA, J. M. da. Michel Maffesoli e a pós-modernidadecomofenômeno de comunicação. RevistaMídia e Cotidiano, v. 13, n. 2, 2019, p. 6-18. DOI: https://doi.org/10.22409/rmc.v13i2.29493

[27] SOARES, J. S. F. LOPES, M. J. M. Experiences of women in situation of violence seeking care in the health sector and in the intersectoral network. Interface, v. 22, n. 66, 2018; p. 789-800.

[28] STEWART, Donna Eileen. VIGOD, Simone Natalie. Mental Health Aspects of Intimate Partner Violence. Psychiatric Clinics of North America, v. 40, n. 2; 2017, p. 321–334. DOI: http://dx.doi.org/10.1016/j.psc.2017.01.009

[29] WHO. Working Group on Violence Against Women. Violence against women prevalence estimates, 2018: global, regional and national prevalence estimates for intimate partner violence against women and global and regional prevalence estimates for non-partner sexual violen against women. Geneva: World Health Organization; 2021.

[30] YAN, Elsie. KARATZIAS, Thanos. Childhood Abuse and Current Intimate Partner Violence: A Population Study in Hong Kong. Journal of Interpersonal Violence, v. 35, issue 1-2; 2020. DOI: 10.1177/0886260516682521

[31] YANG LI. HERBELL, Kayla. BLOOM, Tina. SHARPS, Phyllis. BULLOCK L. F. C. Adverse Childhood Experiences and Mental Health among Women Experiencing Intimate Partner Violence, Issues in Mental Health Nursing, v. 41, issue 9; 2020. DOI: 10.1080/01612840.2020.173163

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.6

Comparative study of computational methods of structural reliability assessment

Carla Simone de Albuquerque[1], Mauro de Vasconcellos Real[2]

[1]Graduate Program in Computational Modeling, Federal University of Rio Grande, Rio Grande do Sul, Brazil
Email: carla19matematica@gmail.com
[2]School of Engineering, Federal University of Rio Grande, Rio Grande do Sul, Brazil
Email: mauroreal@furg.br

Received: 09 Apr 2022,

Received in revised form: 03 May 2022,

Accepted: 08 May 2022,

Available online: 13 May 2022

***Keywords*— FORM, FOSM, Monte Carlo, Reliability index, SORM.**

Abstract *— Safety is an essential requirement of a structural system. Reliability is an additional tool of growing importance in engineering, as it allows us to quantify uncertainties in the design. Thus, reliability assists us in making more suitable decisions regarding the safety of a structure. The present work compares and analyzes structural reliability methods applied to various examples of limit state functions. These methods are essential tools for this analysis because they identify and quantify uncertainties in random variables, allowing the evaluation of the probability of failure of the structure. Structural reliability methods were programmed and simulated in the Python language. The performance of these methods was analyzed through examples of linear, nonlinear, implicit, and explicit limit state functions. The results indicate that the simulation of Monte de Carlo brute force (MCBF) and importance sampling (MCAI) proved to be quite efficient for the examples studied in this work, with values equal to or very close to the reference values from the literature. The First Order and Second Moment Method (FOSM) presented limitations in some examples when the basic random variables do not have a normal distribution and the limit state function is nonlinear. The first-order reliability method (FORM) employs a failure surface linearization, which does not work well for highly nonlinear problems. The second-order reliability method (SORM) has improved the FORM results by including additional information about the curvature of the limit state function.*

I. INTRODUCTION

According to Haldar and Mahadevan [1], most observable phenomena contain a certain amount of uncertainty. In general, repeated measurements of physical phenomena yield multiple results. The occurrence of various outcomes with no pattern is described by terms such as uncertainty and randomness.

According to Real *et al.* [2], the main quantities involved in engineering design are, in reality, random variables, which have a probability distribution. Therefore, the structure's response to loading will also be a random variable.

Thus, ensuring adequate safety levels in structures, and providing good performance, is one of the most significant engineering challenges. Models based on limit states are used in the design standards, where a series of safety criteria is specified in the calculation process of structures. The effect of uncertainties on the safety of structures can be diminished by analyzing the probability of failure of a limit state. (ALBUQUERQUE AND REAL [3]).

For Verma *et al*. [4], reliability is defined as the probability of trouble-free performance under established conditions. Still, it can be considered the probability that an element can perform its intended function for a specified time under pre-established design conditions.

After Beck [5], due to the uncertainties of the parameters of engineering projects, it is necessary to carry out reliability analyzes because of possible failures. The answer, in this case, is the determination of the failure probability or reliability index associated with a limit state function that depends on the random variables of the problem. That way, structural reliability methods are essential tools for this analysis, as they identify and quantify uncertainties in random variables.

According to Santos [6], several methods have been developed to estimate the failure probability and reliability index values. Among these methods, FOSM (First Order Second Moment), FORM (First Order Reliability Method), and SORM (Second Order Reliability Method) stand out. These structural reliability methods, also known as transformation methods, approximate the limit state function at the design point by a hyperplane, in the case of FOSM and FORM. In the case of SORM, a quadratic hypersurface is used. The approximation of these methods can lead to errors, especially when the limit state function is strongly nonlinear. In this way, Monte Carlo simulation can estimate the probability of failure and the correct reliability index, as this method is considered the most exact.

The Brazilian Association of Technical Standards (ABNT) is the main standardization body in the country. The Brazilian Norms (NBR) are technical documents used to standardize and guarantee a quality level. There are still no technical specifications based on structural reliability principles in Brazil, although this is a reality in several other countries. Therefore, this work is justified by the omission of the NBR concerning structural reliability. This paper aims to compare structural reliability methods applied to examples of limit state functions and, thus, analyze the efficiency of the method application.

II. MATERIAL AND METHOD

The methodology used in the elaboration of this work consists of the development of codes for structural reliability analysis through the methods Monte Carlo Brute Force (MCBF), Monte Carlo with Importance Sampling (MCIS), FOSM, FORM with the HLRF algorithms (Hasofer, Lind, Rackwitz and Fiessler) and iHLRF (improved Hasofer, Lind, Rackwitz and Fiessler) and SORM.

After programming, a comparative study between the methods was presented, where eighteen examples of linear, nonlinear, and implicit limit state functions obtained by some researchers are considered. Then, the performance and shortcomings of each method are analyzed.

2.1 – Limit State

Beck [5] states that each distinct form of arriving at an undesirable state is generically called a failure mode. Where each failure mode gives rise to a limit state equation $g(X)$, which is a function of the vector of random variables $X = \{X_1, X_2, \dots, X_n\}$, in such a way that the limit state is determined by equation 1:

$$g(X) = g(X_1, X_2, \dots, X_n) = 0 \quad (1)$$

a limit state equation $g(X)$ is written in such a way as to divide the problem domain into failure Ω_f and safety domains Ω_S, as shown in equations 2 and 3:

$$\Omega_f = \{X | g(X) \leq 0\} \quad (2)$$

$$\Omega_S = \{X | g(X) > 0\} \quad (3)$$

The failure domain Ω_f is constituted of all points in the sample space X that lead to the structure's failure. The secure domain Ω_S is the complementary set to the failure domain.

2.2 – Limit state function

According to Melchers and Beck [8], just as there are uncertainties in engineering projects, a structural system has the risk of not reaching the designed performance. Consequently, the performance of this system cannot be guaranteed to be completely secure. Thus, for Santos [6], it is convenient to define the limit state function; considering a structure with resistance *R* and load *S*, being possible to evaluate the failure probability. A limit state function in a probabilistic analysis can be determined by equation 4:

$$g(x) = R(x) - S(x) \quad (4)$$

Where *x* is the vector of random variables of the problem; $R(x)$ is the random variable representing the strength of the structure; $S(x)$ is the random variable representing the loading.

The probability of failure (P_f) is defined when the structure's resistance is less than the loading, and the safety

probability (P_S) is when the resistance is greater than or equal to the loading, being given by equations 5 and 6:

$$P_f = P[g(x) < 0] \quad (5)$$

$$P_S = 1 - P_f. \quad (6)$$

In compliance with the JCSS [8], the probability of failure must be calculated based on the type of joint distribution of the basic variables and on the standardized distributive formalism of dealing with model uncertainty and statistical uncertainty.

Figure 1 shows a surface with the failure region, the safety region, and the limit state function for a system with two variables.

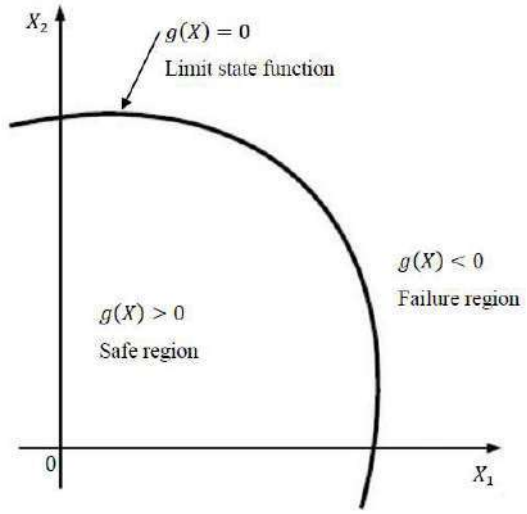


Fig. 1: Limit state function for a system with two variables (ALBUQUERQUE [7])

For Beck [5], the reliability index calculated in problems involving statistically independent normally distributed random variables and a linear limit state function corresponds to the smallest distance between the origin and the limit state function and is given through equation 7.

$$\beta = \frac{\mu_R - \mu_S}{\sqrt{\sigma_R^2 + \sigma_S^2}}. \quad (7)$$

According to Melchers and Beck [8], the failure probability can be obtained directly from the reliability index for linear limit state functions. It can still be defined if the function is nonlinear, but only for an approximate (hyper)tangent plane. In each case, β represents the smallest distance between the origin in standardized normal space and the tangent plane, as shown in Figure 2.

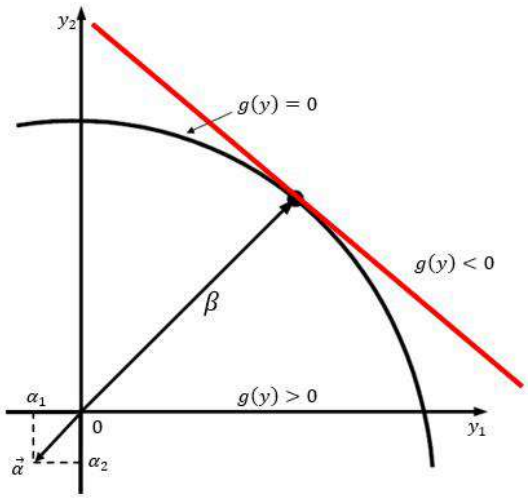


Fig. 2: Representation of the reliability index (ALBUQUERQUE [7])

In Figure 2, the minimum distance point on the hyperplane is denominated as the design point. This point has the highest probability density within the space covered by the failure region, according to Melchers and Beck [8].

2.3 – Reliability Methods

Monte Carlo simulation is a numerical method that is based on random sampling. Second Beck [5], in structural engineering, Monte Carlo simulation adapts to linear and nonlinear, static or dynamic problems. In structural reliability, the simulation solves, with the same ease, problems involving a single limit state equation, time-dependent or not.

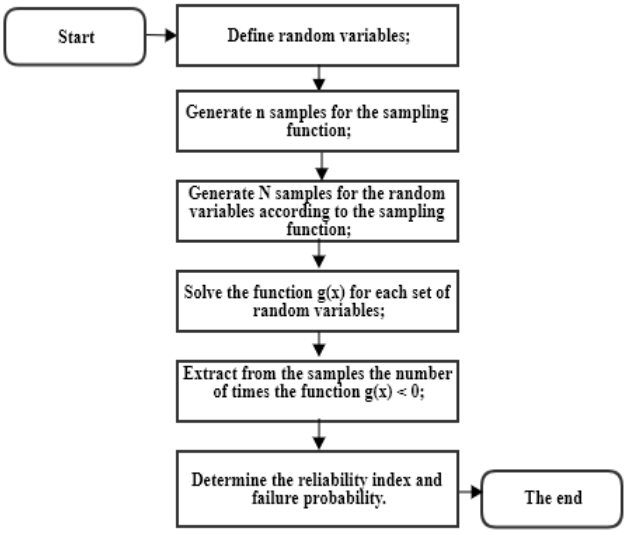


Fig. 3: Flowchart of the brute force Monte Carlo method algorithm (ALBUQUERQUE [7])

The brute force Monte Carlo simulation method (MCBF) is a numerical technique based on repetition of the simulation process, using a specific set of values in each simulation.

According to Haldar and Mahadevan [1], the MCBF simulation has six essential elements, and the algorithm of the method is presented in Figure 3.

One of the techniques to accelerate the convergence of Monte Carlo simulation is utilizing importance sampling. The technique determines the probability of failure in the limit state region. Beck [5] states that the importance sampling technique uses a sampling function to avoid generating samples far from the area of interest, far from the failure domain. The points are generated from a sampling function $h_X(x)$. Multiplying and dividing Equation 5 by $h_X(x)$, we get equation 8:

$$P_f \approx \widehat{P_f} = \frac{1}{N}\sum_{i=1}^{N} I_g(x_i)\frac{f_X(x_i)}{h_X(x_i)} \quad (8)$$

The point x_k is associated with a weight $w_k << 1$, represented by the ratio of the functions $f_X(x)$ and $h_X(x)$. The variance of the failure probability is estimated by equation 9:

$$Var[\widehat{P_f}] = \frac{1}{(N-1)}\sum_{k}^{N}(I_g[x_k]w_k - \widehat{P_f})^2 \quad (9)$$

According to Haldar and Mahadevan [1], the algorithm of the MCIS method is presented in Figure 4.

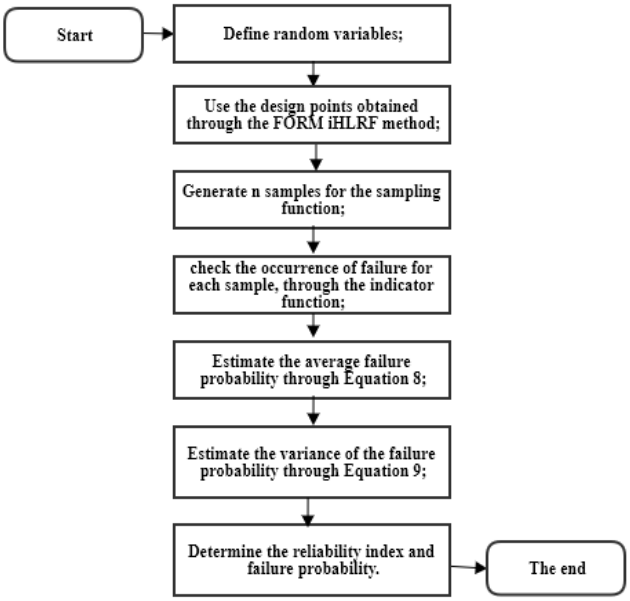


Fig. 4: Flowchart of the Monte Carlo method algorithm with sampling by importance (ALBUQUERQUE [7])

According to Haldar and Mahadevan [1], FOSM and FORM can be used to evaluate a function of normal and statistically independent variables. FORM can also represent a nonlinear limit state function by the first-order approximation with equivalent normal variables. And SORM determines the probability of failure by approximating the nonlinear limit state function by a second-order representation. FORM substitutes the limit state function at the design point by a hyperplane, while SORM uses a quadratic hypersurface. In Figure 5, the first and second-order approximations are shown.

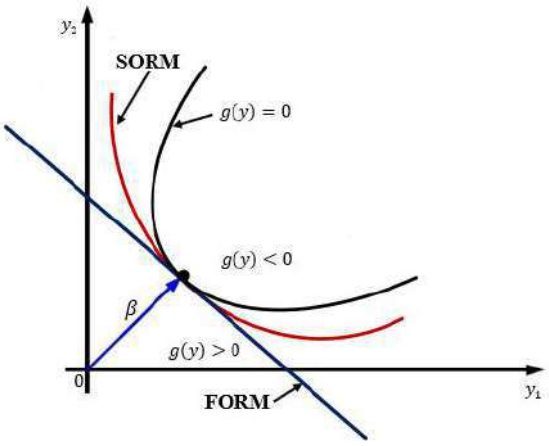


Fig. 5: First and second-order approximation - FORM e SORM (ALBUQUERQUE [7])

According to Beck [5], in the FOSM and FORM methods, the limit state equation is approximated by a linear function. The information for constructing the joint probability density function $f_X(x)$ is limited to moments up to second-order (mean and covariance). A representation of the problem variables by their moments corresponds to assuming them as having a normal distribution.

The FOSM method solution algorithm is presented below, following (BECK [5]).

Algorithm 1. Reliability method FOSM

1. choice of initial failure point $\mathbf{x}^k$ to k=0 (usually the mean point);
2. evaluation of Jacobian matrices ($\mathbf{J}_{yx}$ and $\mathbf{J}_{xy}$) and the vector of the means V;
3. point transformation $\mathbf{x}^k$ of $\mathbb{X} \rightarrow \mathbb{Y}$;
4. evaluation of g ($\mathbf{x}^k$);
5. gradient calculation:

a. calculating the partial derivatives of g(x) in design space $\mathbb{X}$

b. transform the gradient to $\mathbb{Y}$

c. calculating director cosines α (y^k)

6. calculation of the reliability index (β)

7. calculation of the new point of failure y^{k+1} through

$$y^{k+1} = \mu_{Xi}^{N} - \alpha_{Xi}\beta\sigma_{X_i}^{N} \quad (10)$$

8. transformation of y^{k+1} in $\mathbb{X}$;

9. verification of the convergence criterion. If:

$$1 - \frac{\nabla g(y^{k+1})\, y^{k+1}}{||\nabla g(y^{k+1})||\, ||y^{k+1}||} < \epsilon \quad e \quad |g(y^{k+1})| < \delta \quad (11)$$

being $\epsilon = 10^{-6}$; the algorithm is interrupted (y* = y^{k+1}); otherwise, return to item 4 with *k=k+1* until reaching convergence;

10. at the end, evaluation of the reliability index at the design point: β = || y*||.

The FORM algorithm is equal to the FOSM for a problem with a normal probability distribution of random variables. When distributions are mixed, it is necessary to calculate the mean and standard deviation of an equivalent normal distribution (ALBUQUERQUE [7]).

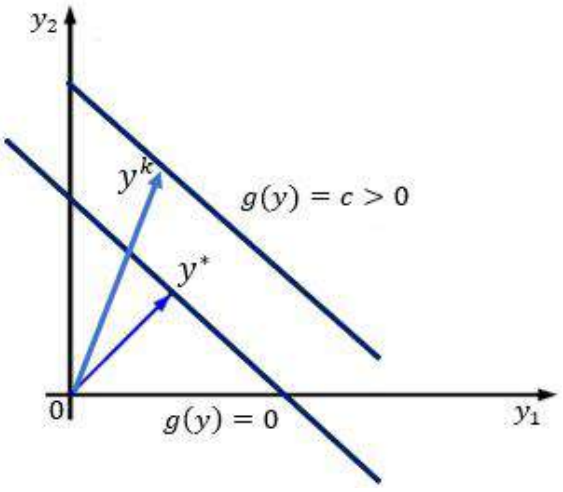


Fig. 6: Representation of the FORM method with the HLRF algorithm - Linear limit state function (ALBUQUERQUE [7])

According to Melchers and Beck [8], the search for the design point *y** is one of the fundamental steps to obtaining the failure probability by the FORM method. The transformation of any variables, correlated or not, into statistically independent equivalent normal variables is performed through the Nataf model transformation.

For Beck [5], the solution of reliability problems via FORM for nonlinear limit state functions involves resolving an optimization problem to search for the design point. The most used algorithm is Hasofer, Lind, Rackwitz and Fiessler (HLRF). For nonlinear limit states, the minimum distance calculation becomes an optimization problem. The solution to this problem is presented in equation 12:

$$d = ||y|| = \sqrt{y\, y^t} \quad (12)$$

Figures 6 and 7 illustrate an iteration of the FORM method with the HLRF algorithm, considering a linear and nonlinear limit state function. It is observed that while the design point is not reached, the condition $g(y) = 0$ is not obtained. That is, the point y^k does not reach the failure surface, but a surface to which $g(y)$ is constant (c). Therefore, the optimization algorithm must start from the point y^k, which may not be in the limit state, and converge to the minimum distance point y^* in the limit state.

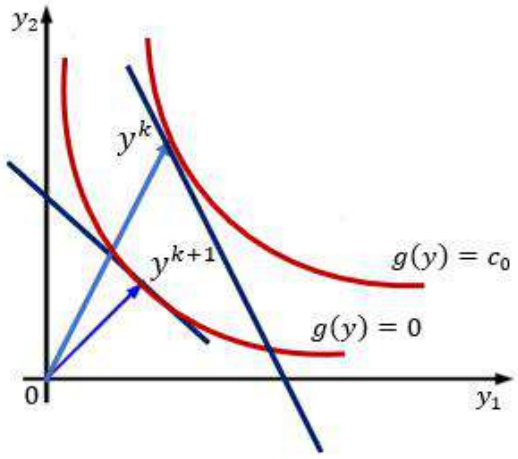


Fig. 7: Representation of the FORM method with the HLRF algorithm - Nonlinear limit state function (ALBUQUERQUE [7])

The recurrence formula for y^{k+1} can be obtained considering the linear approximation of $g(y)$, and is represented through equation 13:

$$y^{k+1} = \frac{[\nabla g(y^k)^t y^k - g(y^k)]\nabla g(y^k)}{\|\nabla g(y^k)\|^2}. \quad (13)$$

According to Sudret and Der Kiureghian [10], the HLRF algorithm can be improved (iHLRF) through a linear search for the fit. The original HLRF algorithm gives the search direction of equation 14:

$$d^k = y^{k+1} - y^k = \frac{\nabla g(y^k)^t y^k - g(y^k)}{\|\nabla g(y^k)\|^2} \nabla g(y^k) - y^k \quad (14)$$

The solution algorithm of the FORM iHLRF method is presented following (BECK, [5]).

Algoritmo 2. Reliability method FORM iHLRF

Data: $y^k \in \mathbb{R}^n, \Delta > 0, \eta > 1, \alpha \in (0,1], 0 < m_1 < 1$

1. Calculate the search direction of d^k given in equation 14;
2. Determine the penalty parameter c of the merit function

If $|g(y^k)| \geq \Delta$

$$c = \eta \max\left\{\frac{\|y^k\|}{\|\nabla g(y^k)\|}, \frac{1}{2}\frac{\|y^k + d^k\|^2}{|g(y^k)|}\right\}$$

If not

$$c = \eta \frac{\|y^k\|}{\|\nabla g(y^k)\|};$$

3. Determine α^k using inequality

While $p(y^k + \alpha d^k) - p(y^k) > m_1 \alpha \nabla p(y^k)^t d^k$

Do $\alpha = \frac{\alpha}{2}$

$\alpha^k = \alpha$;

4. Update the point y:

The SORM approximates the limit state function at the design point by a quadratic hypersurface. Beck [5] states that this method results in a good approximation of the failure probability when the limit state function, in standard normal space, is linear or weakly nonlinear in the vicinity of the design point.

For Cordeiro [11], the SORM method estimates the failure probability through a second-order approximation of the limit state function at the design point. The second-order derivative of this function approximates the curvature of the limit state function with respect to the equivalent normal space variables. The SORM method algorithm is calculated by obtaining the reliability index and failure probability of the FORM method. The algorithm of the FORM and SORM methods is shown in Figure 8.

According to Haldar and Mahadevan [1], the curvature of any function is related to the second-order derivatives in relation to random variables. Therefore, the second-order reliability method (SORM) improves the FORM result by including additional information about the curvature of the limit state of the function.

III. RESULTS AND DISCUSSION

Eighteen problems are presented for comparative analysis, applying Monte Carlo simulation and transformation methods in structural reliability problems. The study consists of a comparative analysis of the convergence of the reliability index of linear, nonlinear, and implicit limit state functions found in the literature.

The transformation methods are interrupted when they encounter a point whose stationarity measure value is sufficiently small. In this way, the conditions are established according to equation 11, using $\epsilon = 10^{-6}$. The method execution is interrupted if these conditions are not met until the code reaches 100 iterations.

In implementing Monte Carlo simulation, MCBF works well for a simulation number up to 9×10^7. The MCIS uses a predetermined point as sampling, using the design point obtained through the FORM iHLRF method.

The probability distributions, the moments (mean and standard deviation) of the random variables, and the limit state function $g(x)$ are presented for each problem analyzed

Problem 1 - Beck [5]: Limit state function $g(x) = x_1 x_2 - x_3$. the variables follow normal probability distribution, with mean values $\mu_{x_1} = 40$, $\mu_{x_2} = 50$ and $\mu_{x_3} = 1000$ and standard deviations $\sigma_{x_1} = 5, \sigma_{x_2} = 2.5$ and $\sigma_{x_3} = 200$.

Problem 2 - Shayanfar [12]: Limit state function $g(x) = x_1^3 + x_1^2 x_2 + x_2^3 - 18$, the variables follow normal probability distribution, with parameters $\mu_{x_1} = 10$, $\mu_{x_2} = 9{,}9$ and $\sigma_{x_1} = \sigma_{x_2} = 5$.

Problem 3 - Keshtegar e Chakraborty [13]: Limit state function $g(x) = x_1^4 + x_2^2 - 50$, the random variables, x_1 has lognormal probability distribution with parameters $\mu_{x_1} = 5$ and $\sigma_{x_1} = 1$, x_2 follows Gumbel distribution with parameters $\mu_{x_1} = 10$ and $\sigma_{x_1} = 10$.

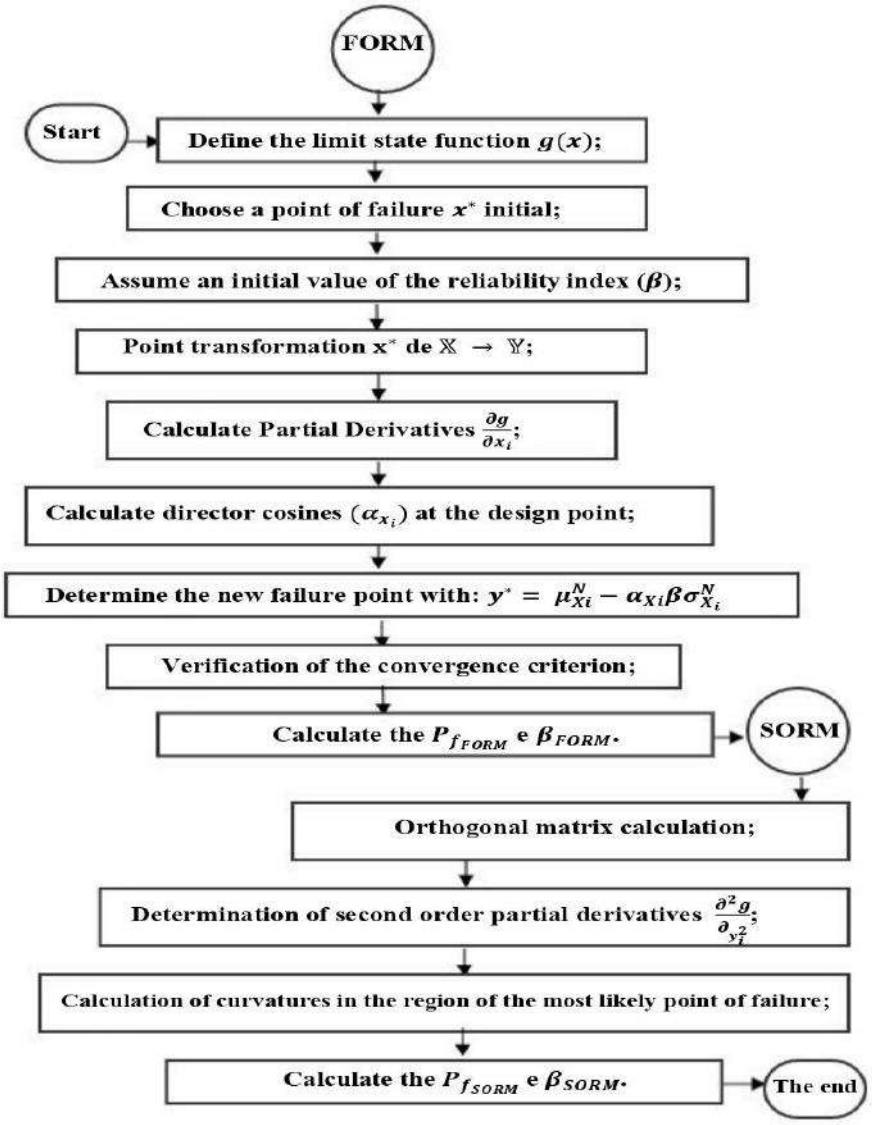


Fig. 8: Algorithm of the FORM and SORM methods (ALBUQUERQUE [7])

Problem 4 - Li e Zhang [14]: Limit state function $g(A,P) = 3.0 - u_4(A,P)$, the random variables, x_1 has lognormal probability distribution with parameters $\mu_{x_1} = 0.0025$ and $\sigma_{x_1} = 0.00025$, x_2 follows Gumbel distribution with parameters $\mu_{x_1} = 200$ and $\sigma_{x_1} = 50$. The authors present an analysis of the plane truss with the dimensions and loads shown in Figure 9. The bars' material has a linear elastic behavior, with a modulus of elasticity E = 200 GPa. The cross-sections of the truss members have an area of $25\ cm^2$. The structure is subjected to loads P = 200 kN, applied vertically at nodes 2 and 4.

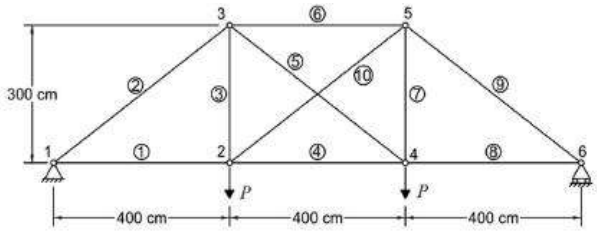


Fig. 9: Structural scheme of the flat truss (Li e Zhang [14])

Problem 5 [Ang e Tang (2007)]: Limit state function $g(R,S) = R - G - Q - W$, the variables have a normal probability distribution, with parameters

$\mu_R = 975$, $\mu_G = 200$, $\mu_Q = 300$, $\mu_W = 150$, $\sigma_R = 146.25$, $\sigma_G = 14$, $\sigma_Q = 36$ *and* $\sigma_W = 30$.

Problem 6 - Ang e Tang [15]: In this example, the same data from Problem 5 are used, with changes in the distributions of the variables, *R* and G have lognormal and normal probability distributions, respectively, *Q* and *W* follow the Gumbel probability distribution.

Problem 7 - GHALEHNOVI *et al.* [16]: Limit state function $g(x) = exp(0.2x_1 + 1.4) - x_2$, the variables follow normal probability distribution, with parameters $\mu_{x_1} = \mu_{x_2} = 0$ and $\sigma_{x_1} = \sigma_{x_2} = 1$. This function is weakly nonlinear and its behavior is illustrated in Figure 10.

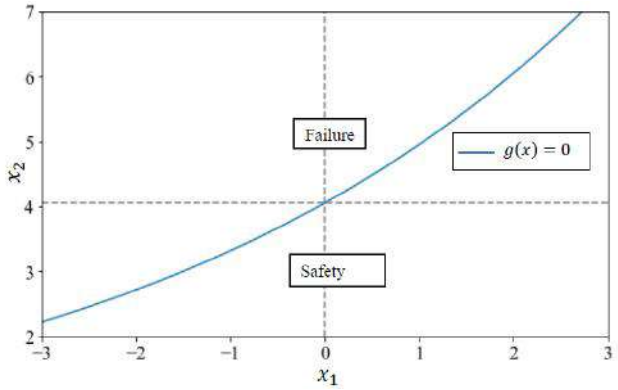


Fig. 10: Failure threshold and failure and safety domains, for problem 7 (ALBUQUERQUE [7])

Problem 8 - SANTOS [6]: Limit state function $g(p,q) = 3 - q + (4p)^4$, the variables follow normal probability distribution, with parameters $\mu_p = \mu_q = 0$ and $\sigma_p = \sigma_q = 1$. This function is strongly nonlinear and its behavior is illustrated in Figure 11.

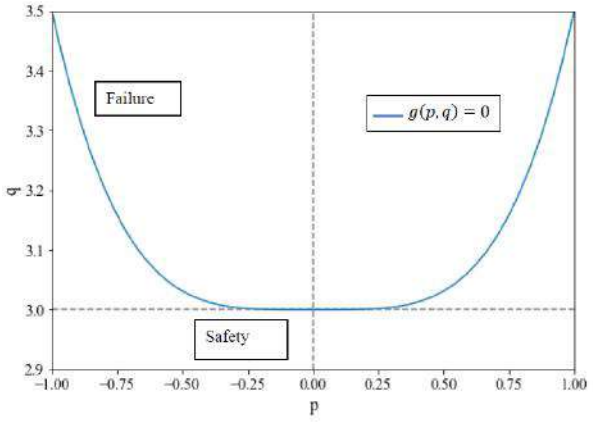


Fig. 11: Failure threshold and the failure and safety domains, for problem 8 (ALBUQUERQUE [7])

Problem 9 - Beck [5]: Limit state function $g(x) = x_1 + 2x_2 + 3x_3 + x_4 - 5x_5x_6$, the variables follow lognormal probability distribution, with mean values $\mu_{x_1} = \mu_{x_2} = \mu_{x_3} = \mu_{x_4} = 120$, $\mu_{x_5} = 50$ and $\mu_{x_6} = 40$ and standard deviations $\sigma_{x_1} = \sigma_{x_2} = \sigma_{x_3} = \sigma_{x_4} = \sigma_{x_6} = 12$ and $\sigma_{x_5} = 15$.

Problem 10 – GROOTEMAN [17]: Limit state function $g(x) = 2.5 - 0.2357(x_1 - x_2) + 0.0046(x_1 + x_2 - 20)^4$, the variables have a normal probability distribution, with parameters $\mu_{x_1} = \mu_{x_2} = 10$ and $\sigma_{x_1} = \sigma_{x_2} = 3$.

Problem 11 - SANTOS *et al.* [18]: Limit state function $g(x) = x_1x_2 - 78{,}12x_3$, the random variables, x_1 and x_2 have lognormal probability distribution with parameters $\mu_{x_1} = 2\ x\ 10^7$, $\mu_{x_2} = 10^{-4}$, $\sigma_{x_1} = 0.5\ x\ 10^7$ and $\sigma_{x_2} = 0.2\ x\ 10^{-4}$, x_3 follows Gumbel distribution with parameters $\mu_{x_3} = 4$ and $\sigma_{x_3} = 1$.

Problem 12 - SANTOS *et al.* [18]: Limit state function $g(x) = x_1^3 + x_2^3 - 18$, the variables follow normal probability distribution, with parameters $\mu_{x_1} = \mu_{x_2} = 10$ and $\sigma_{x_1} = \sigma_{x_2} = 5$.

Problem 13 SANTOS *et al.* [18]: Limit state function $g(x) = x_1^3 + x_2^3 - 18$, the variables have a normal probability distribution, with mean values $\mu_{x_1} = 10$ and $\mu_{x_2} = 9{,}9$, and standard deviations $\sigma_{x_1} = \sigma_{x_2} = 5$.

Problem 14 - Choi *et al.* [19]: Limit state function $g(x) = x_1^4 + 2x_2^4 - 20$, the variables have a normal probability distribution, with parameters $\mu_{x_1} = \mu_{x_2} = 10$ and $\sigma_{x_1} = \sigma_{x_2} = 5$.

Problem 15 - GHALEHNOVI *et al.* [16]: Limit state function $g(x) = \frac{1}{40}{x_1}^4 + 2x_2^2 + x_3 + 3$, the variables have a normal probability distribution, with parameters $\mu_{x_1} = \mu_{x_2} = \mu_{x_3} = 0$ and $\sigma_{x_1} = \sigma_{x_2} = \sigma_{x_3} = 1$.

Problem 16 - [KESHTEGAR e MENG, 2017]: Limit state function $g(x) = 0.03 - \left(ql^2/2\right).\left(3.81/A_cE_c\right) + \left(1.13/A_sE_s\right)$, the random variables, $q, l, A_s\ and\ A_c$ have normal probability distribution with parameters $\mu_q = 20000$, $\sigma_q = 1400$, $\mu_l = 12$, $\sigma_l = 0.12$, $\mu_{A_s} = 9.82\ x\ 10^{-4}$, $\sigma_{A_s} = 5.9852\ x\ 10^{-5}$, $\mu_{A_c} = 0.04$, $\sigma_{A_c} = 0.0048$, E_s follows lognormal distribution with parameters, $\mu_{E_s} = 1.0\ x\ 10^{11}$, $\sigma_{E_s} = 6.0\ x\ 10^9$ and E_c has Gumbel distribution with parameters, $\mu_{E_c} = 2.0\ x\ 10^{10}$ and $\sigma_{E_c} = 1.2\ x\ 10^9$. In this example, a roof truss under uniform load is analyzed, shown in Figure 12. The upper chords and compression bars of the truss are made of

reinforced concrete, and the bottom chords and tension bars are made of steel.

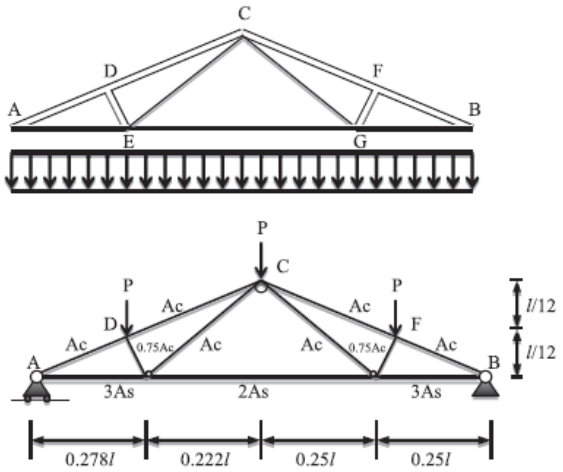


Fig. 12: Vista esquemática da treliça de telhado **(**KESHTEGAR e MENG [20])

Problem 17 - [SHAYANFAR *et al*., 2017]: Limit state function $g(A_1, A_2, A_3, B, P, E) = 0.1 - B \cdot u(A_1, A_2, A_3, P, E)$, the random variables, A_1, A_2, A_3 *e* B have normal probability distribution with parameters $\mu_{A_1} = 10^{-2}$, $\sigma_{A_1} = 5.0\ x\ 10^{-4}$, $\mu_{A_2} = 1.5\ x\ 10^{-2}$, $\sigma_{A_2} = 7.5\ x\ 10^{-5}$, $\mu_{A_3} = 6.0\ x\ 10^{-2}$, $\sigma_{A_3} = 3.0\ x\ 10^{-4}$, $\mu_B = 1.0$, $\sigma_B = 0.1$, P follows lognormal distribution with parameters, $\mu_P = 25.0\ x\ 10^5$, $\sigma_P = 2.5\ x\ 10^4$ and E has Gumbel distribution with parameters, $\mu_E = 6.9\ x\ 10^4$ and $\sigma_E = 3.45\ x\ 10^3$. In this problem, a 10-bar truss structure is presented in Figure 13 with three different cross-sectional areas A_1 (vertical), A_2 (horizontal) e A_3 (diagonal). The structure is subjected to two external horizontal loads *P*. The failure of the structure is considered when the horizontal displacement in the upper right corner exceeds the allowable displacement $d_0 = 0.1\ m$. is the modulus of elasticity. The random variable *B* was introduced for the model uncertainties and $L = 9.0$ m is a deterministic variable. it is assumed that A_1, A_2 , A_3, *B*, *P*, *E* are statistically independent random variables.

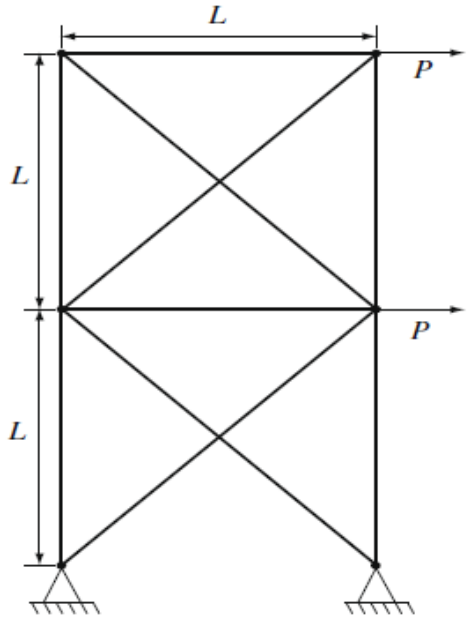


Fig. 13: 10-bar truss structure (SHAYANFAR et al. [12])

Problem 18 - ROUDAK *et al*. [21]: Limit state function $g(x) = (7/360) - 360\left(x_1/x_2 x_3^4\right)$, the random variables, x_1, x_2 e x_3 follow normal probability distribution with parameters $\mu_{x_1} = 10.0$, $\sigma_{x_1} = 0.4$, $\mu_{x_2} = 2.0\ x\ 10^7$, $\sigma_{x_2} = 0.5\ x\ 10^7$, $\mu_{x_3} = 0.4$ e $\sigma_{x_3} = 0.01$. In this problem, a continuous beam with three spans is studied, considering the parameters uniform load intensity, modulus of elasticity, and section height. Figure 14 illustrates the analyzed beam.

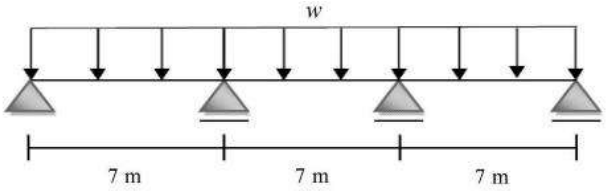


Fig. 14: Three-span continuous beam (ROUDAK et al. [21])

Table 1 shows the results of the reliability indices of each method studied for each problem.

Table 1 - Results of the reliability indices of the analyzed problems

Problems	Methods					
	MCBF	MCIS	FOSM	FORM HLRF	FORM iHLRF	SORM
1	3.04	3.04	3.04	3.04	3.04	3.04
2	2.52	2.52	1.54	1.54	2.30	2.62
3	3.56	3.56	1.51	1.84	3.26	3.53
4	3.20	3.20	4.12	3.19	3.19	3.19
5	2.10	2.10	2.10	2.10	2.10	2.10
6	2.35	2.35	2.10	2.45	2.45	2.45
7	3.38	3.38	3.35	3.35	3.35	3.38
8	3.57	3.57	3.00	3.00	3.00	3.00
9	2.94	2.94	3.65	3.04	3.04	3.04
10	2.75	2.75	2.50	2.50	2.50	2.50
11	4.43	4.43	3.29	4.43	4.43	4.43
12	2.55	2.55	2.24	2.24	2.24	2.63
13	2.55	2.55	1.16	1.16	2.22	2.63
14	2.92	2.92	0.93	0.93	2.36	2.84
15	3.43	3.43	2.52	2.52	3.00	3.37
16	2.35	2.35	0.18	0.59	2.42	2.42
17	4.30	4.30	5.49	3.99	4.30	4.30
18	2.52	2.52	not converged	not converged	2.52	2.52

According to Table 1, problems 1 and 5 tend to converge to the same point, represented by the reliability index. As problems 1 and 5 are characterized by a linear limit state function and normal probability distribution, the application of the methods results in the exact solution of the problems.

From the results obtained in problems 2, 3, 13, 14, and 15, it can be stated that the FOSM and FORM HLRF methods do not converge to stable solutions for highly nonlinear limit state functions, with a significant difference to the reference (MCBF). In these cases, the FORM iHLRF improves the result by decreasing the difference to the reliability index reference but still cannot converge to the results of the MCBF, MCIS, and SORM methods. The high nonlinearity of the functions is the reason for this difference between the methods.

In problem 4, the MCBF method was used with a sample of 10^6 elements and a computational time of 16 min 35 s and MCIS with 10^4 simulations with a time of 9 s, and the FOSM, FORM HLRF, FORM iHLRF, and SORM methods with a time smaller than 1 s the reliability indices of Table 1 were determined. The result of the FOSM method is different from the other methods as it does not take into account mixed distributions. The MCIS showed a better performance for this problem, both in computational time and the number of simulations. The Monte Carlo, FORM, and SORM simulation methods obtained results very close to the reference, with a difference of less than 1%. Thus, it can be said that the methods MCBF, MCIS, FORM HLRF, FORM iHLRF, and SORM adequately represented the values found by the authors since the results were very close.

In problems 6 and 11, only the FOSM method did not converge to the result of the other methods because the distributions are mixed. Given the weak nonlinearity of the limit state function, the FORM HLRF and FORM iHLRF methods present identical behavior to the MCBF, MCIS, and SORM methods.

Regarding the results of problem 7, there is a difference in the values of the reliability index of the

FOSM, FORM HLRF, and FORM iHLRF methods; however, the differences found are approximately 1% compared to the other methods. This difference presents a relatively small divergence. Thus, it can be affirmed that this function is weakly nonlinear and that the analyzed methods effectively determine the reliability index of this function.

In problems 8 and 10, the MCBF was used with a sample with 10^6 elements and MCIS with 10^4 elements. Despite presenting the same results, the transformation methods converge to a result far from the reference (MCBF). In these problems, the second-order curvatures are zero. A surface of zero curvature is a plane, so FORM and SORM got the same results.

It can be noted that the results obtained in problem 9 produced very similar results, except for the FOSM method. Only the FOSM method did not converge to the result of the other transformation methods because it does not converge correctly for non-normal distributions and still obtained a β greater than the other methods. This lack of convergence is because this function is weakly nonlinear, and if the other methods had a normal probability distribution, they would converge to the same result.

In problem 12, the difference between the reliability indices of the Monte Carlo methods compared to the FOSM, FORM HLRF, and FORM HLRF is 12%. The MCIS once again proved to be more efficient in the number of simulations (10^4 elements) than the MCBF (10^6 elements).

The MCBF method was used with a sample with 10^7 elements, MCIS with 10^4 elements. The analysis of problems 16 and 18 was performed considering the MCBF method as a reference. SORM and FORM iHLRF approximate MCBF and MCIS. There are very marked differences between the results of the FOSM and FORM HLRF methods with 92% and 78%, respectively, in problem 16 to the MCBF reliability index. In problem 18, the FOSM and FORM HLRF methods failed to converge to the result. The high nonlinearity is the reason for this difference.

The truss presented in problem 17 is a well-known benchmark example studied by some researchers. And using the MCBF method with a sample with elements, it obtained a computational time of 11h 45min 22 s, MCIS with $9x10^7$ simulations with a time of 15 s, and the FOSM, FORM HLRF, FORM iHLRF, and SORM methods with a time of less than 5 s. The analysis of the results was performed considering the MCBF method as a reference. The MCIS method showed once again that it improves the performance and efficiency of the MCBF regarding the number of simulations and computational time. As expected, FOSM did not converge to the benchmark result. And the FORM HLRF walked 7% away from the target reliability index.

Figure 15 compares the reliability index of the 18 problems analyzed.

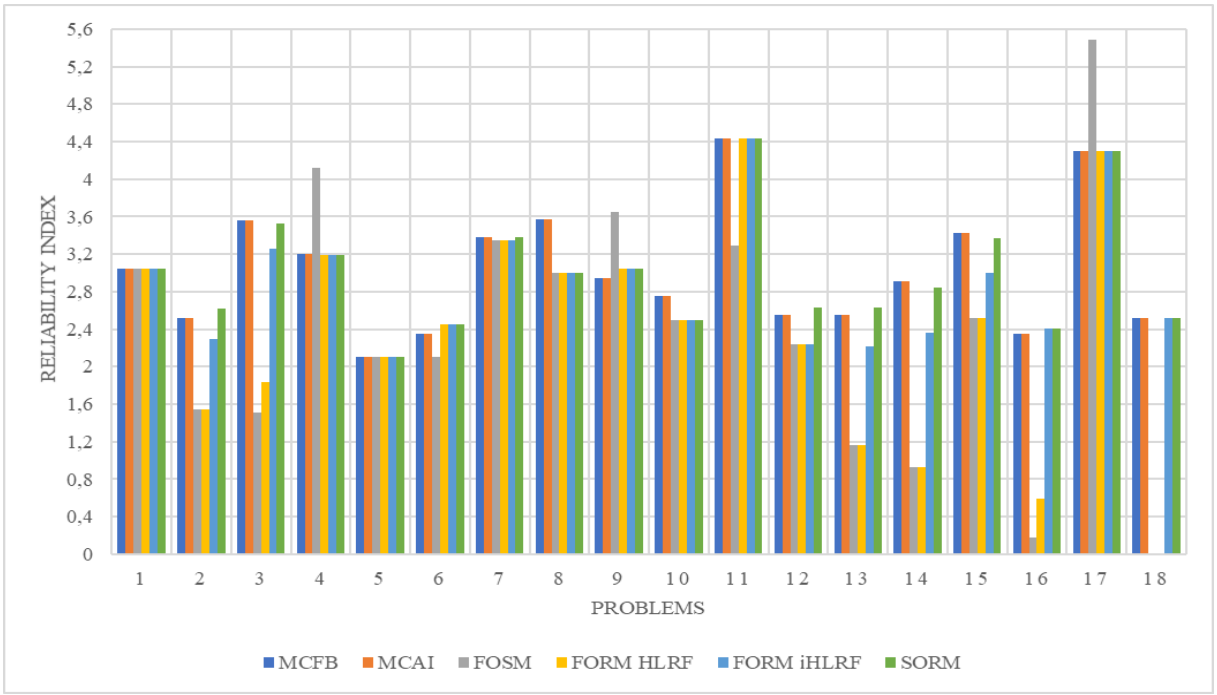


Fig. 15: Comparison of the reliability index of the analyzed examples.

It is observed in Figure 15 that the SORM method proved to be adequate for the probabilistic analysis and returned values equal to or very close to the MCBF and MCIS methods in the analyzed problems. SORM is calculated by obtaining the reliability index of the FORM method. In this way, SORM becomes more advantageous because it improves the FORM result by including additional information about the curvature of the limit state. In the case of problems 8 and 10, the curvatures in the failure region are null despite the function being nonlinear.

Also, according to Figure 15, it is observed that the MCBF and MCIS methods successfully solved 100% of the examples, SORM solved 89%, FOSM, FORM HLRF, and FORM iHLRF solved 11%, 44%, and 56%, respectively. So, of the transformation methods, SORM successfully solved more examples than the FOSM and FORM methods.

Regarding the performance of the FOSM and FORM methods, the number of iterations is considered a criterion. FOSM and FORM HLRF reached the maximum number of iterations (k = 100) in solving problems 11, 13, 14, 15, and 16, and FORM iHLRF reached 56 as the maximum number of iterations in problem 14. Therefore, there is a significant difference based on this performance criterion of the FORM iHLRF against the FORM HLRF.

IV. CONCLUSION

This work presented a comparative study of structural reliability methods (MCBF, MCIS, FOSM, FORM HLRF, FORM iHLRF, and SORM), taking into account the results of the reliability index. The performance of the methods implemented in the Python language was verified through eighteen linear, nonlinear and implicit limit state function problems.

The MCBF and MCIS simulation methods worked well for all analyzed examples. The MCIS method presented the same precision as the MCBF but with greater efficiency, converging faster by using a smaller number of simulations and with a much lower computational cost in analyzing the implicit limit state functions.

It was observed that the use of the FOSM method is quite limited, as it presents results far from the references. Thus, it can be said that the technique is not suitable for most of the analyzed examples, as it only uses moments of first and second order, not taking into account the form of the probability distribution. If the basic random variables are not normal and the limit state function is linear, the imprecision level grows.

The FORM HLRF and FORM iHLRF methods did not obtain good results for the highly nonlinear functions analyzed. Although these methods transform distributions that are not normally distributed into equivalent normals, they work with a linearization of the failure surface. If the function is highly nonlinear around the point of failure, the results of this method are not as good as the MCBF and MCIS methods. The FORM iHLRF is closer to the reference values for the analyzed functions. Therefore, the iHLRF algorithm improves the HLRF through a linear search for the design point.

The SORM presented the same or very close results concerning the reference (MCBF). The application of this method proved to be efficient in sixteen of the eighteen problems analyzed and carried out the analysis of second-order structural reliability for the functions effectively, optimizing in a relevant way the results obtained by the FORM iHLRF method. SORM is more beneficial because it improves the FORM result by including additional information about the limit state curvature at the design point. In problems 8 and 10, the second-order curvatures are zero. A surface of zero curvature is a plane; FORM and SORM gave the same results.

ACKNOWLEDGEMENTS

The authors would like to thank the Coordination for the Improvement of Higher Education Personnel (Capes) and the National Council for Scientific and Technological Development (CNPq) for the financial support in developing this study.

REFERENCES

[1] HALDAR, A.; MAHADEVAN, S. 2000. Reliability assessment using stochastic finite element analysis. John Wiley & Sons.

[2] REAL, M. V.; 2000. CAMPOS FILHO, A.; MAESTRINI, S. R. 2003. Response variability in reinforced concrete structures with uncertain geometrical and material properties. Nuclear Engineering and Design, v. 206, p. 205-220. https://doi.org/10.1016/S0029-5493(03)00110-9

[3] ALBUQUERQUE, C. S.; REAL, M. V. (2020). Estudo comparativo de métodos de confiabilidade estrutural aplicados a estruturas de concreto, 62º Congresso Brasileiro do concreto. https://doi.org/10.4322/2175-8182.62CBC005

[4] VERMA, A. K.; AJIT, S.; DURGA, R. K. (2016). Reliability and Safety Engineering. – 2. ed. – Springer-Verlag London Ltd.

[5] BECK, A. T. 2019. Confiabilidade e Segurança das Estruturas – 1. ed. – Rio de Janeiro: Elsevier.

[6] SANTOS, K. R. M. dos. 2014. Técnicas de amostragem inteligente em simulação de Monte Carlo. Dissertação de

Mestrado - Universidade de São Paulo - Escola de Engenharia São Carlos, São Paulo.

[7] ALBUQUERQUE, C. S. 2021. Estudo comparativo de métodos computacionais de avaliação de confiabilidade estrutural. Dissertação de Mestrado - Universidade Federal do Rio Grande, Rio Grande -RS.

[8] MELCHERS, R. E; BECK, A. T. 2018. Structural Reliability Analysis and Prediction. John Wiley & Sons.

[9] JOINT COMMITTEE ON STRUCTURAL SAFETY, JCSS: Probabilistic Model Code, 2001.

[10] SUDRET, B.; DER KIUREGHIAN A. 2000. Stochastic Finite Element Methods and Reliability: A state-of-the-art Report. Research report No. UCB/SEMM-2000/08, Dep. of Civil & Env. Eng., University of California, Berkeley.

[11] CORDEIRO, A. L. R. 2009. Aplicação dos métodos FORM e SORM para avaliação de dutos corroídos. Dissertaçãode Mestrado, Pontifícia Universidade Católica do Paraná, Curitiba.

[12] SHAYANFAR, M. A.; BARKHORDARI, M. A.; ROUDAK, M. A. 2017. An efficient reliability algorithm for locating design point using the combination of importance sampling concepts and response surface, Communications in Nonlinear Science and Numerical Simulation. (47) 223–237. https://doi.org/10.1016/j.cnsns.2016.11.021

[13] KESHTEGAR, B.; CHAKRABORTY, S. 2018. A hybrid self-adaptive conjugate Þrst order reliability method for robust structural reliability analysis. Applied Mathematical Modelling, 53: 319-333. https://doi.org/10.1016/j.apm.2017.09.017

[14] LI, Y.; D. Zhang, D. 2013. Plane Truss Reliability Numerical Simulation Based on MATLAB. Applied Mechanics and Materials, Vols. 256-259, p. 1091-1096. https://doi.org/10.4028/www.scientific.net/AMM.256-259.1091

[15] ANG, A. H-S.; TANG, W. H. 2007. Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering. – 2. ed. – John Wiley & Sons.

[16] GHALEHNOVI, M.; RASHKI, M.; AMERYAN, A. 2020. First order control variates algorithm for reliability analysis of engineering structures. Applied Mathematical Modelling, v. 77, p. 829–847. https://doi.org/10.1016/j.apm.2019.07.049

[17] GROOTEMAN, F. 2008. Adaptive radial-based importance sampling method for structural reliability. Structural Safety, 30, 533-542. https://doi.org/10.1016/j.strusafe.2007.10.002

[18] SANTOS, S. R.; MATIOLI, L. C.; BECK, A. T. 2012. New optimization algorithms for structural reliability analysis. Computer Modeling in Engineering and Science, v. 83, p. 23–56. https://doi:10.3970/cmes.2012.083.023

[19] CHOI, S. K.; GRANDHI, R. V.; CANFIELD, R. A. 2007. Reliability-based Structural Design**.** Springer-Verlag London Limited.

[20] KESHTEGAR, B.; MENG, Z. 2017. A hybrid relaxed first-order reliability method for efficient structural reliability analysis, Structural Safety. 66, 84–93. https://doi.org/10.1016/j.strusafe.2017.02.005

[21] ROUDAK, M.; SHAYANFAR, M.; BARKHORDARI, M.; KARAMLOO, M. 2017. A robust approximation method for nonlinear cases of structural reliability analysis, International Journal of Mechanical Sciences. 133, 11-20. https://doi.org/10.1016/j.ijmecsci.2017.08.038

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.7

A new approach for compounding system integration risks with system maturity: A supporting methodology in the selection of candidate architectures for a system

Hadler Egydio da Silva[1], Leonel Fernando Perondi[2]

[1]SEGPR Department, National Institute for Space Research (INPE), São José dos Campos - São Paulo / Brazil
Email: hadler.silva@inpe.br
[2]National Institute for Space Research (INPE), São José dos Campos - São Paulo / Brazil
Email:leonel.perondi@inpe.br

Received: 12 Apr 2022,

Received in revised form: 26 Apr 2022,

Accepted: 02 May 2022,

Available online: 14 May 2022

***Keywords*— Architecture Selection, Risk Assessment, SRL, RWIRL, RWSRL.**

***Abstract*—*Integrating a space system is an iterative process aimed at assembling the system according to user requirements and demonstrating through tests that the system is apt to operate in the target environment. The integration effort varies from system to system, and there is no standard methodology for its accomplishment. Researchers have proposed different approaches and metrics to estimate the effort associated with integrating a system. Sauser introduced the concept of an integration readiness level metric (IRL) for a system as a maturity assessment of the integration effort. This methodology parallels the technology readiness level (TRL) introduced by NASA in the 80s to assess the maturity of new technologies in a space system. The authors propose a methodology for the risk assessment of a system's internal interfaces that translates and quantifies the perception of work teams about the challenges involved in the integration of a system. It consists of a structured survey of specialized opinion among project technical personnel to capture relevant technical and programmatic risks related to integrating system elements. The framework is designed to support the processes associated with choosing a system architecture. Although proposed for application in the early phases of the life cycle of a space system project, there are no restrictions on its application to different projects and life cycle stages. Applications include ranking systems components and interfaces according to readiness level and integration risks, supporting risk management in conventional risk management processes and supporting risk-informed decision-making processes to select system architectures.*

I. INTRODUCTION

1.1 Context

Assessing the maturation of both new technologies and their interfaces in a system is critical to the success of advanced development projects. The attendance of performance, schedule and budget requirements are central to project execution.

Between phases 0 and B of the life cycle of a space project, the project team carries out the following tasks: definition of mission requirements, identification of architecture concepts, feasibility analysis, identification of

activities and resources, evaluation of initial technical and programmatic risk, elaboration of technical and functional requirements, among others. During these phases, the decisions that commit a large part of the project's resources occur.

Early identification of the risks and uncertainties of these decisions may avoid critical failures affecting performance, schedule, or budget. In the initial phases, thus, managers shall have the necessary technical support for identifying risks and putting in place strategies for minimizing them, mainly the risks that have the potential for adverse developments in performance, cost, and schedule.

A study carried out by Reeves et al. [1] with two National Aeronautics and Space Administration (NASA) projects has shown that among 135 identified risks, most are internal to the project. Many of these risks are usually related to technical activities, including system integration. The study demonstrates the importance of decision-making in a project, mainly in the initial phases.

Risk management methodologies may vary from one organization to another. NASA preconizes the practice of risk-informed decisions in all instances that affect the security, performance, cost, and execution time of a mission[2].

Among the decisions mentioned above, the choice of the system architecture deserves special attention. The option for a given architecture presents long-lasting repercussions in a project and should be carried out within the best available technique and information. The main architecture challenges that have the potential to impact performance, cost, and time must be identified and mapped. Among them, one finds the definition and selection of the architecture's constituent parts and the difficulties posed by their integration.

The integration of a space system is an iterative process, with a significant number of concurrent tasks carried out by a multidisciplinary team, aimed at assembling the system according to user requirements and, at each stage, demonstrating through tests that the system is apt to operate in the target environment. The integration effort may vary from system to system, and there is no standard methodology for its accomplishment.

Researchers have proposed different frameworks and metrics to estimate the maturity of system components and interfaces. In general, such metrics attempt to quantify the integration effort and the maturity of the whole set of interfaces. In this line, Sauser et al. [3] introduced the concept of an integration readiness level metric (IRL) for a system. This methodology parallels the technology readiness level (TRL) metric introduced by NASA in the 80s[4] to assess the maturity of new technologies in a space system.

Researchers have dedicated significant effort to developing methodologies to identify and quantitatively define the risks associated with the evolution of the maturity of the elements of a system. Often, difficulties regarding the technological advancement of system components and interfaces and their subsequent infusion may result in schedule delays, cost overruns, cancellations, or failures[5].The Research and Development Degree of Difficulty (R&D3) metric[6, 4]estimates the probability of failure of an R&D project. Together with the TRL assessment of the project, which in the methodology gets related to the impact of the project's failure, the R&D3 metric provides the necessary input elements for a project's risk management. The Advanced Degree of Difficulty Assessment (AD2) framework [5] extends the above approach. It considers the scenario of the project of a system. It attempts to provide basic information for the project's Technology Development Plan and improve the management of the projects' cost, schedule, and risk [7].

This article explores a methodology for assessing integration risks, which shows similarity to the AD2 framework. It ponders integration maturity indices with risk factors, aiming at translating and quantifying the perception of work teams about the challenges accruing the integration work of a system.

1.2 Problem

Risk identification is commonly undertaken during the early design phases but often fails to identify all events and circumstances that challenge project performance. Risk events associated with the maturation of the technologies considered during the design of a system and those associated with system integration may have significant repercussions on the cost and schedule of the corresponding project. Therefore, it is imperative to (a) identify the maturity level of technologies and interfaces, (b) identify the risks associated with the maturation of the technologies and interfaces that have a maturity level below that defined as a minimum for infusion in the project and (c) identify the risks associated with the integration of the system and its elements. For instance, NASA's projects for space systems require a minimum TRL index of 6 for all technologies and interfaces belonging to a system baseline architecture[8, p. 1].

In project communications, managers should emphasize attributions, interaction, integration, and reliability. Otherwise, significant problems are more likely to occur, especially those linked to interfaces [9].

The problems that this work proposes to address may be summarized as follows:

a) the mismatch between expectations of project managers and work teams about the resources required to deal with the integration of system elements;

b) lack of identification or poor understanding of the risks related to schedule and cost that the decision-maker is accepting when adopting a specific system architecture solution;

c) lack or insufficiency of communication when considering competing alternatives and their associated risks.

1.3 Objective

In this article, the authors propose an interface risk assessment methodology that weighs integration maturity indices with risk factors, with the latter conveying the perception of work teams about the challenges and risks involved in the integration of a system.

The methodology consists of a structured way of capturing a broad spectrum of technical and programmatic risks related to integrating system elements. The proposed risk assessment methodology will, in principle, be capable of addressing the technical and programmatic difficulties foreseen in the integration of a system.

The generated information will aid project managers when comparing different architectural solutions since most of the architecture problems, potentially impacting both cost and time, will, in principle, have been brought to light. The information will also assist managers in design decision-making and purchase decisions, such as selecting sources for acquiring equipment or subsystems.

II. LITERATURE REVIEW

The TRL index measures the maturity of individual system technologies at a given time in a project. Its computation at different phases of a project enables an assessment of the evolution of the work performed throughout the project's phases. In the development and production of flight systems, TRL assessments are usually carried out until the end of Phase B. Afterwards, data from the engineering, qualification, and flight models at different system levels typically provide enough information for assessing the maturity evolution of technologies [10, p. 15].

NASA adopted a seven-level Technology Readiness Level (TRL) metric to assess the development of a particular technology in the 1980s [11].The metric evolved into the current nine levels metric in the 1990s. Since then, the TRL methodology has been widely used at NASA as a systematic metric/measurement system to assess the maturity of a particular technology and enable the ranking of different technologies concerning their maturity[8].

According to the prescription by NASA [12, p. 3], typically, new technology conception takes place from TRL 1 to 3, and development and demonstration from TRL 4 to 6. After reaching TRL 6, new designs would follow the usual engineering development cycle, which involves building and testing engineering and qualification models. After qualification, the system reaches a readiness level for flight with a TRL 8 level assignment. After successful launching and in-orbit operation, the system is finally assigned a TRL 9 level.

The measure provided by the TRL methodology may have different applications: project internal communication; setting of a target/success criterion; project planning; technology selection; communication or establishment of integration arrangements; portfolio management; cost estimation; risk indicator; and guide or measure for engineering development before Preliminary Design Review (PDR)[10]. Fig. 1displays the process currently commended by NASA for TRL assessment at a given project instant. Space projects typically involve a blend of either existing, evolving, or advanced technologies [13].

The TRL of a system technology does not measure the difficulty of integrating this technology into an operational system [13, 14]. TRL is a measure of the maturity of individual technology. The maturity assessment of several technologies integrated into a system is not given by a trivial composition of the individual TRLs. Knowledge of individual TRLs does not provide insight into the components' integration maturity or the resulting system's overall maturity. Yet complex systems have an appreciable chance of failing at integration points [15].

The question of computing the maturity of a system from the maturity of its component technologies, including system-specific characteristics, such as integration maturity, has received significant attention. The proposed frameworks vary in how the TRL of system individual technologies are compounded with measures of system-specific characteristics, such as integration and manufacturing readiness, to produce a whole-system readiness level. NASA preconizes the TRL of a system as being determined by the lowest TRL present in the system [12, p. 26]. The European Cooperation for Space Standardization (ECSS) equally preconizes that "… *a TRL can only be reached by an element if all of the sub-elements are at least at the same level* …"[16, p. 17]. Sauser et al. [8] introduced the concept of System Readiness Level (SRL),which gives the maturity of a system as a composition of the maturity of the system

components with the maturity of the interfaces between the components. The latter is given by a matrix, termed integration readiness level (IRL) matrix, having as its elements the maturity assessment of each interface between pairs of technologies. Just as the TRL is used to assess the maturity of developing technologies, the IRL is used to assess the maturity of integrating these technologies. Formally, the SRL is computed as a composition of the IRL and TRL metrics [8, 17, 18]. The IRL scale has evolved over the last decade, with the most recent improvements published by Austin and York [19, 20]. More specific studies aimed at understanding the SRL dependency or sensitivity on a given component technology, in terms of this technology's impact on the readiness, cost, and overall performance of the system, are provided by Gove et al. [21].

There has been a great deal of discussion regarding a proper definition and method of computation of the SRL index of a system, with the publication of several different proposals [22, 23, 24, 25, 26, 27]. In particular, Ross [27] has proposed a framework that differentiates between the technology readiness level of an isolated technology and its maturation status concerning insertion in a given system. The readiness level of a given technology is taken as dependent on the target system's maturity characteristics considered for its insertion, such as its integration maturity. In this framework, the TRL of each component technology is multiplied by indices, with values between zero and one, measuring component promptness for integration and manufacturing. The whole-system maturity readiness level is then taken as the average of the computed maturity levels of the system components.

The TRL assessment at different project milestones gives an overview of technology maturity progression towards a planned application. However, the knowledge of TRL values at varying instants of the life cycle does not provide enough information for assessing technology development risks [10, p. 40].Differences in TRL indices do not measure either the effort or the risk involved in moving from one TRL level to the next in an R&D development [4, 10, p. 40]. Hence, other metrics have been proposed to assess technology risks and effort for progression in a project.

Mankins [6, 4] has proposed the Research and Development Degree of Difficulty (R&D3) metric, which gives a qualitative estimate of the probability of failure for an R&D project with an assignment scheme containing five difficulty levels. The approach proposed by Mankins, termed Technology Readiness and Risk Assessment (TRRA), combines the R&D3 probability with a qualitative estimate of the impact of project failure (F). Using the pair (R&D3, F), a diagram like the probability x impact matrix in risk management is constructed. Risk classification for technology maturation is then implemented, as illustrated in Fig. 2. The impact of project failure is taken as proportional to the difference between the current and target TLR, multiplied by a factor referred to as Technology Need Value (TNV), which gives a measure of the expected impact of a failure in making the considered technology available for future programs. The TRRA framework considers the scenario of a technology project inside an R&D program. The framework must be adapted in several ways when considering the scenario of the project of a system that involves innovative technologies, such as developing and manufacturing a satellite. There is, for instance, the parallel development of different technologies to be integrated into the system, changing TNV assessment definitions.

The Advanced Degree of Difficulty Assessment (AD2) methodology by Bilbro [5] expands theR&D3 scheme by combining the information from several maturity level metrics, such as Integration Readiness Levels, System Readiness Levels, Manufacturing Readiness Levels, and others. In the AD2 methodology, the number of difficulty levels is increased from five to nine, in line with the current TRL scale.

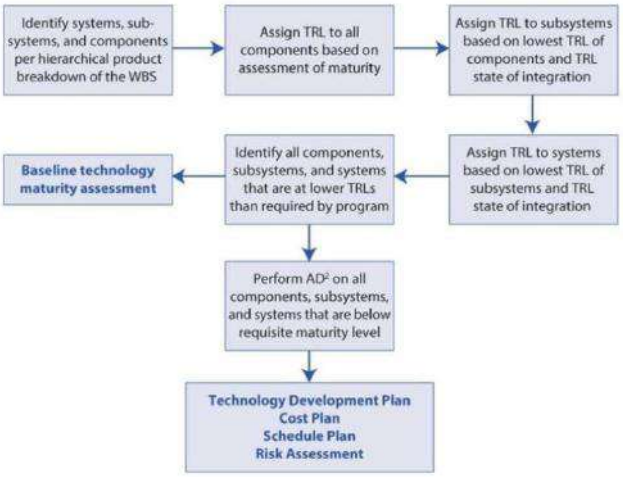


Fig. 1: Recommended NASA technology assessment process [28]

The AD2 framework considers the scenario of developing a system with a broad range of possibilities regarding the component technologies, from new developments to the partial or total reuse of heritage technologies.

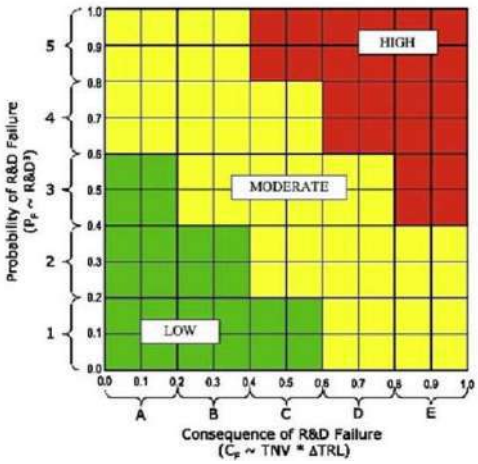


Fig. 2: Mankins [4]. A typical result of the Technology Readiness and Risk Assessment (TRRA) methodology. Each technology is characterized by a point in the diagram. Regions with different colors provide the risk classification for each technology

The system architecture defines the system's physical building blocks in terms of functions and interfaces. The project team chooses the system architecture by the end of Phase A and the beginning of Phase B. Usually, there are two or more paradigmatic proposals. For each proposal, several possible variants spring up from the possibilities opened by, for instance, alternative technologies, make or buy tradeoffs, reuse of equipment or subsystems, alternative subsystem or equipment providers, and so forth. Careful system decomposition and decision-making processes are normal activities at this stage, which precedes the system requirements review (SRR) when subsystems' preliminary design receives full attention. After the SRR, decomposition and decision-making processes are still regular activities, but now at the subsystem level.

To support decision-making processes and control and monitor the project's progress during these phases, engineering managers usually make use of different metrics, which may be used as input both for RIDM processes and the evaluation of the preliminary and critical design efforts. The metric of Technology Readiness Level has been successfully applied within this context in different organizations, mainly to assess the maturity of technologies envisaged for incorporation into a system or subsystem[29, p. 281]. The TRL index gives the readiness or maturity of a single equipment/technology at a given time instant. The index results from an assignment by qualified personnel using a standard TRL scale.

RIDM processes are carried out whenever decisions involve high stakes, complexity, uncertainty, multiple attributes, or diversity of stakeholders [30]. They are conducted with the intervenience of subject experts, technical authorities, stakeholders, and the decision-maker [30].

Risk management methodology may vary from one organization to another. At NASA, risk management is an integral part of the Systems Engineering process[28]. It emphasizes the use of risk analysis in a broad sense, promoting the practice of risk-informed decisions in all instances that affect the security, performance, cost, and execution time of the mission.

The NASA Risk Management Process (RM) integrates two complementary processes in a single framework: Risk-Informed Decision Making and Continuous Risk Management (CRM). The RIDM process addresses the selection of a given alternative among a set of options based on the qualitative and quantitative (probability) assessment of each choice by a qualified panel to ensure the selection process achieves performance objectives. The RIDM process is applicable throughout the project life cycle whenever critical tradeoff decisions, such as architecture and design decisions, make-buy decisions, source selection in significant procurements, and budget reallocation, are demanded [30, p. 13]. The CRM process deals with the selected alternatives' risk management, planning actions to mitigate and control the associated risks, and avoiding performance shortfalls[30, p. 14].

Table. 1 gives a brief description of different studies and corresponding references concerning the concepts of TRL, SRL, and risk associated with technology maturation in a project/program.

Table. 1: Assessment techniques

Study	Description
TRL Schedule Risk Curve	This quantitative model does not communicate the maturity of technology at a certain point in time but instead leverages the TRLs metric to identify the appropriate schedule margins associated with each TRL level to mitigate schedule slips [31].
SRL Max	The SRL Max is a quantitative mathematical model aiming to maximize the SRL under constraint resources. The SRL MAX's objective is to achieve the highest possible SRL based on the availability of resources such as cost and schedule [32].
Advanced Degree of Difficulty (AD2)	Leveraging the concept of RD3, the AD2 augments TRLs by assessing the difficulty of advancing technology from its current level to the desired level on a 9-tier scale [33].

Research And Development Degree of Difficulty (RD3)	The RD3 is a 5-level scale intended to supplement the TRL by conveying the degree of difficulty in proceeding from the current TRL state to the desired level, with five being very difficult and one being the least difficult to mature the technology [6].
Technology Readiness and Risk Assessment(TRRA)	"*TRRA is a quantitative risk model that incorporates TRLs, the degree of difficulty (RD3) of moving a technology from one TRL to another, and Technology Need Value (TNV). The TRRA expands the concept of the risk matrix by integrating*" the "probability of failure" on the y-axis and the "consequence of failure" on the x-axis[34].

III. METHODOLOGY

3.1 Description of the proposed framework

We consider the situation of the project of a space system that incorporates new technologies during the end of Phase A and the beginning of Phase B, when decisions with long-lasting impact are to be taken, such as the definition of the system's architecture. The availability of TRL values at different instants of the project's life cycle does not provide information on the risks associated with technology maturation. It should be supplemented with risk assessments, making use, for instance, of such schemes as the AD2 framework.

The expression "architecture solution" in this article is defined as the set of specific elements (products Part Numbers) that make up the physical architecture. To compare different architecture solutions, we consider that an assessment of integration risks shall complement the TRL data of system components and the IRL data of interfaces; additionally, an evaluation of the technology maturation risks pointed out above should be available. Typically, these data are fed into RIDM processes that substantiate decision-making activities.

Analyses of the work of integrating each interface, considering all candidate equipment, shall focus, for each alternative, on the following points: the type of the integration, i.e., electrical, mechanical, thermal, signal, etc.; the risk of delays in the program; the risk of an increase of the initially estimated cost for the realization of the system; the identification of difficulties and challenges associated with each alternative.

This routine must be applied to the complete system, considering all supply options. In this way, a system integration risk assessment is produced for each architecture solution, giving visibility to the system compositions with the most significant potential for adverse developments regarding the performance of the work of integration, schedule, and cost.

The information gathered will typically make part of the input data package for the tradeoff study to select the most balanced system architecture, possibly within the scope of a RIDM process. Once a choice has been made among the options, the identified risks must be addressed and mitigated, typically in a project's CRM risk management process.

The integration risk assessment shall be carried out for all interfaces of each architecture configuration by specialists involved in the project and performed separately.

The assessment is carried out for a specially selected set of integration risks, chosen according to the experience of one of the authors (HES)in space projects and through interviews with systems engineering teams, specialist engineers, project managers, and Assembly, Integration, and Testing (AIT) teams of the Brazilian space program. They constitute a set of risks that cover most of the causes for cost and schedule increases in space systems development.

Table. 2 lists the selected risks in the format used in the assessment. The questions were designed in the form of an ordinal unipolar survey [35]. Each *general* risk event is unfolded into three excluding possibilities, with the leftmost possibility being taken as the *zero point* option. The *general* and unfolded risk options were carefully chosen to explore project integration risks localized in the relevant severity region highlighted in *Fig. **3***. The three possibilities are associated with different impacts of the corresponding *general* risk. Selection of the first option, referred to as *Negligible (N),* indicates that the assessor considers that the event associated with the stated *general* risk has a low likelihood or no chance of occurring. Selection of one of the other two possibilities, referred to as *Low (L)* and *Moderate to High* (*M/H*), indicates that the evaluator considers the risk relevant, with severity in the range from low to medium (option 2) or from high to extremal (option 3). The assignment of option 1 to a given risk indicates that the evaluator assesses its likelihood at less than 30%. Table. 3 shows the assumed likelihood levels[7].

Table. 2: Classification criteria of the expected difficulty in integration

	Risk Statement	Unfolded Risk Options		
		N - Negligible	**L - Low**	**M/H - Moderate to high**
Know-how 1	Given that the personnel belonging to the following teams: a) system, (b) manufacturing, and (c) integration might not entirely dominate the technological solutions to be employed in the interface integration, there might be unanticipated technical difficulties, adversely impacting the integration work, therefore leading to interface nonconformities and schedule and cost overruns.	The technological solutions to be employed in the interface integration are thoroughly dominated by the personnel belonging to the following teams: a) system, (b) manufacturing, and (c) integration team.	The technological integration solutions are not thoroughly dominated by the personnel of one of the following teams: a) system, (b) manufacturing, and (c) integration team.	The technological integration solutions are not thoroughly dominated by the personnel of at least two of the following teams: a) system, (b) manufacturing, and (c) integration team.
GSE 2	Given the limited state of knowledge about the use of ground support equipment and tooling in the interface integration effort, there is the possibility of unanticipated technical difficulties, adversely impacting the interface integration work, therefore leading to interface nonconformities and schedule and cost overruns.	There are no envisaged challenges regarding ground support equipment and tooling in the integration effort.	There are anticipated entry-level challenges regarding ground support equipment and tools in the integration effort.	There are anticipated moderate to high-level challenges regarding ground support equipment and tools in the integration effort.
Adaptation & Mastery 3	Given that the integration effort might require physical and/or logical adaptations and that the teams involved might not entirely dominate the technology for the necessary adaptions, there might be unanticipated technical difficulties and additional training, adversely impacting the interface integration work, therefore leading to interface nonconformities and schedule and cost overruns.	Any necessary physical (electrical, mechanical, etc.) or logical adaptations involve technological solutions available and thoroughly mastered by the teams involved in the effort to integrate the studied pair.	Any necessary physical (electrical, mechanical, etc.) or logical adaptations will likely involve technological solutions not entirely available or thoroughly mastered by the teams involved in the effort to integrate the studied pair.	Any necessary physical (electrical, mechanical, etc.) or logical adaptations will highly likely involve technological solutions not either available or dominated by the teams involved in the effort to integrate the studied pair.
Task Volume 4	Given that the workload for the mechanical/electrical/logical integration of the interface elements might not be accurately predicted, there might be unanticipated delays, adversely impacting the allocation of personnel to the integration work, therefore leading to schedule overruns.	The workload foreseen by the teams involved in the mechanical/electrical/logic integration of the interface elements is considered very low.	The workload foreseen by the teams involved in the mechanical/electrical/logic integration of the interface elements is considered low.	The workload foreseen by the teams involved in the mechanical/electrical/logic integration of the interface elements is considered moderate or high.
Training 5	Given the possibility of limited knowledge by the personnel from the evaluator's team about training necessities in the face of the scope of the integration work, there might be unanticipated training necessities, adversely impacting the allocation of personnel to the integration work, therefore leading to schedule and cost overruns.	From the perspective of the evaluator's team, the scope of the integration work is well known, and it is highly unlikely that additional training of the personnel will be necessary.	From the point of view of the evaluator's team, the scope of the integration work is reasonably known, and additional, low-complexity training for the teams involved will be required.	From the point of view of the evaluator's team, the scope of the integration work is not thoroughly known, and additional training of moderate to high complexity for the teams involved will be required.
Nonconformance 6	The history of non-conformities and recurrences associated with the technological solution for the integration of the studied pair might indicate the possibility of difficulties in the interface integration work that will lead to time and cost overruns depending on its level of recurrence.	The history of nonconformities and recurrences does not suggest difficulties in the integration work associated with the interface.	The history of nonconformities and recurrence suggests the possibility of difficulties in the integration work associated with the interface.	The history of nonconformities and recurrence strongly suggests the possibility of difficulties in the integration work associated with the interface.

Interface Requirements 7	Given the limited knowledge about the completeness of the technical requirements set, there is the possibility of the need for additional physical and logical requirements, negatively impacting the integration work, leading to time and cost overruns.	The requirement analyses indicate that it is highly unlikely that additional physical (mechanical, electrical, etc.) or logical requirements will be needed during the integration work.	The requirements analyses indicate a low probability that additional physical (mechanical, electrical, etc.) or logical requirements will be needed during the integration work.	The requirements analysis indicates a moderate to high probability that additional physical (mechanical, electrical, etc.) or logical requirements will be needed during the integration work.
Verification Approach 8	Given the current state of knowledge about the scope of the necessary verification work, there might be unanticipated additional analyses and tests associated with the verification effort, adversely impacting the integration work, therefore leading to schedule and cost overruns.	Considering that the scope of the verification work is well-known, it is highly unlikely that additional analyses and tests associated with the verification effort will be necessary.	Considering that the scope of the verification work is reasonably known, there is a low probability that additional analyses and tests associated with the verification effort will be necessary.	Considering that the scope of the verification work is poorly known, there is a moderate to high probability that additional analyses and tests associated with the verification effort will be necessary.
Complexity 9	Given the current state of knowledge about the complexity of the adopted integration technology, there might be an unanticipated increase in the workload and training necessities, adversely impacting the allocation of personnel to the integration work, therefore leading to technical nonconformities and schedule cost overruns.	Considering that the adopted integration technology shows very low complexity, it is highly unlikely that there will be an unanticipated increase in the workload and training necessities.	Considering that the adopted integration technology shows low complexity, it is likely that there will be an unanticipated increase in the workload and training necessities.	Considering that the adopted integration technology shows moderate to high complexity, it is highly likely that there will be an unanticipated increase in the workload and training necessities.

For example, Table. 4 shows the unfolding of the first general risk listed in the first column in Table. 2 into three event possibilities with different impacts. The leftmost option corresponds to the assessment that the risk has a low likelihood or is not applicable. The other options correspond, by design, to the judgment that the risk is relevant, from likely to near certainty chance and severity in the range highlighted in Fig. 3.

	1 Minimal	2 Minor	3 Moderate	4 Significant	5 Severe
1 - Not likely	**1**	**2**	**3**	**4**	**5**
2 - Low likelihood	**2**	**4**	**6**	**8**	**10**
3 - Likely	**3**	6	9	12	15
4 - Highly likely	**4**	8	12	16	20
5 -Near Certainty	**5**	10	15	20	25
Risk Rating	**Minimal 1 - 2**	**Low 3 - 9**	**Medium 10 - 15**	**High 16 - 20**	**Extremal 25**

Fig. 3: Risk classification used in the proposed framework. The highlighted region of the diagram shows the severity (probability x impact) region of the considered risks in the proposed framework

Table. 3: Likelihood levels

Level	Likelihood	Probability of Occurrence
1	Not likely	~ 10 %
2	Low likelihood	~ 30 %
3	Likely	~ 50 %
4	Highly likely	~ 70 %
5	Near Certainty	~ 90 %

An example of a typical evaluation form is given in Table 5. The line *Frequency* gives the proportion of each option *N*, *L*, and *M/H* in the form. The line *Weighting factors* list the weight values for each option; they shall be conveniently defined for the computation of a *weighted average*, which will be taken as a measure of the *riskiness* of the integration work associated with the concerned interface, as will be discussed ahead.

From the filled forms, important information, which expresses the specialized opinion of the project team responsible for most of the integration work's scope, may be extracted from simple statistics. For each selected risk *m* and interface *q*, by computing overall numbers from all forms *l*, one obtains the fraction of options *0* as given by:

$$y_{mq}^{o}=\frac{1}{N_a}\sum_{l=1}^{N_a} Y_{mql}^{o}, \quad (1)$$

$$o \in\{N, L, M/H\},$$

$$m \in\{1, 2, \ldots, 9\},$$

$$q \equiv \textit{interface identificator},$$

where Y_{mql}^{o} is equal to 1 if the evaluator has chosen option *o*, in the form *l*, for the risk *m*; otherwise Y_{mql}^{o} is equal to 0; N_a is the number of filled forms for the interface *q*.

Table. 4: Possible impacts which may emerge from the first risk listed in Table. 2

RISK STATEMENT: *Given that the personnel belonging to the following teams: a) system, (b) manufacturing, and (c) integration may not fully dominate the technological solutions to be employed in the interface integration, there is the possibility of unanticipated technical difficulties, adversely impacting the integration work, therefore leading to interface nonconformities and schedule and cost overruns.*		
Impact		
Negligible or not applicable	2 - 3 (Minor to Moderate)	4 – 5 (Significant to Severe)
The technological solutions to be employed in the interface integration are thoroughly dominated by all the following teams: a) system, (b) manufacturing, and (c) integration.	The technological solutions to be employed in the interface integration are not thoroughly dominated by one of the following teams: a) system, (b) manufacturing, and (c) integration.	The technological solutions to be employed in the interface integration are not thoroughly dominated by two or more of the following teams: a) system, (b) manufacturing, and (c) integration.

Table. 5: Example of an integration risk evaluation form. The numbered lines are in correspondence with lines in Table. 2. The meaning of the acronyms is as follows: N for Negligible, L for Low, and M/H for Moderate to High

Case study identification:			
Evaluator identification:			
Identification of the interface/integration:			
Equip. A:	Equip. B:		
Criteria	N	L	M/H
1 - Know-how	X		
2 - GSE		X	
3 - Adaptation & Mastery			X
4 - Workload		X	
5 - Training	X		
6 - Nonconformance		X	
7 - Interface Requirements			X
8 - Verification Approach		X	
9 - Complexity	X		
Frequency (%) (100 x)	3/9	4/9	2/9
Weighting factors	W_N	W_L	W_{MH}
Criterion's weight	$3W_N$ /9	$4W_L$ /9	$2W_{MH}$ /9

The expression:

$$I_{mq} = W_N y_{mq}^{N} + W_L y_{mq}^{L} + W_{M/H} y_{mq}^{M/H}, \quad (2)$$

gives an index, with values between W_N and $W_{M/H}$, expressing the severity of each considered risk. For I_{mq} near W_N, the risk is considered negligible or non-existent, while for I_{mq} near $W_{M/H}$, the risk is considered severe. By using these indices, it is possible to rank, for each interface *q*, the risks *m* according to their relevance. In this way, from the assessments carried out by each specialist, one obtains the set of risks that the specialized project team considers most critical in the project's system integration effort. The collection of integration risks ranked according to the index I_{mq} provides an easy and convenient way of communicating integration risks across the whole project hierarchy.

It would also be desirable to consolidate the information through a representative index for each configuration. This possibility would enable a ranking of the solutions and facilitate communication in selecting a system architecture. Some of the options are discussed below.

Typically, the project team will have at its disposal, for each possible architecture, the information condensed in Table. 6.

Table. 6: Available information for each system configuration

Equipment	Interfaces	Maturation Risks	Integration Risks
TRL for each piece of equipment.	IRL for each interface, considering the different integration types (E, M, T, D/C).	Risks related to the maturation of the technologies of components and interfaces; usually identified and characterized by an AD2 analysis.	Most relevant integration risks, for each interface, considering the different integration types (E, M, T, D/C).

As reviewed in Section II, the concept of a system readiness level, SRL, formed from the TRL and IRL values of system components and interfaces, is usually taken as a measure of the readiness level of the whole system. There are different proposed methods for the computation of the *SRL* index. This measure should be supplemented by a risk analysis, which is usually undertaken under the AD2 methodology preconized by NASA. The AD2 method has been designed to identify and characterize the risks associated with upgrading a system, subsystem, or component from a given TRL to a higher one. The AD2 methodology focuses on the following risk areas: design and analysis, manufacturing, software development, testing, and operations. The framework proposed in this work may be interpreted as proposing that the AD2 methodology be complemented by a risk analysis dedicated to identifying and characterizing the risks associated with the integration of a given system configuration, providing, in principle, an additional set of risks that complements the set of risks provided by the AD2 methodology.

A measure of the integration risk for each architecture may be constructed as follows. For each interface and integration type, a Technical Difficulty Factor (TDF) is computed from the fractions of N, L, and M/H assessments in the complete set of responses as:

$$freq_q(o) = \left(\frac{1}{N_a}\right)\sum_{l=1}^{N_a}\left(\frac{1}{9}\right)\sum_{m=1}^{9} Y_{mql}^{o}, \quad (3)$$

$$freq_q(o) = \left(\frac{1}{9}\right)\sum_{m=1}^{9} y_{mq}^{o}, \quad (4)$$

$$TDF_q = freq_q(N) * W_N + freq_q(L) * W_L + freq_q(M/H) * W_{M/H}\ , \quad (5)$$

where Y_{mql}^{o} has been defined in (1), N_a is the number of filled forms, $freq_q(o)$ gives the fraction of options o for the interface q considering all forms and risks, and q designates the different interfaces, including the multiplicities introduced by the different integration types. The index TDF_q, with values between W_N and $W_{M/H}$, expresses the severity of each considered risk on the integration of interface q: the larger the value of TDF_q, the larger the chance of difficulties in the integration of interface q, according to the project team. It gives a measure of the risk affecting the integration work associated with interface q. The set of interfaces ranked according to the index TDF_q providesan ordered list of the interfaces that the specialized project team considers most critical in the project's system integration effort. Similarly, as the index I_{mq} facilitates integration risk communication, the index TDF_q provides a straightforward way of communicating to the project hierarchy which interfaces are considered critical in the integration effort.

Averaging, now, the index TDF_q over all interfaces:

$$TDF = \left(\frac{1}{Q}\right)\sum_{q=1}^{Q} TDF_q\ , \quad (6)$$

where Q is the number of interfaces, including the multiplicities introduced by the different integration types, defines an index with values between W_N and $W_{M/H}$ that gives a measure of the overall integration risk of the configuration for which it has been computed. Hence, ordering the studied architectures according to the corresponding values of *TDF* provides a ranked list of the architectures, from riskiest to least risky, according to the assessment of the specialized project team. Hence, the *TDF* index offers a straightforward way of communicating to the project hierarchy which architecture is considered most risky regarding the integration effort.

The indices I_{mq}, TDF_q and TDF provide information regarding the risks associated with the integration effort of each system architecture. In contrast, the indices *TRL* and *IRL* provide information regarding the maturity of equipment and interfaces, respectively. Next, a proposal for the composition of these metrics is discussed.

The interface attributes expressed by IRL_q and TDF_q provide a measure of the maturity and the integration risk associated with interface q, respectively. While the IRL_q index may be used to rank interfaces according to their maturity, the TDF_q index may be used to rank interfaces according to their integration risk. One question that naturally arises at this point is how to rank the system interfaces by composing the two attributes IRL_q and TDF_q. The problem of ranking a variable with multiple attributes has received much attention [36, 37, 38]. In most applications, a weighted multiplicative scoring is considered more reliable than a weighted additive scoring

[38].Along this line, a possible index for ranking interfaces, based on the attributes of maturity and integration risk, may be constructed from a multiplicative scoring function involving the indices of the corresponding attributes.

An appropriate function, with equal weight exponents for both attributes, may be expressed as:

$$RWIRL_q = IRL_q \; x \; (W_N + \; W_{M/H} \; - TDF_q), \qquad (7)$$
$$IRL_q \; \in \{1, 2, \dots, 9\},$$

where q designates the considered interface.

The scale for *TDF* has been reversed, aligning both attributes so that the value of the proposed index increases with increasing maturity and decreasing integration risk.

The $RWIRL_q$ index shall be used exclusively for ranking purposes. It may be considered as giving for interface q, at a given instant, a composite measure of both integration maturity and severity of perceived risks for its integration.

Using the $RWIRL_q$ indices, it is possible to rank the interfaces according to their relevance in terms of maturity and integration risks. The set of interfaces ranked according to the index $RWIRL_q$ provides a convenient way of communicating the most critical interfaces, regarding maturity and integration risks, to the project hierarchy.

Averaging, now, the index$RWIRL_q$over all interfaces:

$$RWIRL\_int = \left(\frac{1}{Q}\right) \sum_{q=1}^{Q} RWIRL_q \; , \qquad (8)$$

introduces an index that gives a measure of the overall integration maturity and integration risks associated with the considered system architecture. The risk-weighted interface readiness level index,$RWIRL\_int$,is a system-wide index that combines overall interface maturity with overall interface integration risk. It may have relevance in a decision-making process dedicated to selecting a system architecture.

Next, along the same lines, we discuss the definition of a system-wide index that incorporates the maturity of the components that define the system architecture.

Following the previous discussion, a weighted multiplicative scoring is defined for each equipment based on the attributes of (a) maturity of the equipment, (b) maturity of the equipment's interfaces, and (c) the interfaces' integration risk. Since a piece of equipment may have more than one interface, a possible scoring function may consider an average for the interfaces, as given by:

$$\overline{RWSRL_i} = TRL_{\,i} \; x \; \frac{1}{Q_i} \sum_{j \neq i} IRL_{ij} \; x \; (W_N + \; W_{M/H} \; - \; TDF_{ij}), \qquad (9)$$

$$= TRL_i \; x \; \overline{RWIRL_i}, \qquad (10)$$
$$TRL_i \; \in \{1, 2, \dots, 9\},$$
$$IRL_{ij} \; \in \{1, 2, \dots, 9\},$$

where:

$$\overline{RWIRL_i} = \frac{1}{Q_i} \sum_{j \neq i} RWIRL_{ij} \; , \qquad (11)$$

the pair *(ij)* labels interfaces in the system, identified through the system elements between which the interface exists, Q_i is the number of interfaces of element *i*,$IRL_{ij}$is the maturity of the interface between elements *i* and *j*, TDF_{ij} is the technical difficulty factor for the interface between elements *i* and *j*, and $TRL_i$is the technical readiness level of element *i*. A note on the convention is in place. Interfaces will be identified either through a simple ordinal index q or by a pair of indices (*ij*) indicating the system elements between which the interface exists. Thus, if q labels the interface between system elements *i* and *j*, both$RWIRL_q$ and $RWIRL_{ij}$ designate the same index corresponding to the interface between elements *i* and *j*. The same holds for the indices IRL_q and TDF_q. In (7), a prescription like the one followed by Ross [27]for the association of interface maturity with a system element has been observed: for a given system element *i*, the average of the indices $RWIRL_{ij}$,associated with the interfaces of element *i*, referred to as $\overline{RWIRL_i}$, has been taken as an "average" interface attribute associated with the element *i*. The index $\overline{RWIRL_i}$ may be used to rank equipment according to its interface maturity and the perceived difficulty of its integration into the system.

Like the previous indices, the index $\overline{RWSRL_i}$shall be used exclusively for ranking purposes. The index applies to system elements and may be considered as giving, at a given instant, a composite measure of (a) equipment maturity,(b) integration maturity of the equipment's interfaces, and (c) severity of perceived integration risks associated with the equipment's interfaces. Hence, through the $\overline{RWSRL_i}$ indices, it is possible to rank system architecture elements according to their relevance in terms of the aforementioned three elements' attributes.

An index that compounds, at a system level, the attributes of (a) maturity of the system's equipment, (b) maturity of interfaces, and (c) risk associated with the integration of interfaces may then be defined by:

$$RWSRL = \left(\frac{1}{n}\right) \sum_{i=1}^{n} \overline{RWSRL_i}, \qquad (12)$$

where n is the number of system elements. The *RWSRL* index is defined for each system architecture. It may be relevant in a decision-making process dedicated to selecting a system architecture when it may be employed to rank different architectures.

Similarly, an index that compounds interface maturity and equipment integration risk for a given system configuration may be defined as:

$$\overline{RWIRL} = \left(\frac{1}{n}\right)\sum_{i=1}^{n} \overline{RWIRL}_i \,. \qquad (13)$$

Both the indices $RWIRL_int$and $\overline{RWIRL}$ compound the attributes of interface maturity and interface risk of integration at a system level. The difference between them lies in the fact that while $RWIRL_int$is computed over all interfaces indistinctly, the index $\overline{RWIRL}$ iscomputed considering the partitioning of the interfaces among the system components, as seen from (11). The latter index, thus, depends on the configuration of the system and is, in principle, a more appropriate measure for ranking configurations according to interface maturity and perceived risk of integration of the configuration.

3.2 Step-by-step procedure for application of the proposed framework

Fig. 5 gives the methodology's step-by-step process to obtain the RWSRL of each architectural solution and other indices. The following sections detail each step.

3.2.1 STEP 1

The technical team shall identify the equipment pieces in the system with more than one candidate supplier and all possible architectural solutions, considering the possible combinations of candidate equipment.

3.2.2 STEP 2

All interfaces between system elements are identified, possibly using an N-squared diagram (N^2). The technical team then classifies each interface according to the integration characteristics depicted in Table. 7.

Table. 7: A proposed classification scheme for interfaces

TYPE OF INTEGRATION	SUBTYPES	DESCRIPTION
Mechanical (M)		Comprises the mechanical joints and fastenings between the pairs of elements; geometries, mass property and stiffness matching, etc.
Electrical (E)	Power (P) Ground (G)	Comprises the supply of power (voltage and current) and grounding between the pairs of elements.
Thermal (T)		Comprises the heat exchanges (conduction and radiation) and thermal insulation between the pairs of elements.
Data and Command (D/C)	Data (D) Command (C)	Interface involving the exchange of digital data and analog signals, such as telemetry and telecommands.

The classification given in the table provides a sufficiently broad characterization that encompasses usual integration challenges. Depending on the system, it may be convenient to distinguish between subtypes of integrations, as shown in Table. 7. Building more than one N2 diagram may also be necessary when there is more than one way to provide the same function through a different arrangement of candidate equipment.

Fig. 4 gives an example of a system with four elements represented in an N2 diagram as a function of the integration types between each pair of elements. The acronyms are defined in Table. 7.

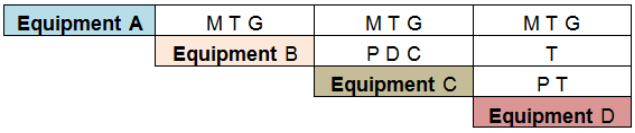


Fig. 4: Example of mapping integrations types

Legend: M- Mechanical; T-Thermal; P- Power; G-Electrical Ground; D- Data; C-Command.

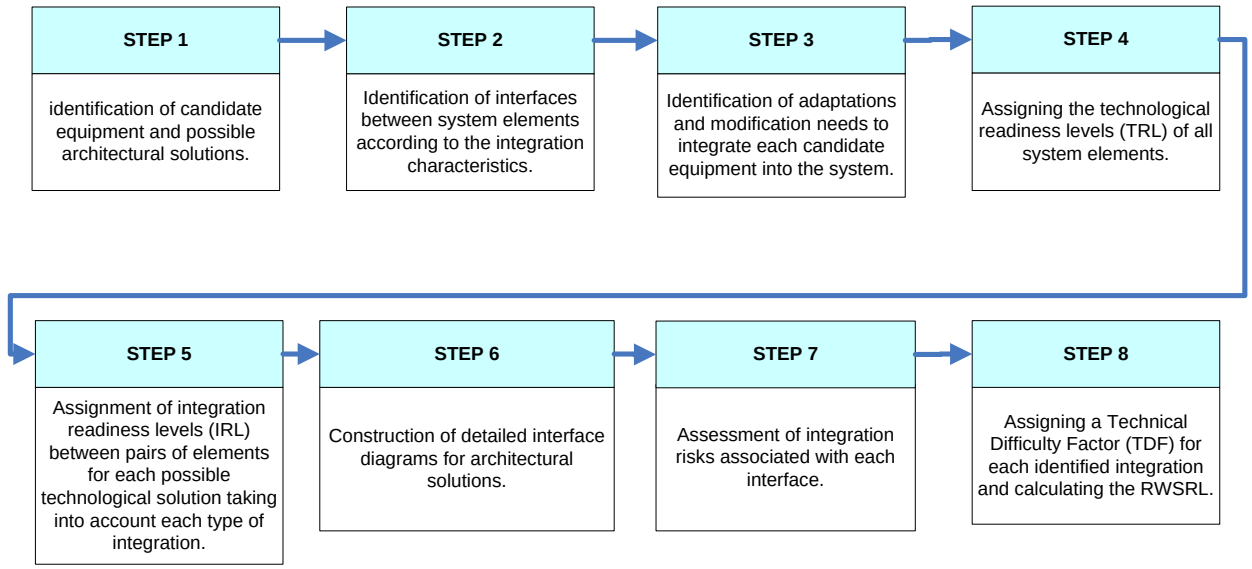


Fig. 5: Roadmap for using the RWSRL methodology

3.2.3 STEP 3

In this step, considering the requirements and preliminary design specifications, the technical team identifies adaptation and modification needs for integrating each candidate equipment into the system. Repercussions over other equipment and subsystems shall also be considered in this assessment. The need for further analysis addressing testing and modification of qualification status should also be contemplated. Usually, such studies are carried out by specialists in system engineering and assembly, integration, and testing (AIT) from the organization responsible for developing the system.

3.2.4 STEP 4

From the information gathered in Steps 2 and 3, the technical team shall assign a technology readiness level (TRL) index to the system components. According to the TRL philosophy, the TRL assessment gives the readiness level of each system element at a given moment of the project life cycle and for the environment prevailing at that moment [16, p. 15]. Hence, when the conditions holding at the time of a TRL assessment change, as in the case of equipment reuse in a different system, with eventual alterations in either the design, development process, targeted environment, or operations[16, p. 16], a reassessment of the *TRL* index will be necessary.

The TRL assignment may be carried out according to the classification given in Table. 8, which gives the ISO and ECSS standards for TRL classification.

Table. 8: ECSS-E-HB-11A [19] TRL scale

TRL	ISO 16290 standard
1	Basic principles observed and reported.
2	Technology concept and application formulated
3	Proof-of-concept
4	Component and breadboard ***functional verification*** in a laboratory environment
5	Component and breadboard ***critical function verification*** in a relevant environment
6	Model ***demonstrating the critical functions of the element*** in a relevant environment
7	***Model demonstrating the element performance for the operational*** environment
8	Actual system completed and ***accepted for flight ("flight qualified")***
9	Actual system "flight-proven" through successful mission operations

3.2.5 STEP 5

The technical team shall assign an interface readiness level (IRL) index to each identified interface, considering all possible architectures. The integration readiness levels (IRL) assignment for each interface type (M, E, T, and D/C), between each technology pair, shall consider the analyses carried out in Step 3. The assignment of an IRL index for each interface must be followed by evidence. Just as changes influence the TRL index, the IRL index is also susceptible to changes in the environment and must be

reassessed in the event of modifications. Hence, the same pair of technologies may display different IRLs, either as a function of the type of integration (M, E, T, or D/C) or due to varying choices of candidate equipment. In summary, all integrations mapped in STEP 2 and all architectural solutions must undergo an evaluation regarding their maturity index. An example of decision criteria for the IRL assignment is given in Table. 9.

3.2.6 STEP 6

The technical team shall construct detailed interface diagrams for each system architecture, considering the different interface classifications given in Table. 7 (M, E, T, and D/C). The charts will be employed in identifying and analyzing the technical difficulties associated with each interface in the following steps. Fig. 6 displays an example of interface diagrams for a four-element system.

3.2.7 STEP 7

The technical team shall assess the integration risks associated with each interface using the assignment criteria given in Table. 2. The risk assessment must be carried out by subject matter experts and performed separately for each specified architecture. The assignment procedure makes use of specialized opinion. The evaluator goes through the nine criteria given in Table. 2 and identifies the best assessment for each interface. This procedure must be performed for all mapped integrations in the system.

Table. ***5*** shows a typical assessment form.

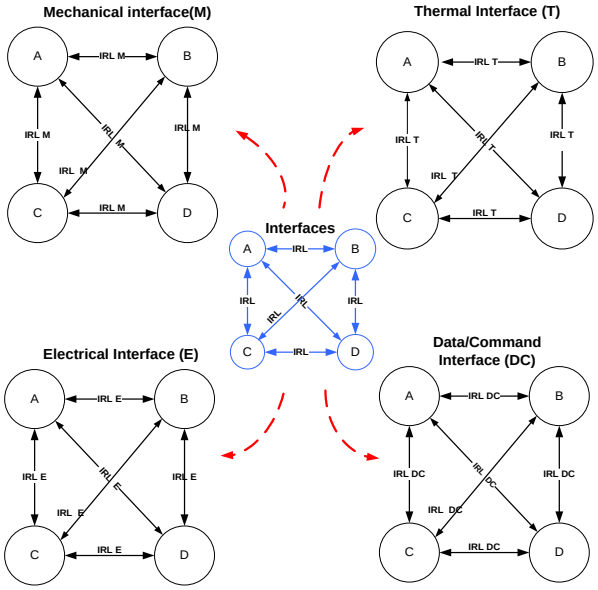


Fig. 6 Example of decomposition of integrations

All identified technical difficulties, with an assessment from *Low* to *Moderate or High* risk, must be accompanied by a brief description of the problem, from which the needs and magnitude of possible impacts, in terms of schedule and costs, may be assessed. Once a given architecture is chosen, these identified risks shall be treated and mitigated as part of the risk management of the technological solution selected.

3.2.8 STEP 8

In this step, the technical team shall compute the indices listed in Table. 10. The table lists indices whose rationale and form of computation are given in Section 3.1. All these indices are specific proposals of this article. The application of each index for ranking purposes is shown in the rightmost column of Table. 10.

We briefly review the methodology used to compute the TDF indices and their applications proposed in the present article. From each expert's assessment form, the frequencies of negligible (N), low (L), and moderate or high (M/H) assignments are computed. The TDF index for each interface is computed from the whole set of forms. The system-wide TDF index is then calculated as an average of the TDF indices for each interface. A new IRL matrix, referred to as the risk-weighted IRL matrix (RWIRL), is computed using (7).

Table. 9: Austin, M. F., & York, D. M. [19] Decision Criteria for Assessing Integration Readiness Level (IRL)

IRL	Definition	Evidence Description
0	No Integration	**No integration between specified components has been planned or intended.**
1	A high-level concept for integration has been identified.	**Principal integration technologies have been identified.** Top-level functional architecture and interface points have been defined. A high-level concept of operations and main use case has been started.
2	There is some level of specificity of requirements to characterize the interaction between components.	**Inputs/outputs for principal integration technologies/mediums are known, characterized, and documented.** Main interface requirements and specifications for integration technologies have been defined/drafted.
3	The detailed integration design has been defined to include all interface details.	**The detailed interface design has been documented.** System interface diagrams have been completed. Inventory of external interfaces is completed, and data engineering units are identified and recorded.
4	Validation of interrelated functions between integrating components in a laboratory environment.	**Integrating technologies (modules/functions/assemblies) has been successfully demonstrated in a laboratory/synthetic environment.** Data transport method(s) and specifications have been defined.
5	Validation of interrelated functions between integrating components in a suitable environment.	**Individual modules are tested to verify that the module components (functions) work together.** External interfaces are well defined (e.g., source, data formats, structure, content, method of support, etc.).
6	Validation of interrelated functions between integrating components in an appropriate end-to-end environment.	**The end-to-end Functionality of Systems Integration has been validated.** Data transmission tests were completed successfully.
7	System prototype integration demonstration in an operational high-fidelity environment.	**A fully integrated prototype has been successfully demonstrated in an actual or simulated operational environment.** Each system/software interface is tested individually under stressed and abnormal conditions. Interface, Data, and Functional Verification complete.
8	System integration completed and mission qualified through test and demonstration in an operational environment.	**A fully integrated system can meet overall mission requirements in an operational environment.** System interfaces qualified and functioning correctly in an operating environment.
9	System Integration is proven through successful mission-proven operations capabilities.	**A fully integrated system has demonstrated operational effectiveness and suitability in its intended or a representative operating environment.** Integration performance has been fully characterized and is consistent with user requirements.

The technical team shall choose the values of the weights W_N, W_L and $W_{M/H}$. A few prescriptions apply. For consistency, the value of the Technical Difficulty Factor index for an interface shall increase with increasing integration risk. Hence, the values given to the weights shall obey the relations:

$$W_N < W_L < W_{M/H}. \quad (14)$$

A natural choice for W_L is $\frac{1}{2}(W_N + W_{M/H})$. This choice considers a linear relation between option and weight.

Since the prescription for deriving system indices from system element indices is still an open issue [24, 22], below, we give alternative ways of computing the index RWSRL, following different prescriptions given in the literature.

Table. 10: Ranking indices and their use according to the proposed framework

$I_{mq}(2)$	Severity of risk m for the integration of interface q.	Ranking of the risks m for each interface q, according to risk severity.
TDF_q (5)	Technical Difficult Factor associated with interface q.	Ranking of interfaces q for a given system architecture, according to assessed interface risk of integration.
TDF (6)	System-wide Technical Difficult Factor.	Ranking of architectures, according to interface risk of integration.

$RWIRL_q$ (7)	Risk-weighted interface readiness level for interface *q*.	Ranking of the interfaces *q* for a given system architecture, according to composite measure of Interface Readiness Level and assessed interface risk of integration.
$RWIRL\_int$ (8)	System-wide risk-weighted interface readiness level.	Ranking of architectures, according to a composite measure of the attributes: (a) integration maturity of the equipment's interfaces and (b) severity of perceived integration risks of equipment's interfaces.
$\overline{RWIRL}_i$ (11)	Risk-weighted interface readiness level for equipment *i*.	Ranking of equipment according to its interface maturity and the perceived difficulty of its integration to the system.
$\overline{RWIRL}$ (13)	System-wide risk-weighted equipment readiness level for integration to the system.	Ranking of architectures according to equipment interface readiness for integration and perceived equipment integration risk.
$\overline{RWSRL}_i$ (9)	Risk-weighted readiness level for component *i*.	Ranking of the elements *i* of a system architecture according to a composite measure of the attributes equipment *i* maturity, integration maturity of the equipment *i* interfaces and severity of perceived integration risks associated with equipment *i* interfaces.
$RWSRL$ (12)	System-wide risk-weighted interface readiness level.	Ranking of architectures, according to a composite measure of the attributes of maturity of system's equipment, maturity of system's interfaces, and risk associated with the integration of system's interfaces.

3.2.8.1 Prescription by Ross

Here, the computation of the RWSRL is adapted from the SRL prescription given by Ross[27].

For a system with *n* elements, the complete prescription is as follows:

A –assign a TRL index to each system element, according to the scale given in Table 8, and express the system TRL in the form of a vector:

$$TRL = (trl_1, trl_{2,} \dots, trl_n)\ ; \tag{15}$$

B –for the considered integration type (M, E, T or D/C) assign an IRL index to each identified interface in the system, according to the scale given in Table. 9, and express the result in matrix form as:

$$IRL^x = \begin{bmatrix} {irl_{11}}^x & {irl_{12}}^x \dots & {irl_{1n}}^x \\ {irl_{21}}^x & {irl_{22}}^x \dots & {irl_{2n}}^x \\ \vdots & & \\ {irl_{n1}}^x & {irl_{n2}}^x \dots & {irl_{nn}}^x \end{bmatrix}, \tag{16}$$

where ${irl_{ij}}^x$ identifies the index corresponding to the system elements *i* and *j*, for the integration of type *x*; the diagonal elements, which give the index corresponding to the integration of a component with itself, are not used in this *SRL* computation prescription;

C –from the elements of the matrixIRL^x, compute the matrix below, the rationale of which is given in Section 3.1:

$$rwirl_{ij}^x = irl_{ij}^x \ x\ \frac{(W_N + W_{M/H} - TDF_{ij})}{(W_{M/H} - W_N)}, \tag{17}$$

where TDF_{ij} is given by (5) and W_N and $W_{M/H}$are weights used in the interface risk analysis, defined in the Step 8;

D – compute the average value of the matrix elements in (17) as:

$${rwirl_i}^x = \frac{1}{{Q_i}^x} \sum_{j \neq i} {rwirl_{ij}}^x\ , \tag{18}$$

where ${Q_i}^x$ is the number of non-zero elements in the considered line;

E – assign a manufacturing readiness level (MRL) index to each system element, according to a proper scale[27], and express the system MRL in the form of a vector:

$$MRL = \frac{1}{9}\left(mrl_1, mrl_{2,} \dots, mrl_n\right); \tag{19}$$

F – compute the component system readiness level vector:

$$RWSRL^x = \left({rwsrl_1}^x, {rwsrl_{2,}}^x \dots, {rwsrl_n}^x\right), \tag{20}$$

from the expression:

$${rwsrl_i}^x = \ mrl_i \times trl_i \ \times \frac{1}{9} {rwirl_i}^x\ ; \tag{21}$$

G – finally, compute the system readiness level$RWSRL^x$for the integration of type *x*, as the average of the elements of the vector given in (18):

$$RWSRL^x = \frac{1}{n} \sum_i {rwsrl_i}^x\ . \tag{22}$$

It should be noted that the index ${rwsrl_i}^x$is equivalent to the index $\overline{RWSRL}_i$defined in (9), with the difference that here the type of integration *x* is being considered in an explicit way. When the system's topology does not change with the integration type (M, E, T or D/C) such explicit

distinction is not necessary, being then possible to refer to each interface by a single index *q*, allowing for the multiplicity introduced by the different integration types.

The sequence of calculations leading to $RWSRL^x$ is carried out for the four types of integration. The RW*SRL* index of the system is finally computed from the equation:

$$RWSRL = \frac{RWSRL^M + RWSRL^E + RWSRL^T + RWSRL^{D/C}}{4} \quad (23)$$

The above computation should be carried out for all architecture solutions considered in the analysis.

It should be noted that (23) is equivalent to (12) if one considers the manufacturing readiness level for each component equal to its maximum value, i.e., if there are no limitations as regards manufacturing of system elements. Thus, the methodology given in Section 3.1, based on the theory of ranking a variable with multiple attributes [36, 37], is equivalent to the approach of Ross[27] for computing a system readiness level from the TRL and IRL of system elements.

3.2.8.2 Prescription by Sauser

The presentation given here is based on the work of Austin, M.F., & York, D. M. [19] and follows the prescription given by Sauser [8].

The complete prescription is as follows:

A – for each integration type *x* (M, E, T e D/C), assign an IRL index to each identified interface in the system, according to the scale given in Table. 9, and compute the $rwirl_{i,j}^x$ matrix from (17); in the present case, each diagonal element of IRL is assigned a value of 9;

B –the *RWSRL* vector is obtained by multiplying the normalized *TRL* vector by the normalized *RWIRL* matrix:

$$rwsrl_i^x = \sum_{j=1}^{n} \frac{rwirl_{ij}^x}{9} \text{ x } \frac{trl_j}{9}, \quad (24)$$

where the normalization factor is taken as the maximum of the corresponding assignment scales;

C –compute the *component RWSRL* vector from the expression:

$$crwsrl_i^x = rwsrl_i^x / m_i, \quad (25)$$

where m_i is the number of integrations of component i, as defined by the system architecture, including the integration of the component with itself;

D – the arithmetic average of the elements of the *component RWSRL* gives the *composite RWSRL*, which is interpreted as a measure of the system readiness, is then provided by:

$$RWSRL^x = \frac{1}{n}\sum_{i=1}^{n} crwsrl_i^x, \quad (26)$$

where *n* is the number of elements in the considered architecture.

The sequence of calculations must be repeated for the four types of integration, and the RWSRL of the system is, finally, computed from the equation (23):

IV. DISCUSSION

Multi-attribute Decision-making (MADM) is conceptually considered a branch of the area of Multi-criteria Decision-making (MCDM) in the field of Operations Research[39].

We note that the general form of a weighted multiplicative scoring function, with k attributes, is given by:

$$F = \prod_{i=1}^{k} a_i^{v_i}, \quad (24)$$

$$\sum_{i=1}^{k} v_i = 1, \quad (25)$$

where v_i designates the weight exponent of the index associated with the attribute a_i. If all v_i are equal, they may be dropped from (24) and (25). All the weighted multiplicative scoring functions defined in Section 3.1 use equal weight exponents. In principle, the formalism may be further developed through a judicious choice of the weight exponents, considering the specificities of the intended application. It should also be noted that the effective scoring functions leading to the indices *RWIRL* and *RWSRL* are composed of a mix of multiplicative and additive scoring functions. These indices should be carefully analyzed for each specific application, given the possible idiosyncrasies affecting additive scoring functions, as discussed in detail by Tofallis [38].

The framework given in this article has not explicitly considered an index for the attribute of technology maturation risks. Such risks might be assessed through an AD2 framework, as already discussed in Section 3.1. We emphasize that the AD2 methodology investigates the risk areas of design and analysis, manufacturing, software development, testing, and operations, which may be considered complementary to the risk area considered in the present framework. In principle, an index associated with the attributes associated with technology maturation risk might be devised and implemented following the concepts given in this article.

Fig. 7 shows the relation between the AD2 level scale and risk severity, represented by its two components: impact and probability. The chart in the lower part of the figure gives descriptions for the classification of risks' impact into five levels, while the upper chart gives the correspondence of each AD2 scale level with corresponding values of impact level and probability (severity).

The framework proposed in this article may be interpreted as a version of the AD2 framework, adapted for the assessment of integration risks. To further ascertain this point, Fig. 8 gives the relation between the assessment of the selected integration risks listed in Table. 2 and risk severity, represented by the pair impact and probability. Comparing with the charts given in Fig. 7, it is seen that the present framework and the AD2 framework are conceptually equivalent, although applied to the different risk areas.

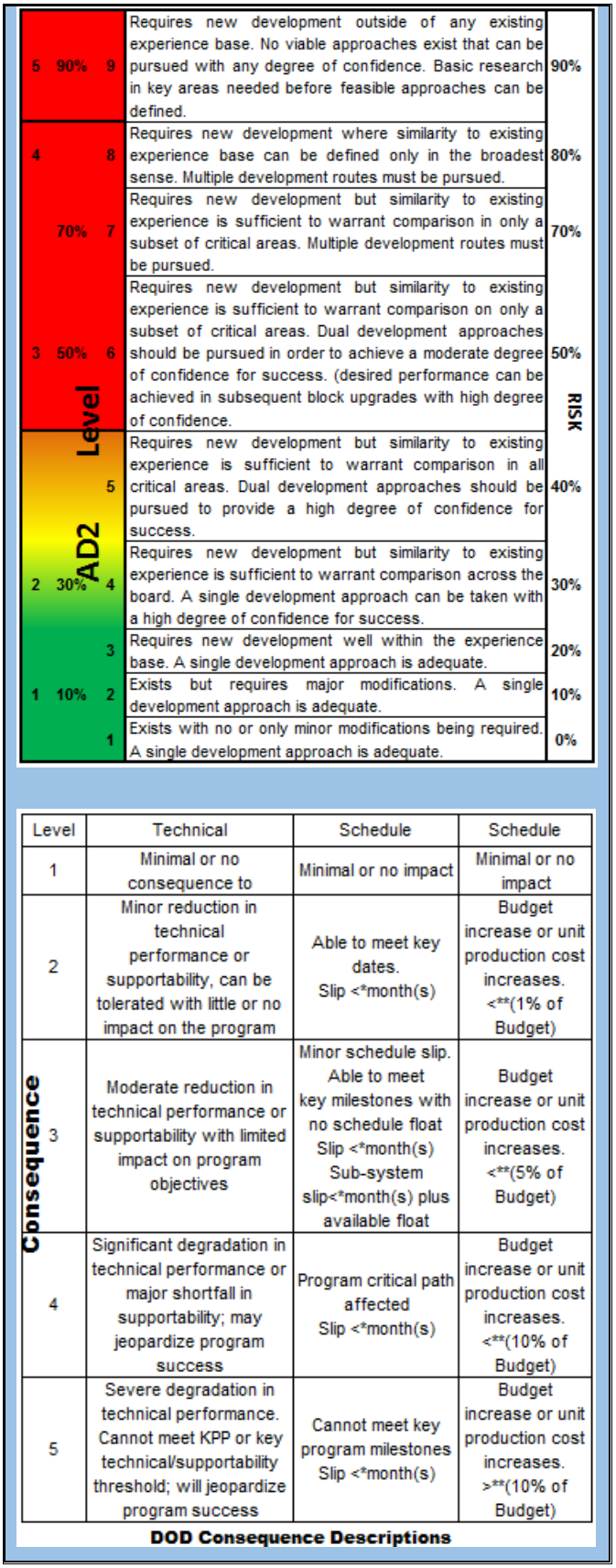


Fig. 7: Relation between the AD2 framework and the risk management process in a project. Adapted from Bilbro[7]

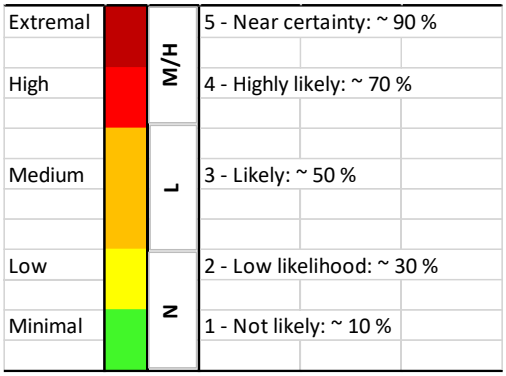


Fig. 8: Relation between the proposed framework and the risk management process in a project. Colors indicate the severity level, according to the scale depicted in Fig. 3

Using the concepts introduced in this article makes it possible to associate an index to each of the risks investigated in the AD2 framework. As an illustration, Fig. 9 gives a possible correspondence betweenAD2 scale levels with the computation concepts introduced in this article.

AD2 levels	Risk Options	Weights
9	M/H	$W_{M/H}$
8		
7		
6	L	W_L
5		
4		
3	N	W_N
2		
1		

Fig. 9: Possible relation between the AD2 scale levels and the framework presented in this article.

Legend: N: negligible; L: low; M/H: moderate to high

In order to accommodate the AD2 scheme into the present framework, it would then be necessary to formulate the AD2 specific questions as risk statements and unfold them into three excluding possibilities, following the logic illustrated in Table. 2. Instead of a form for each interface, there would be a form for each element of the system work breakdown structure (WBS). From this point on, a TDF factor would then be computed for each WBS element and composed with the other attributes, as discussed in Section 3.1, giving origin to different indices. This additional step would complete the procedure of the framework proposed in this article. The outcome is a project technology assessment framework that composes the following technology readiness assessments and risks: technology readiness level of equipment, technology readiness level of interfaces, technology maturation risks, and integration risks.

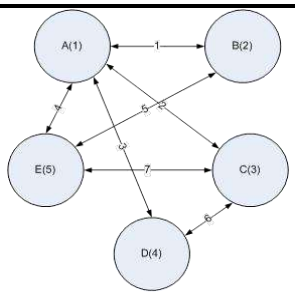
V. RESULTS

This section illustrates the application of the proposed framework. Two examples are developed in order to show that the proposed methodology can capture relevant information from the system through indices, which are consistent with the information from the analysis.

5.1 Example 1

An example involving one interface type, or a configuration in which the architectures for the different interface types are topologically equivalent, is presented in the following. Table. 11 shows the parameter values used in the example.

Table. 11: Parameters' values for Example 1

Number of Evaluators (N_a)	32				
Number of system components (n)	5				
Number of interfaces (Q)	7				
W_N	0.8				
W_L	1.0				
$W_{M/H}$	1.2				
TRL	3	9	9	4	7
IRL matrix	0	7	9	3	7
		0	0	0	1
			0	3	2
				0	0
					0

The assessment of the 7 interfaces (Q) by 32evaluators (Na) has been simulated by randomly selecting an assignment for each risk. Fig. 10 gives the aggregated result for each risk, for Interface 1, as an example. Similar results are obtained for the other interfaces.

Identification: INTERFACE 1				
Risk	**N**	**L**	**M/H**	I_{mq}
1 - Know-how	8	15	9	0,9777
2 - GSE	17	9	6	0,9893
3 -	7	19	6	0,9955
4 - Workload	12	8	12	0,9911
5 - Training	11	8	13	0,9893
6 - Nonconformance	12	13	7	1,0179
7 - Interface	12	9	11	1,0000
8 - Verification	11	10	11	1,0205
9 - Complexity	4	13	15	1,0134
Frequency	0,33	0,33	0,34	
Weighting factors	0,80	1,00	1,20	
Criterion's weight	0,26	0,33	0,41	
TDF				**0,99944**

Fig. 10: Aggregated result for Interface 1, according to the simulated assessment of Na = 32 evaluators. The cells in red and in green identify what would be the most and least severe risks, as assessed by the technical personnel

The rightmost column shows the values of the index$I_{mq}$for each risk. The values give a measure, for ranking purposes only, of the relevance of the corresponding risk (m) for the considered interface integration (q). The highlighted maximum (red) and minimum (green) values correspond to the most and least severe risks for the assessed interface.

Interface	*IRL*	TDF_q	$RWIRL_q$
1	7	0,9972	7,0194
2	9	0,9944	9,0500
3	3	1,0021	2,9938
4	7	0,9986	7,0097
5	1	1,0063	0,9938
6	3	0,9896	3,0313
7	2	1,0076	1,9847
TDF		0,9994	
RWIRL_int			4,5832

Fig. 11: The indices TDF_q and $RWIRL_q$ are given for each interface for the simulated example discussed in the text. The system-wide indices TDF and RWIRL_int are also shown

The IRL, TDF_q and $RWIRL_q$ indices for each interface are given in Fig. 11, with the least and most favorable cases identified with red and green colors. The figure also lists the corresponding system-wide indices, *TDF* and $RWIRL\_int$, for the simulated configuration. When considering only the difficulties perceived by the technical team, i.e., when considering only the index *TDF*, this simulated example would show that interface 7, with IRL equal to 2, would rank first in risk severity when compared to the other interfaces. Interface 6, although with a low IRL value, equal to 3, would present the most favorable situation within the considered set of risks. When composing integration risk with maturity, interface 5, with the lowest IRL, equal to 1, would be the most challenging interface, while interface 2, with IRL equal to 9, would represent the most favorable case.

Equipment / Interfaces	***TRL***	$\overline{RWSRL_i}$	$\overline{RWIRL_i}$
1 / 1-2-3-4	3	19,5547	6,5182
2 / 1-5	9	36,0594	4,0066
3 / 2-6-7	9	42,1979	4,6887
4 / 3-6	4	12,0500	3,0125
5 / 4-5-7	7	23,3058	3,3294
RWSRL		**26,63355**	

Fig. 12: The index RWSRLi for each equipment is given. The last line shows the system-wide index RWSRL

Fig. 12 gives the values of $RWSRL_i$ andthe average values of the risk-weighted integration level, $\overline{RWIRL_i}$, associated with each element *i*. The figure also gives the value of the system-wide index *RWSRL*. In the simulated scenario, with random assessments of each interface, the system component ranked as most critical has TRL 4 and coincides with the element that shows the most unfavorable value for the index $\overline{RWIRL_i}$.

5.2 Example 2

The hypothetical case of a system with five component equipment with four alternatives for one of the components is now studied through simulation.

It is assumed that the system displays different configurations for different interface types. Fig. 13 shows the assumed configurations for the four types of interfaces defined in Table. 4 (M, E, T, and D/C). Ordinal numbers identify interfaces, while system components are identified by letters, sequentially from A to E. Alternative candidate equipment, for the "A" position, are identified by A1 through A4.

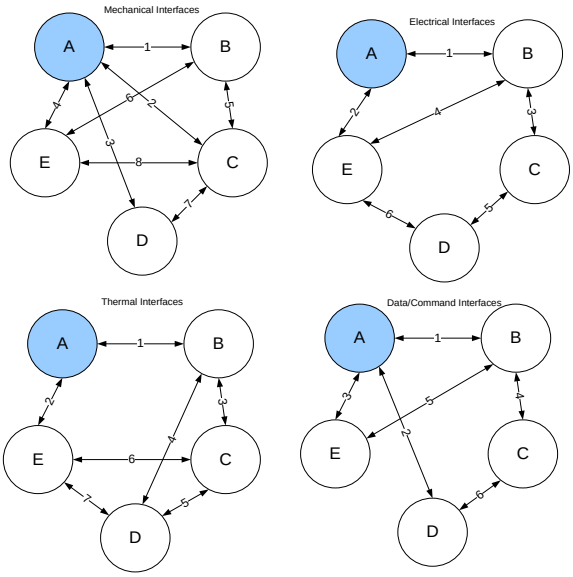


Fig. 13: System decomposed into the four types of interfaces.

TRL and IRL values for equipment and interfaces have been randomly selected and are displayed in Fig. 14, with the provision that the IRL indices are the same for each type of interface (M, E, T, and D/C), even when switching between candidates for the "A" position. Also, it is assumed that the insertion of candidate equipment does not affect the TRL of the remaining system equipment B, C, D, and E. The assessment of the 9 risks by 3 specialists has also been randomly selected. Although the specific simulated situation would seldom be verified in actual cases, the conceptual case of choosing a piece of equipment among several possibilities is quite common.

IRL	A1	B	C	D	E
A1	0	1	7	5	9
B	1	0	3	0	3
C	7	3	0	3	6
D	5	0	3	0	6
E	9	3	6	6	0

IRL	A2	B	C	D	E
A2	0	7	0	0	2
B	7	0	2	0	6
C	0	2	0	3	0
D	0	0	3	0	7
E	2	6	0	7	0

IRL	A3	B	C	D	E
A3	0	5	0	0	4
B	5	0	9	8	0
C	0	9	0	8	3
D	0	8	8	0	6
E	4	0	3	6	0

IRL	A4	B	C	D	E
A4	0	6	0	8	8
B	6	0	9	0	6
C	0	9	0	7	0
D	8	0	7	0	0
E	8	6	0	0	0

Equip.	A1	A2	A3	A4	B	C	D	E
TRL	6	6	7	7	6	6	5	7

Fig. 14: Simulation input data.

Fig. 15 lists the$RWSRL$ index for each type of interface, referred to as $RWSRL(x)$, with $x \in (M, E, T, D/C)$, as well as the system$RWSRL$ for each architectural solution formed with the candidate components. It is seen that the solution with the equipment A4 presents the highest $RWSRL$ value. Comparing the $RWSRL(x)$ values among the different solutions, it is observed that Solution 4 ranks first, except for the D/C interface type, when Solution 3 ranks first. Concerning the TDF index, which would give a measure of integration risk for each configuration as perceived by the technical team, Solution 4 also ranks first as the preferred solution (lower risk). It is also seen from Fig. 14 that the alternatives A3 and A4 show TRL values equal to 7, superior to the value 6 for alternatives A1 and A2. From Fig. 14, it is also seen that the average IRL for component A4, equal to 22/3, is superior to the equivalent values for alternatives A1 to A3, equal to 22/4, 9/2, and 9/2, respectively. Thus, from the analysis of the basic input indices it would be expected that alternative 4 would fare better than the other alternatives. The virtue of methodologies belonging to the MADM class is to condense, through one or more indices, computed straightforwardly, information that would be obtained through detailed analysis. In this example, the proposed methodology would give, through the language of ranking indices, the same answer as would be obtained by a detailed analysis of the problem.

	Composition		RWSRL sys	TDF sys
Architecture Solution 1	**A1-B-C-D-E**			
	RWSRL (M)	28,3062	33,0733	1,0123
	RWSRL (E)	25,6551		
	RWSRL (T)	35,6578		
	RWSRL (D/C)	42,6741		
Architecture Solution 2	Composition		RWSRL sys	TDF sys
	A2-B-C-D-E			
	RWSRL (M)	27,9211	33,5081	0,9990
	RWSRL (E)	26,5911		
	RWSRL (T)	36,2514		
	RWSRL (D/C)	43,2689		
Architecture Solution 3	Composition		RWSRL sys	TDF sys
	A3-B-C-D-E			
	RWSRL (M)	28,5743	34,6057	1,0045
	RWSRL (E)	27,4289		
	RWSRL (T)	36,0402		
	RWSRL (D/C)	46,3795		
Architecture Solution 4	Composition		RWSRL sys	TDF sys
	A4-B-C-D-E			
	RWSRL (M)	29,9407	34,9820	0,9890
	RWSRL (E)	27,8131		
	RWSRL (T)	36,4193		
	RWSRL (D/C)	45,7548		

Fig. 15: Result of the ranking simulation of the architectural solutions formed between candidates A1, A2, A3 and A4.

The TDF index also synthesizes relevant information for the project risk management process, pointing out which risks require more attention from project management.

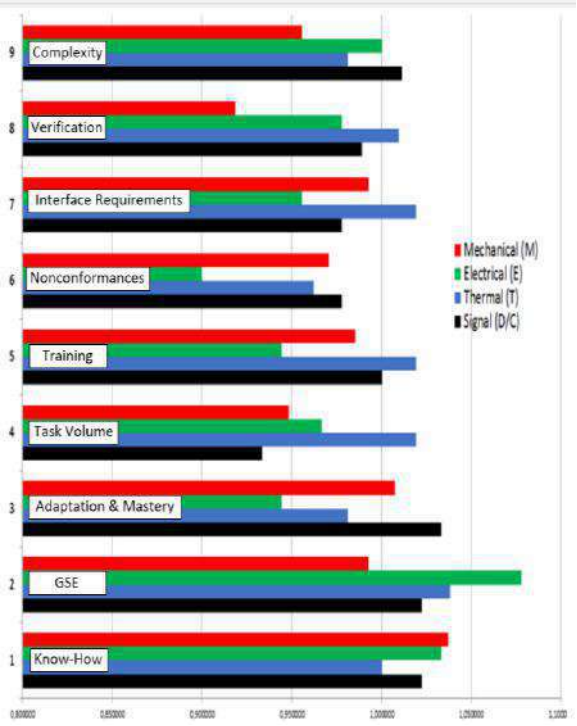


Fig. 16: Ranking result of the architecture solution 4 by risk type and by interface type

Fig. ***16*** shows a comparison of the relevance of each assessed risk for each interface type as given by the I_{mq} index, for Solution 4. For instance, risk 9, "Complexity", is ranked first for the Signal interface, while risk "Verification" ranks first for the Thermal interface. Among all risks, the risk GSE ranks first, for the case of an Electrical interface type, according to the technical team risk assessment leading to the *TDF* index.

When the objective is to understand which type of interface presents the highest integration risk, the Technical Difficulty Factor (TDF) may be computed for each interface type. This index makes it possible to rank the different interface types according to their integration risk. For the example under scrutiny, Fig. 17shows that the simulated data would indicate that the thermal and signal interface types would require greater attention than the other interface types in the integration effort.

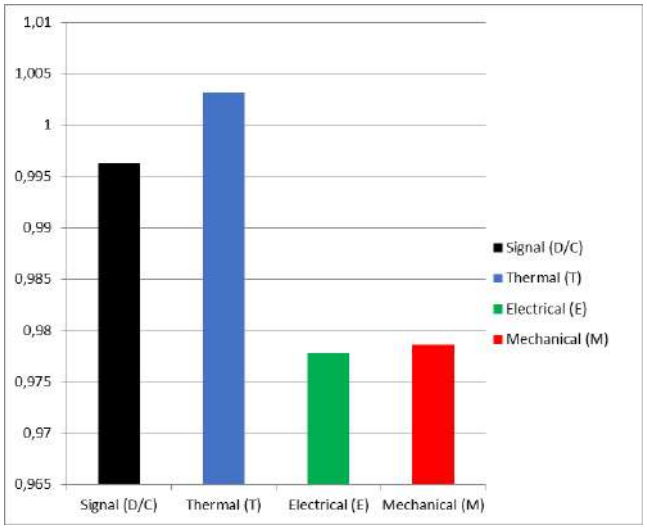


Fig. 17: Ranking of TDF by interface types of architecture solution.

VI. CONCLUSION

The methodology given in this article aims to propose ranking indices that measure the integration risks of system architectures, to be compounded with system technology and interface readiness levels indices to define multiple attribute indices adequate for the ranking of different system architectures. This objective has been implemented as follows.

The integration risk assessment is based on specialized opinion. In the methodology version presented here, a selection of nine integration risks, covering a broad range of disciplines, is submitted, in the format of an individual form survey, to the assessment of systems engineering personnel, specialty engineers, project managers, and assembly, integration and testing specialists. The detailed risk information that emerges from the survey is translated into an index, referred to as the Technical Difficulty Factor (TDF), which gives a measure of integration risk severity for each interface.

Through the composition of this index with the set of IRL indices, a new composite index, referred to as Risk-weighted Integration Readiness Level (RWIRL), is defined for each interface. The RWIRL indices are then compounded with the equipment TRL indices, giving origin to a new set of indices, referred to as RWSRLi, which may be used to rank system equipment according to the attributes of equipment maturity, interface maturity, and integration risk. From the set of RWSRLi indices, a system-wide index, termed Risk-weighted System Readiness Level (RWSRL), is derived, which may be used to rank different system architectures, considering the attributes mentioned above.

With additional effort, through a procedure indicated in the article, the TDF index may be compounded with a conveniently defined AD2 index, thus defining a compounded TDF risk index, which now considers integration risks and technology maturation risks. Following the procedure already delineated above, one obtains equivalent indices as those above defined, incorporating both maturity and risk information.

The outcome is a project technology assessment framework that composes the following elements: equipment readiness level, technology readiness level of interfaces, technology maturation risks, and integration risks.

It is pointed out that the RWSRL methodology proposed in this article deals with the definition of ranking indices and their applications. Values of *computed* indices have meaning only for comparison purposes; it is not possible to assign them a scale as in the TRL, IRL, and SRL methodologies. The variability of the results generated will always depend on the values adopted for the weights W_N, $W_{L,}$ and $W_{(M/H)}$. The values may be tailored according to the conveniences of the intended application. This will not affect the result whenever linearity between them is observed.

Although conceived for application in space projects` Phases A and B, the RWSRL methodology may be applicable, in principle, to a wide range of project types, at different life cycle stages, for instance, whenever a decision among multiple supply options is necessary or as an input for related RIDM processes. The proposed risk assessment model is sufficiently generic to be tailored to other design applications.

The various ranking indices proposed in the article provide potentially relevant data for project management, not only as a selection tool among candidate items for the system's composition but also as an input for a conventional CRM process for detailing and mitigating risks. The proposed risk assessment may indicate the areas and aspects related to system integration that require great or special attention in the system design.

There is a relationship between the AD2 scale levels and the structure presented in this article, as shown in Fig. 8 and Fig. 9. It can be argued that both tools work similarly and that the AD2 and RWSRL methodologies may work as complementary frameworks.

The RWSRL metric captures the potential risks at a given moment of the project, as perceived by the technical team. Beyond their utility in decision-making processes, the proposed indices provide an effective communication bridge between systems teams and project management. They convey appropriate identification and characterization of integration difficulties and risks foreseen in each evaluated architecture solution.

The utility of multi-attribute decision-making methodologies as applied to projects is to condense, through one or more indices, computed straightforwardly and systematically, information that would be obtained through detailed analysis. The examples given in Section 3 indicate that the proposed methodology is successful in providing through the language of ranking indices information that would be obtained only through a detailed analysis.

REFERENCES

[1] Reeves, J. D., Eveleigh, T., Holzer, T., & Sarkani, S. (2012, March). The impact of early design phase risk identification biases on space system project performance. In 2012 IEEE International Systems Conference SysCon 2012 (pp. 1-8). IEEE

[2] Dezfuli, H., Benjamin, A., Everett, C., Maggio, G., Stamatelatos, M., Youngblood, R., ... & Williams, R. (2011). NASA risk management handbook (No. NASA/SP-2011-3422-Version-1.0).

[3] Sauser, B. J., Long, M., Forbes, E., & McGrory, S. E. (2009, July). 3.1. 1 Defining an Integration Readiness Level for Defense Acquisition. In INCOSE International Symposium (Vol. 19, No. 1, pp. 352-367).

[4] Mankins, J. C. (2009). Technology readiness assessments: A retrospective. Acta Astronautica, 65(9-10), 1216-1223.

[5] Bilbro, J. W. (2006). Systematic Assessment of the Program/Project Impacts of Technological Advancement and Insertion. George C. Marshall Space Flight Center, Dec.

[6] Mankins, J. C. (1998). Research & development degree of difficulty (R&D3). White Paper, March, 10.

[7] Bilbro, J. W. (2008). Using the Advancement Degree of Difficulty (AD2) as an input to Risk Management. JB CONSULTING INTERNATIONAL HUNTSVILLE AL.

[8] Sauser, B., Verma, D., Ramirez-Marquez, J., & Gove, R. (2006, April). From TRL to SRL: The concept of systems readiness levels. In Conference on Systems Engineering Research, Los Angeles, CA (pp. 1-10). sn.

[9] Silva Jr, A. C. (2011). Desenvolvimento integrado de sistemas espaciais-Design for AIT-Projeto para Montagem, Integraçao e Teste de Satélites D4AIT (Doctoral dissertation, PhD thesis, Instituto Tecnológico de Aeronáutica).

[10] Hirshorn, S., & Jefferies, S. (2016). Final report of the NASA Technology Readiness Assessment (TRA) study team (No. HQ-E-DAA-TN43005).

[11] Mankins, J. C. (1995). Technology readiness levels. White Paper, April, 6(1995), 1995.

[12] Beauchamp, P. M., Frerking, M. A., Kimmel, B., Kline, T. R., Vassigh, K. K., Willard, D. E., ... & Trenkle, T. G. (2020). Technology Readiness Assessment Best Practices Guide.

[13] Mankins, J. C. (2002). Approaches to strategic research and technology (R&T) analysis and road mapping. Acta Astronautica, 51(1-9), 3-21.

[14] Valerdi, R., & Kohl, R. J. (2004, March). An approach to technology risk management. In Engineering Systems Division Symposium (Vol. 3, pp. 29-31).

[15] Magnaye, R. B., Sauser, B. J., & Ramirez-Marquez, J. E. (2010). System development planning using readiness levels in a cost of development minimization model. Systems Engineering, 13(4), 311-323.

[16] Secretariat, E. (2016). ECSS-E-HB-11A DIR1, Space engineering-Technology readiness (TRL) guidelines. draft standard, ESA-ESTEC, Requirements & Standards Division, Noordwijk, The Netherlands.

[17] Sauser, B., Ramirez-Marquez, J., Henry, D., Dimarzio, D., & Rosen, J. (2007). Methods for estimating system readiness levels. School of Systems and Enterprises White Paper, 1, 1-40.

[18] Sauser, B. J., Ramirez-Marquez, J. E., Henry, D., & DiMarzio, D. (2008). A system maturity index for the systems engineering life cycle. International Journal of Industrial and Systems Engineering, 3(6), 673-691.

[19] Austin, M. F., & York, D. M. (2015). System Readiness Assessment (SRA) an illustrative example. Procedia Computer Science, 44, 486-496.

[20] Austin, M. F., & York, D. M. (2016). System Readiness Assessment (SRA) a Vade Mecum. In Complex Systems Design & Management (pp. 53-68). Springer, Cham.

[21] Gove, R., & Uzdzinski, J. (2013). A performance-based system maturity assessment framework. Procedia Computer Science, 16, 688-697.

[22] London, M. A., Holzer, T. H., Eveleigh, T. J., & Sarkani, S. (2014). Incidence matrix approach for calculating readiness levels. Journal of Systems Science and Systems Engineering, 23(4), 377-403.

[23] McConkie, E., Mazzuchi, T. A., Sarkani, S., & Marchette, D. (2013). Mathematical properties of system readiness levels. Systems Engineering, 16(4), 391-400.

[24] Kujawski, E. (2012). Analysis and critique of the system readiness level. IEEE Transactions on Systems, Man, and Cybernetics: Systems, 43(4), 979-987.

[25] Azizian, N., Mazzuchi, T., Sarkani, S., & Rico, D. F. (2011). A framework for evaluating technology readiness, system quality, and program performance of US DoD acquisitions. Systems Engineering, 14(4), 410-426.

[26] Azizian, N., Sarkani, S., & Mazzuchi, T. (2009, October). A comprehensive review and analysis of maturity assessment approaches for improved decision support to achieve efficient defense acquisition. In Proceedings of the World Congress on Engineering and Computer Science (Vol. 2, pp. 20-22). San Francisco.

[27] Ross, S. (2016). Application of System and Integration Readiness Levels to Department of Defense Research and Development (Postprint). AIR FORCE RESEARCH LAB KIRTLAND AFB NM KIRTLAND AFB United States.

[28] Hirshorn, S. (2016). NASA System Engineering Handbook SP-2016-6105 Rev2.

[29] Tan, W., Ramirez-Marquez, J., & Sauser, B. (2011). A probabilistic approach to system maturity assessment. Systems Engineering, 14(3), 279-293.

[30] NASA, N. (2010). Risk-Informed Decision Making Handbook. NASA/SP-2010-576 Version 1.0, NASA Headquarters, Washington, DC.

[31] Dubos, G. F., Saleh, J. H., & Braun, R. (2008). Technology readiness level, schedule risk, and slippage in spacecraft design. Journal of Spacecraft and Rockets, 45(4), 836-842.

[32] Ramirez-Marquez, J. E., & Sauser, B. J. (2009). System development planning via system maturity optimization. IEEE Transactions on Engineering Management, 56(3), 533-548.

[33] Bilbro, J. W. (2007). A suite of tools for technology assessment. JB CONSULTING INTERNATIONAL HUNTSVILLE AL.

[34] Mankins, J. C. (2009). Technology readiness and risk assessments: A new approach. Acta Astronautica, 65(9-10), 1208-1215.

[35] VOXCO, "Ordinal survey questions," VOXCO, [Online]. Available: https://www.voxco.com/blog/ordinal-survey-questions [Accessed on 06.03.2022 March 2022]

[36] Lu, J., Han, J., Hu, Y., & Zhang, G. (2016). Multilevel decision-making: A survey. Information Sciences, 346, 463-487.

[37] Leoneti, A. B. (2016). Considerations regarding the choice of ranking multiple criteria decision making methods. Pesquisa Operacional, 36, 259-277.

[38] Tofallis, C. (2014). Add or multiply? A tutorial on ranking and choosing with multiple criteria. INFORMS Transactions on education, 14(3), 109-119.

[39] Tzeng, G. H., & Huang, J. J. (2011). Multiple attribute decision making: methods and applications. CRC press.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.8

TL Glow Curve and Kinetic Parameters of Amethyst Exposed to High Dose of Gamma Radiation

Grazziella Nuzzi Ribeiro D'Angelo[1], Álvaro Barbosa de Carvalho Júnior[2], Jeniffer Uberty Garcia Ferreira Cunha[3], Samara Guedes Ramos[4], Francisco Tadeu Freire[5], Debora Santos Rodrigues[6], René Rojas Rocca[7]

[1, 2, 3, 4,5]Graduate Program of Computational Modeling and Systems, State University of Montes Claros, Brazil
[6]Department of Sciences Exact and Technological, State University of Montes Claros, Brazil
[7]Department of Marine Science and Technology, Federal University of São Paulo, Brazil

Received: 15 Apr 2022,
Received in revised form: 05 May 2022,
Accepted: 10 May 2022,
Available online: 15 May 2022

***Keywords*—Thermoluminescence, Amethyst, Kinetic, Lifetime.**

Abstract*—*To know if a certain thermoluminescent (TL) peak is suitable for dosimetry, it is important to determine its lifetime. The mean lifetime may be calculated using the geometrical factor of the TL glow curve to determine the kinetic parameters such as activation energy and frequency factor of electrons in traps. The kinetic parameters to the peak at 202 ºC of a natural amethyst from Brazil, were obtained by using the peak shape methods applied on the TL glow curve, before and after deconvolution procedure. The peak at 202 °C was chosen because lies between 180 °C and 400 °C, a region of interest for dosimetric applications. Before deconvolution, the calculated lifetime for the peak at 202 °C was relatively short close to 35 days. However, the calculated lifetime after deconvolution was around 312 days, suggesting a longer lifetime. The results showed the importance of deconvolution for the calculation of the kinetic parameters of the TL peak of amethyst exposed to high dose of gamma radiation.

I. INTRODUCTION

Some studies bring an easier understanding introduction to the phenomena of thermoluminescence (TL) and its applications, but in general it is known that the TL materials when pre-excited by radiation (cosmic, ultraviolet,α, β, X or γrays) may retain energy within them [1, 2].

The principle of TL dosimetry is based on the statement that ionizing radiation produces free electrons, some of which can be trapped by point defects existing in the crystalline lattice of an insulating material. After being exposed to ionizing radiation, the TL material emits light while they are heated. The intensity of the emitted visible light is proportional to the number of trapped electrons and therefore to the amount of absorbed radiation [3, 4]. The emitted light can be detected by a photomultiplier Anda associated electronic equipment. In many cases, the detected light is proportional to the radiation absorbed and it is possible to use TL dosimetry for several applications [3,5].TL dosimetry is a well-established dosimetric technique with applications in areas such as personnel, environmental, archaeological, dating, retrospective and clinical dosimetry [3].

Many synthetic materials are produced with properties suitable for TL applications, among which are lithium fluoride (LiF), calcium fluoride (CaF_2), calcium sulfate ($CaSO_4$), beryl oxide (BeO) and aluminum oxide (Al_2O_3) [4,5]. On the other hand, there are natural minerals with interesting TL properties, such as zirconite ($ZrSiO_4$), microcline ($KAlSi_3O_8$), albite ($NaAlSi_3O_8$), calcite ($CaCO_3$), topaz $Al_2(F,OH)2SiO_4$ and quartz (SiO_2) [6-9].Among these, quartz is one of the most popular ones

and can be used in many TL dosimetry applications [3, 9-12].

Natural amethyst is a purple variety of α-quartz (SiO_2) and has received considerable attention from the point of view of technological applications with low and highγ dose radiation [13, 14, 17, 18]. Thus, these studies have published the thermoluminescence analysis, as well as suitability of amethyst as dosimeter.

In many industrial processes the high doses can be used to material sterilization, food tuber germination treatments, grain and seed growing, water purification, among other possibilities [19, 20]. Then, there is a possibility of using the amethyst to high dose dosimetry in similar applications.

Amethyst generally exhibits a TL glow curve with two or more main peaks. The TL glow curve is an intrinsic characteristic of each amethyst crystal and is associated to high concentration of electron or hole traps and high efficiency of light emission associated with recombination process between electron and hole [3]. However, the iron (Fe^{3+}), which exist as impurities into the amethyst lattice, is generally responsible for the concentration of electrons and holes traps, can vary from one deposit to the other affecting the intensity of TL glow curve [21-23].

To determine if the peaks on the TL glow curve are useful for dosimetry, it is important to know its lifetime. The lifetime may be calculated using the trap physical parameters as order of kinetic, activation energy and frequency factor [3, 4, 23].

In order to obtain these physical parameters, some procedures can be used, such as initial rise, different heating rates and peak shape methods [23-25]. However, the methods that use the peak shape are probably the simplest because activation energy can be determined by knowing only two or three characteristic temperatures of the peak and no additional measurements are needed.

Thus, the aim of this study was to calculate the kinetics order (*b*), activation energy (*E*)and frequency factor (*s*) of the peak at 202 °C for an amethyst taken from a deposit located in South of Brazil. By using peak shape methods was possible to estimate the life time of TL peak at 202 °C with the order of days at 25 °C of room temperature.

II. EXPERIMENTAL

2.1 Peak shape methods for general order

The geometrical shape of the peak on TL glow curve is an important characteristic for the material that will be used as a TL dosimeter. This characteristic can be evaluated using the peak shape methods, that is based on measurements of a few points of the isolated glow peak as shown in Figure 1 [4].In this figure, it is possible to define the following parameters: T_m = temperature at maximum intensity; $T_1$and T_2 = temperatures on either side of T_m, corresponding to half of the maximum intensity; $\tau = T_m - T_1$is the half-width of the low temperature side of the peak; $\delta = T_2 - T_m$ is the halfwidth at the high temperature side of the peak; $\omega = T_2 - T_1$is the total half-width and$\mu = \delta/\omega$ is the geometrical form factor or symmetry factor. The factor μ is adopted as 0.42 for first order kinetics peaks, 0.52 for the second order and for values other than 0.42 and 0.52 the general order peaks is adopted.

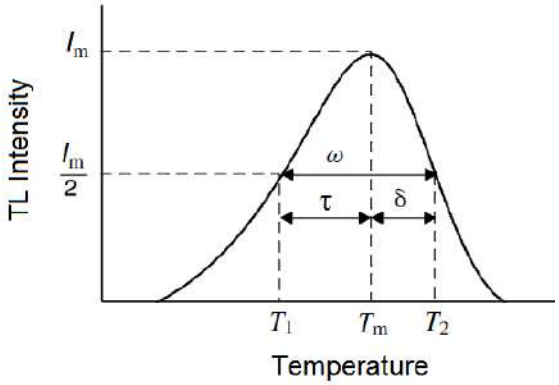


Fig.1: Geometrical parameters of the TL peak

By determining the form factor μ, the corresponding order of kinetic *b* can be predicted from the calibration curve shown in Figure 2. It is pertinent to mention that μ is practically independent of *E* in the range from 0.1 to 1.6 eV and strongly dependent on the kinetics order *b*, to the range $0.7 \leq b \leq 2.5$ [4].

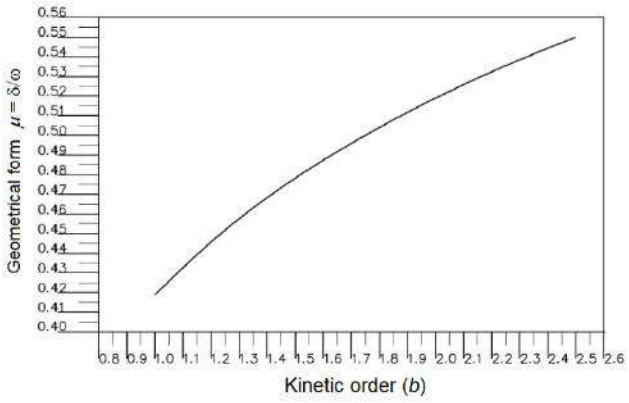


Fig.2: Variation of μ with order of kinetics b

In the general order peaks case, the energy *E* (eV) can be calculated using Equation 1, that require only knowledge of the parametersτ, δ, ω and μ [4].

$$E_\alpha = C_\alpha \frac{kT_m^2}{\alpha} - B_\alpha \,.\,(2kT_m) \qquad (1)$$

Where the index α stands for τ, δ, ω and *k* = Boltzmann constant (8.62 x 10^{-5} eV/K).

The values or C_α and B_α for the three methods are presented in the Equations 2, 3 and 4 [4].

$$C_\tau = 1.51 + 3(\mu - 0.42), B_\tau = 1.58 + 4.2(\mu - 0.42) \quad (2)$$
$$C_\delta = 0.976 + 7.3(\mu - 0.42), B_\delta = 0 \quad (3)$$
$$C_\omega = 2.52 + 10.2(\mu - 0.42), B_\omega = 1 \quad (4)$$

The frequency factor s (s^{-1}) for the general order kinetics peaks is calculated using the Equation 5 [25].

$$s = \left(\frac{\beta E}{kT_m^2}\right)\frac{1}{1 + (b-1)\left(\frac{2kT_m}{E}\right)} exp\left(\frac{E}{kT_m}\right) \quad (5)$$

Where b = value of kinetic order, β= heating rate (K/s).

2.2 Sample preparation

The natural amethyst used in the present study was a single crystal extracted from one deposit located in the district of Lajeado (Rio Grande do Sul State, South of Brazil). The crystal (Figure 3) was cleaned with acetone for 20 minutes using an ultrasonic bath and then were manually crushed using an agate mortar and pestle. After crushing, the grains were classified into 75 x 150 μm by using standard Tyler sieves. After that, the grains were submitted a heat treatment in order to guarantee the release of charge carriers from the trap levels. The heat-treatment were performed in a muffle furnace at 400 °C for 1hour and cooling at room temperature of 25 °C.

Fig.3: Amethyst crystal

2.3 TL measurements

To determine the TL glow curve of the amethyst exposed to high gamma doses, five powder aliquots with approximately 20 mg were used. The weight of each aliquot was determined with an analytical balance accurate to 0.1 mg. The aliquots were exposed to doses ranging from 1 to 50 kGy in a gamma-cell irradiator with a dose rate close to 10 kGy/h. The TL measurements were carried out at temperatures ranging from 50to 350 ºC with a heating rate of 5 ºC/s, using a TL Harshaw3500 reader equipment. After that, the TL glow curve obtained with intermediate dose of 25 kGy was deconvoluted to calculate the lifetime.

2.4 Deconvolution and TL peak lifetime

Another important subject in dosimetric studies is the stability of the stored signal at room temperature. Then, the TL glow curves were analyzed by using the peak shape methods before and after the deconvolution procedure with Origin program. The deconvolution is defined as a mathematical method to create a curve using some theoretically and experimentally determined parameters [26, 27]. Thus, it was possible to analyze the overlapping peaks in the region between 125 and 275 °C of TL glow curve and determine the kinetics parameters of an isolated peak for the lifetime (t) calculation by using Equation 6.

$$t = s^{-1}\, exp(E/kT) \quad (6)$$

Where T = room temperature (298 K).

The accuracy of the deconvolution method used for TL peaks determination is similar to that found with the first, second and general order TL kinetic equations [25, 28]. In this study, the method was validated by analyzing the Figure of Merit (FOM), which is the degree of similarity between the theoretical and experimental curves. In this case, an FOM value of less than 2.5% indicates a good result [27, 28]. Four peaks were considered for the deconvolution, being one of first order, another of second order and two of general order, with activation energies ranging between 0.83 and 1.41 eV.

2.5 XRD Analysis

To investigate the crystal structure of amethyst, standard X-ray diffraction (XRD) analyses were carried out. For that, XRD patterns were obtained with a 2θ diffractometer between 10° to 60° using Cu-Kα radiation. Then, the result was compared with XRD pattern ofα-quartz.

III. RESULTS AND DISCUSSION

Figure 4 shows the XRD patterns of powdered sample amethyst and α-quartz. By comparing the two diffractograms recorded between 10° and 60° (in 2θ scale), it can be seen that they have the same peak positions. There is an intense peak at 26.56°and several other diffraction peaks of moderate and low intensity between

20.78° and 59.88°. The peaks presented correspond to the crystalline planes of natural quartz and are in accordance with the XRD pattern found for α-quartz [29].

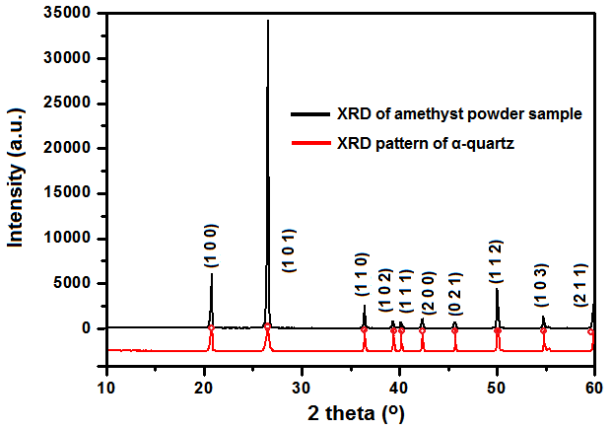


Fig.4: XRD of amethyst compared to pattern of α-quartz

Figure 5 shows the TL glow curve for amethyst powdered exposed to doses of 1, 5, 7, 10, 25 and 50 kGy of ^{60}Co. This result shows two overlapping glow peaks near to 125 and 202 °C, respectively. In the present study, the peak at 125 °C was not considered due to its unstable behavior at room temperature. On the other hand, the peak at 202 °C is located in the region of interest for TL dosimetry, which lies between 180 °C and 400 °C [3, 23].

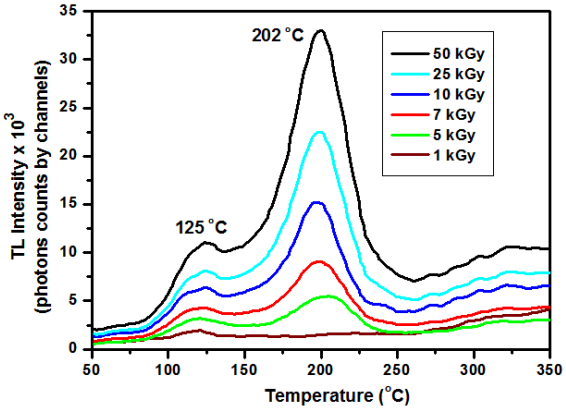


Fig.5: TL glow curve of amethyst exposed to high doses of gamma radiation.

The peak at 202 °C may exhibit different behaviors depending on the origin or shape of the sample investigated. For example, in samples powdered irradiated with doses in an interval of 0.89 – 21.36 Gy (^{90}Sr/^{90}Y), the peak at 202 °C may appears at 240 °C [18]. However, in amethyst sintered pellet irradiated with 1 kGy (^{60}Co) the glow peak is observed at 210 °C [17].

The TL intensity of the peaks at 125 and 202 °C increases within creasing dose from 1to 50 kGy, but only with 5 kGy the peak at 202 °Cis noticed. Some amethysts from Brazil show a very well defined dosimetric peak near to 210 °C that can be observed with 1 kGy of ^{60}Co or with lower doses [7, 17]. It is known that the TL intensity of quartz exposed to gamma radiation decreases with high content of OH defect centers, which varies in samples from one deposit to another [30]. It is pertinent to mention that others studies have reported the high OH concentrations in some amethysts from South of Brazil [21,31]. Thus, it is believed that the absence of the TL peak at 202 °C for dose of 1 kGy can be associated with the high content of OH centers present in the sample.

Figure 6 shows the TL glow curve of amethyst exposed to 25 kGy. The peak shape expressions for general order were used assuming that the peaks at 125 °C and 202 °C were sufficiently isolated. In this case, it was possible to calculate the following parameters:ω = 51.66, τ = 29.00, δ = 22.66 and μ = 0.44. After that, the value of μ = 0.44 was projected on the graph in Figure 2, which yielded one values for the kinetic order *b* = 1.15 for the peak at 202 °C.

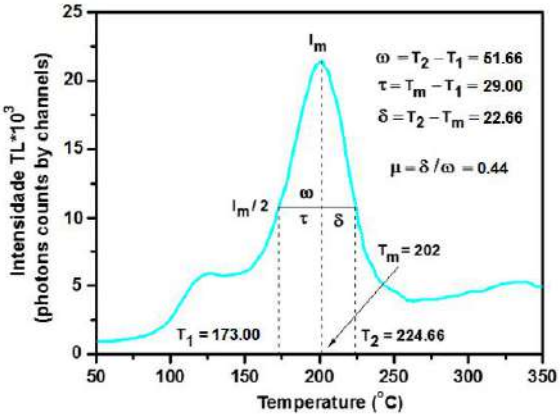


Fig.6: Peak shape methods in glow peak of amethyst exposed to 25 kGy.

Figure 7 shows the TL glow curve after deconvolution. This result suggests that the TL glow curve of amethyst exposed to 25 kGy consists of four overlapping peaks, three of them in the region between 125 °C and 275 °C, as shown in Figure 7(a). According to Figure 7(b), the Figure of Merit (FOM) presents a degree of similarity between the theoretical and experimental curves indicating a good result with FOM = 2.5%. The FOM values in the range 2.5% to 3.5% are acceptable and indicate only small flaws in the method [28]. The peak shape expressions for general order were used in the isolated main peak at 200 °C (Figure 8). Thus, were obtained the parameters:ω = 48.19, τ = 25.91, δ = 22.28 and μ = 0.46. The value of μ = 0.46 was projected on the graph in Figure 2for the kinetic order *b* = 1.32.

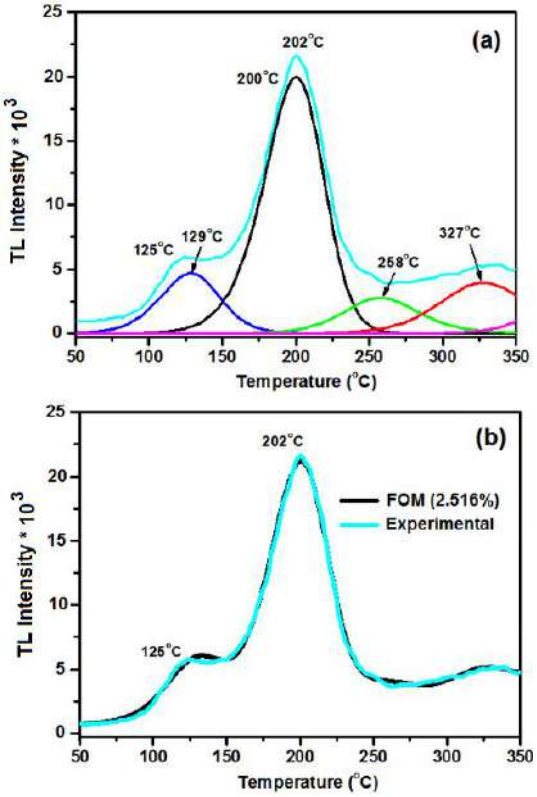


Fig.7: TL glow curve of amethyst: (a) after deconvolution and (b)degree of similarity between the theoretical and experimental curves

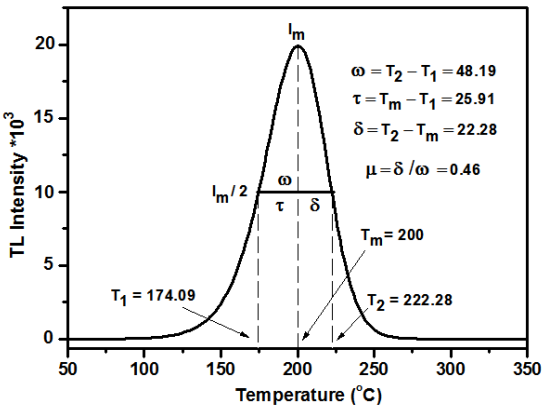


Fig.8: Peak shape methods in glow peak deconvoluted

Table 1 summarizes the values of the activation energy (E) to the glow peak before and after deconvolution. These results were obtained by using the Equations 1, 2, 3 and 4. The calculated values of the activation energy as a function of the geometric parameters (ω, τ and δ) showed only a small variation around 0.2 eV between the peaks at 202 °C and at 200 °C. The average activation energy (E_a) for the glow peak at 202 °C was equal to 0.93 ± 0.02 eV and 1.10 ± 0.02 eV for the peak at 200 °C.

Table 1 - Activation energy (E) values: peak at 202 °C and at 200 °C after deconvolution

T_m(°C)	E_ω(eV)	E_τ(eV)	E_δ(eV)	E_a (eV)
202	0.94	0.91	0.95	0.93 ± 0.02
200	1.10	1.08	1.11	1.10 ± 0.02

Table 2 presents the frequency factor (s) and lifetime (t) values considering general order kinetics. To calculate the frequency factor, the average activation energy (E_a) and kinetic order (b) were used in Equation 5. The mean lifetime was estimated at 25 °C (298 K) room temperature by using the Equation 6.

Table 2 - Frequency factor(s) and kinetic order b values

T_m (°C)	b	E_a (eV)	s (s^{-1})	t (days)
202(475 K)	1.15	0.93	1.72×10^9	35.45
200 (473 K)	1.32	1.10	1.47×10^{11}	311.76

The differences found in the activation energy (E_a) and kinetic order (b) values interfere significantly in the calculation of frequency factor (s). As a consequence, the calculated lifetime at room temperature for the glow peak of amethyst is also affected. Before the deconvolution procedure, the mean lifetime for the peak at 202 °C was approximately35 days. However, the calculated lifetime for the peak at 200 °C after deconvolution was around 312 days, suggesting a longer lifetime. The divergence in the results suggests that the peak at 202 °C may not be isolated enough for analysis with the peak shape methods.

In the powdered amethyst from Turkey (grains size 90x 140 μm), the main peak at 270 °C decay 14% after 7 days of stored at room temperature of 25°C (298 K) [14]. After that, no significant fading effect was observed around one month [14]. This result is more compatible with the lifetime calculated for the peak at 200 °C showed in Table 2.

In another study carried out in quartz from Japan, the parameters E = 1.07 eV and b = 1.32 for the TL peak at 192°C were observed after deconvolution [15]. These results are similar to the values of E and b for the peak at 200 °C shown in Table 2. On the other hand, in a natural quartz from Brazil, it was observed for the deconvoluted peak at 200 °C the parameters E = 1.28 eV and b = 1.38. In this case, a mean lifetime of 82 years was obtained at room temperature of 18 °C [16].

According to other authors, the fading observed after about one month of storage does not prevent the use of the amethyst for dosimetric applications [14]. In addition, the amethyst has the advantage that it can be reused without any substantial loss in sensitivity and various publications suggest the feasibility of utilizing the luminescence properties of amethyst for dosimetry purposes in high doses [14, 17, 18].

IV. CONCLUSION

By using the peak shape methods, it was observed a difference in the values of the kinetic parameters *b*, *E* and *s* before and after the deconvolution procedure. Different values of kinetic parameters directly interfere to calculated lifetime of the glow peak at 202 °C of amethyst investigated.

The mean lifetime found at room temperature of 25ºC, before and after deconvolution, were of the order of 35 and 312 days, respectively. These divergent results show the importance of the deconvolution to analysis of glow peaks that are not sufficiently separated.

It is important to highlight that no study has been found until now that investigated the kinetic parameters of the glow peak at 202 °C of amethyst from Lajeado exposed to high dose of gamma radiation. Therefore, further studies are still necessary that can affirm these preliminary results.

REFERENCES

[1] Ogundare, F. O., Balogun, F. A. & Hussain, L. A. (2006). Evaluation of kinetic parameters of traps in thermoluminescence phosphors. *Radiation Measurements*,41(7-8), pp. 892-896. DOI: 10.1016/j.radmeas.2006.06.014

[2] Strauss, L. & Hajek, M. (2007). *Review of methods for the determination of the kinetic parameters of thermoluminescence dosimeters.* Project thesis, Atomic Institute of Austrian Universities, Vienna, Austria.www.ati.ac.at

[3] Mahesh, K., Weng, P. S. & Furetta, C. (1989). *Thermoluminescence in solids and its applications.* Kent, Ashford:Nuclear Technology Publishing.

[4] Chen, R. & McKeever, S. W. S. (1997). *Theory of thermoluminescence and related phenomena.*Singapore: World Scientific. DOI: https://doi.org/10.1142/2781

[5] Bos, A. J. J. (2001). High sensitivity thermoluminescence dosimetry. *Nuclear Instruments & Methods in Physics Research. Section B: Beam Interactions with Materials and Atoms*, 184, pp. 3-28.

[6] Es, H. J., Vainshtein, D.I., Rozendaal, A., Donoghue, J.F., Meijer, R.J. & Hartog, H.W. (2002). Thermoluminescence of $ZrSiO_4$ (zircon): A new dating method? Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms. DOI: 10.1016/S0168-583X(02)00627-4.

[7] Tatumi, S.H., Kinoshita, A., Fukumoto, M.E., Courriol, L.C., Kassab, L.R.P., Baffa, O. & Munita, C.S. (2005). Study of paramagnetic and luminescence centers of microcline feldspar. *Applied Radiation and Isotopes*, 62(2), pp. 231-236.

[8] Souza, D. N., Lima, J. F., Valério, M. E. G. & Caldas, L. V. E. (2006). Thermally stimulated luminescence and EPR studies on topaz. Applied Radiation and Isotopes 64, pp. 906–909. DOI: 10.1016/j.apradiso.2006.03.006.

[9] Carvalho Júnior, Álvaro & Barros, Thiago & Guzzo, Pedro & Khoury, Helen. (2012). Manufacturing Polycrystalline Pellets of Natural Quartz for Applications in Thermoluminescence Dosimetry. Materials Research, 15, pp. 536-543. DOI: 10.1590/S1516-14392012005000075.

[10] D.J. Huntley, D.I. Godfrey-Smith, M.L.W. Thewalt & G.W. Berger. (1988). Thermoluminescence spectra of some mineral samples relevant to thermoluminescence dating. Journal of Luminescence, 39(3), pp. 123-136.DOI: https://doi.org/10.1016/0022-2313(88)90067-1

[11] McKeever, S. W. S. (1984). Thermoluminescence in quartz and silica. Radiation Protection Dosimetry, 8(1-2), pp. 81-98.

[12] Preusser, F., Chithambo, M., Götte, T., Martini, M. Ramseyer, K., Sendezera, E., Susino, G. & Wintle, A. (2009). Quartz as a natural luminescence dosimeter. Earth-Science Reviews, 97, pp. 184-214. DOI: 10.1016/j.earscirev.2009.09.006.

[13] Rossman, G. (1994). Colored varieties of the silica minerals. Reviews in Mineralogy 29, 433–468.

[14] Nur, N., Yeğingil, Z., Topaksu, M., Kurt, K., Doğan, T., Sarıgül, N., Yüksel, M., Altunal, V., Özdemir, A., Güçkan, V.& Günay, I. (2015). Study of thermoluminescence response of purple to violet amethyst quartz from Balikesir, Turkey. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms.* DOI: 10.1016/j.nimb.2015.05.011

[15] Song, K. W., Kim, K. B.& Hog, D. G. (2010). Determination of trap parameters for thermoluminescence glow peaks of red thermoluminescence of quartz from Japan. *Radiation Effects & Defects in Solids: Incorporating Plasma Science & Plasma Technology*. 165(4), pp. 305-312.

[16] Khamis, F.& Arafah, D. E. (2017). Thermoluminescence characteristics of natural quartz and synthesized silica glass prepared by sol-gel technique. *Asian Journal of Physical and Chemical Sciences.* 3(1), pp. 1-16.

[17] Rocha, F. D.G.,Oliveira, M. L., Cecattib, S. G. P., Caldas, L. V. E. (2003) Properties of sintered amethyst pellets as thermoluminescent dosimeters. Applied Radiation and Isotopes, 58, pp. 85–88.

[18] Silva, N. A., Tatumi, S. H., Soares, A. de F., & Barbosa, R. F. (2021). Characterization of amethyst applied to TL and OSL dosimetry. *Brazilian Journal of Radiation Sciences*, 9(1A). DOI: https://doi.org/10.15392/bjrs.v9i1A.1394.

[19] McLaughlin, W.L., Boyd, A.W., Chadwick, K.H., McDonald, J.C., & Miller, A. (1989). Dosimetry for radiation processing. United Kingdom: Taylor and Francis.

[20] Morrissey, R. F. & Herring, C. M. (2002). Radiation Sterilization: Past, Present and Future. Radiation Physics and Chemistry, 63, pp. 217-221.

[21] Lameiras, F. S., Nunes, E. H. M., Vasconcelos, W. L. (2009). Infrared and Chemical Characterization of Natural Amethysts and Prasiolites Colored by Irradiation. Materials Research, 12(3), pp. 315-320.

[22] Dotto, C. T. & Isotani, S. (1991). Irradiation and heating effects in amethyst crystals from Brazil. Radiat. Eff. Defects Solids. 117, pp. 355–361.
[23] McKeever, S. W. S. (1985). Thermoluminescence of solids. Cambridge University Press, Cambridge, 390 pp
[24] Karmakar, M., Mazumdar, P., & Azharuddin, S.M. (2012). Peak Shape Method in Thermoluminescence: An Overview. *Material Science Research India, 9*, 39-49.
[25] Pagonis, V., Kitis, G., & Furetta, C. (2006). Numerical and practical exercises in thermoluminescence.
[26] Kitis, George & Pagonis, V. (2007). Peak shape methods for general order thermoluminescence glow-peaks: A reappraisal. *Nuclear Instruments & Methods in Physics Research Section B-beam Interactionswith Materials and Atoms*, 262. 313-322. DOI: 10.1016/j.nimb.2007.05.027.
[27] Kitis, G, Gomez-Ros, J M, & Tuyn, J W.N. *Thermoluminescence glow-curve deconvolution functions for first, second and general orders of kinetics*. United Kingdom. DOI: https://doi.org/10.1088/0022-3727/31/19/037Baliam
[28] Balian, H. G., Eddy, N. W. Eddy. (1977). *Figure-of-merit (FOM), an improved criterion over the normalized chi-squared test for assessing goodness-of-fit of gamma-ray spectral peaks*. Nuclear Instruments and Methods, 145(2), pp.389-395. DOI: https://doi.org/10.1016/0029-554X(77)90437-2.
[29] Tahiri, N., Khouchaf, L., Elaatmani, M., Louarn, G., Zegzouti, A. & Daoud, M. (2014). *Study of the thermal treatment of SiO_2 aggregate*. Materials Science and Engineering, 62, pp. 1088-1757. DOI: 10.1088/1757-899X/62/1/012002.
[30] Guzzo, P.L., Khoury, H.J., Miranda, M.R., Barreto, S.B., Shinohara, A.H. (2009). *Point Defects and Pre-dose Requirements for Sensitization of the 300°C TL peak in natural quartz*. Phys. Chem. Minerals,36, 75-85.
[31] Guzzo, Pedro & Iwasaki, Fumiko & Iwasaki, Hideo. (1997). *Al-related centers in relation to γ-irradiation: Response in natural quartz*. Physics and Chemistry of Minerals, 24, pp. 254-263. DOI: 10.1007/s002690050037.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.9

The addition of *Syzygium aromaticum* essential oil preserves the microbiological and physicochemical quality of the fermented milk beverage during storage

Paula Karoline Soares Farias[1], Francine Souza Alves da Fonseca[2], Ernane Ronie Martins[3], Marinilza Soares Mota Sales[4], Agda Silene Leite[5], Fabíola Belkiss Santos de Oliveira[6], Pedro Miranda Mendes[7], Alcinei Místico Azevedo[8], Igor Viana Brandi[9], Renata Ribeiro Durães[10], João Matheus Almeida Ravnjak[11], Cintya Neves de Souza[12], Cláudia de Andrade Souto[13], Anna Christina de Almeida[14]

[1]Instituto de Ciências Agrárias, Universidade Federal de Minas Gerais – ICA/UFMG, Montes Claros – MG, Brazil.
Email: paulak.soares@hotmail.com
[2]Instituto de Ciências Agrárias, Universidade Federal de Minas Gerais (UFMG), Montes Claros – MG, Brazil.
Email: francinefonseca@yahoo.com.br
[3]Instituto de Ciências Agrárias, Universidade Federal de Minas Gerais (UFMG), Montes Claros – MG, Brazil.
Email: ernane.ufmg@gmail.com
[4]Universidade Estadual de Montes Claros – Unimontes, Montes Claros – MG, Brazil.
Email: marinilzamota@gmail.com
[5]UNIFIPMoc University Center, Montes Claros – MG, Brazil.
Email: agdaleite@santacasamontesclaros.com.br
[6]UniFIPMOCAFYA, Montes Claros – MG, Brazil.
Email: fabiolabelkiss@hotmail.com
[7]Universidade Estadual de Montes Claros – Unimontes, Montes Claros – MG, Brazil.
Email: pedromir1978@hotmail.com
[8]Instituto de Ciências Agrárias, Universidade Federal de Minas Gerais (UFMG), Montes Claros – MG, Brazil.
Email: alcineimistico@hotmail.com
[9]Instituto de Ciências Agrárias, Universidade Federal de Minas Gerais (UFMG), Montes Claros – MG, Brazil.
Email: ibrandi@hotmail.com
[10]Faculdades Integradas do Norte de Minas – FUNORTE. Montes Claros, MG. Brazil.
Email: renataaduraes@gmail.com
[11]Medical Student at UniFIPMOCAFYA, Montes Claros – MG, Brazil.
Email: jmasmc1999@gmail.com
[12]Instituto de Ciências Agrárias, Universidade Federal de Minas Gerais (UFMG), Montes Claros – MG, Brazil.
Email: cintyamicro@hotmail.com
[13]Universidade Estadual de Montes Claros – Unimontes, Montes Claros – MG, Brazil.
Email: claudiaasouto@gmail.com
[14]Instituto de Ciências Agrárias, Universidade Federal de Minas Gerais (UFMG), Montes Claros – MG, Brazil.
Email: aca2006@ica.ufmg.br

Received: 03 Apr 2022,
Received in revised form: 29 Apr 2022,
Accepted: 05 May 2022,
Available online: 15 May 2022

Abstract *— The addition of essential oils (EO) as a natural preservative in dairy products and food matrices has been an alternative to synthetic preservatives. Clove EO (Syzygium aromaticum L.) is a potential possibility because it has therapeutic functions, antimicrobial and antioxidant activity, as well as bioactive compounds. In this study,*

***Keywords* — Clove, Natural Preservative, Dairy Products, Headspace, Eugenol.**

concentrations of S. aromaticum EO were added to a fermented milk drink and the effect on the conservation of the microbiological and physicochemical quality of the product during storage was evaluated. Headspace analysis identified four bioactive chemical compounds from the EO of S. aromaticum in the fermented milk drink, namely eugenol, β-Caryophyllene, α-Humelene and copaene. The microbiological and physicochemical stability parameters of the fermented milk beverage were maintained during storage, indicating that the EO of S. aromaticum contributed to the maintenance of the quality of the manufactured product. In conclusion, the addition of S. aromaticum EO at concentrations of 10, 20 and 30 µL/mL in fermented milk drink helped to preserve the quality of the product in storage. In addition, the milk matrix does not interfere with the presence of bioactive chemical compounds in the oils.

I. INTRODUCTION

In recent years, the general population has been concerned about consuming healthier foods, which favor physical well-being and prevent the risk of diseases [1]. As a consequence, there was a reduction in the intake of processed foods, especially due to the presence of potentially carcinogenic preservatives [2]. In this sense, replacing the use of synthetic preservatives with "natural" components makes essential oils a potential alternative [3,4].

Essential oils (EO), known as volatile or ethereal oils, are volatile, hydrophobic and rarely colored aromatic compounds, originating from the secondary metabolism of plants [2,5]. According to Worwood (2016) [6], EO have several therapeutic functions such as anti-inflammatory, antiseptic, tonic, antispasmodic and diuretic activity. In addition, studies report antimicrobial effects in controlling pathogenic microorganisms [7-9].

Due to their medicinal characteristics, EO have been used as a natural preservative in dairy products and other food matrices [10-12]. Clove (*Syzygium aromaticum* L.) is one of the most valuable spices since antiquity, being widely used in traditional foods and medicines around the world [13]. The *S. aromaticum* EO is extracted from the dried flower bud of the plant and has several activities, demonstrated so far, such as anti-inflammatory, antimicrobial, antibacterial, antiviral [14], antioxidant and antifungal [15], due to the presence of bioactive chemical compounds such as eugenol and other phenolics [2].

Although there are several studies that report the use of EO as a preservative in dairy products and stored foods, so far, there are no scientific reports on the use of EO from *S. aromaticum* in the conservation of fermented milk drinks and, therefore, studies in the area should be carried out. In view of the above, the objective of this study was to evaluate the effect of the addition of EO of *S. aromaticum* on the conservation of the microbiological and physicochemical stability of fermented dairy beverage during storage.

II. MATERIALS AND METHODS

2.1 Materials

Whey and UHT milk were purchased from the local market. For the fermentation of the dairy beverage, a culture Direct Vat Set (DVS) containing lyophilized mixed strains of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp bulgaricus (YoFlex Harmony 1.0 –C.H, Horsholm, Denmark) was used. The EO of *S. aromaticum* was provided by Ferquima (Vargem Paulista, SP, Brazil), as adopted by Farias et al. (2019) [16]. The other ingredients used in the formulation were purchased from a local establishment. All reagents used in this study were of analytical grade.

2.2 Production of fermented milk drink added with *S. aromaticum* EO

Four formulations were developed according to Figueiredo et al. (2019) [17], with modifications. The developed formulations contained concentrations of 10, 20 and 30 µL/mL of *S. aromaticum* EO and a control formulation added with the preservative potassium sorbate.

The drinks made consisted of 44.5% UHT whole milk, 44.5% reconstituted whey (15%), 10% sucrose and 1% modified starch. This first mixture was heat treated (65 °C for 30 minutes), with subsequent cooling (43 °C) and inoculation of 0.1% of thermophilic DVS lactic culture, containing mixed strains of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. bulgaricus, in the form of lyophilized granules. Then, the mixture was incubated at 43 °C in a BOD oven (model EL202/4E) until the moment it reached pH 4.60 and clot formation, with subsequent cooling at 5 °C for 5 hours.

Then, the clot was agitated and *S. aromaticum* EO was added, with subsequent homogenization. For the control formulation, 0.003 g/mL of the preservative potassium sorbate was added. Beverages were packaged in one-liter hermetically sealed plastic packages, labeled and stored under refrigeration (5 °C) until analysis.

Stability of the fermented milk drink during storage evaluate the stability of dairy beverages, microbiological and physical-chemical tests were carried out during a 28-day storage period. The analyzes were performed using a randomized block design (RBD), with three replications for the concentration of essential oil formulations and one for the control formulation.

2.3 Microbiological analyzes

The microbiological analyzes were performed according to the methods described by APHA (2015) [18]. The presence of total and thermotolerant coliforms was determined using the series of 3 multiple test tubes, and the results were expressed as the most probable number (MPN) per mL. The viable lactic acid bacteria count was assessed by MRS agar plate counting and incubated in anaerobic conditions at 37 °C for 72 hours. Results were expressed in colony-forming units (CFU) per mL.

2.4 Physicochemical analysis

The physicochemical analyzes were performed according to the methods adopted by AOAC (2000) [19]. The determination of pH was carried out at room temperature (25 ± 2 ºC) using a digital pH meter (model LUCA-210). For acidity, 10 mL of sample was diluted in 10 mL of distilled water and titrated with NaOH solution (0.1M). Results were expressed in g lactic acid/100g sample.

The analysis of protein and fat contents was based on Kjeldahl and Gerber methods, respectively [19]. The syneresis index was determined using the method described by Amaya-Llano et al. (2008) [20].

2.5 Headspace analysis

Product headspace analysis was performed according to Aguiar et al. (2014) [21], with modifications. The headspace flasks (20 mL) containing the product (1 mL) were transferred to the autosampler (HS combi-PAL) where they were homogenized (500 rpm), incubated (75 °C, 5 minutes) and the volatile substances extracted by static headspace. The injection volume was defined (1000 µL) and the syringe was preheated (75 °C).

Agilent Technologies (7890A) system coupled to a mass spectrometer (MS 5975C) equipped with a DB-5 MS fused silica capillary column (30 m x 0.25 mm x 0.25 µm) and helium (flow 1 mL min-1) as carrier gas was used for the identification analysis of volatile chemical compounds. The temperature was programmed from 60 ºC to 240 ºC, with an increment of 3 ºC min-1. The system was operated in scan mode (monitoring) with electronic impact at 70 eV, in a range from 45 to 550 (m/z).

The generated data were analyzed using the MSD Chemstation software together with the NIST library (National Institute of Standards and Technology). The relative abundance (%) of the total ions referring to the compounds was calculated from the peak area of the chromatogram (GC) and organized according to the elution order. The percentage of each component was calculated from the normalized mean of the chromatogram area. The identification of compounds was performed by comparing the mass spectrum with that of the NIST library (2.0, 2009) and compared with information from the literature [22].

2.6 Statistical analysis

Statistical analyzes were performed using the R software. For the microbiological results of total coliforms, thermotolerant coliforms and lactic acid bacteria counts, these were transformed into counts for Log X + 1, and beta regression was used, in the link function (logit). For the comparison of means, the Dunnett test was used at a 5% significance level.

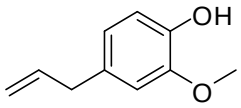
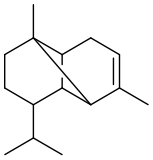
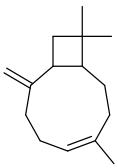
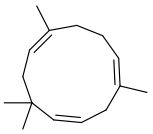
To study the effects of oil concentrations in dairy beverages, the multiple regression methodology was used. In this analysis, the statistical model was considered: $zi = a + bxi + cxi^2 + dyi + fyi^2 + gxiyi + hxiyi^2 + ei$. To estimate the regression coefficients, the least squares method was used, with the help of the lm function of the R software.

For the selection of the best fitted models, the Akaike information criterion (AIC) was considered, in which models with lower estimates are preferable. From the regression models, the values predicted by the predict function were obtained and from these values the response surface graphs were created using the SigmaPlot V11 software.

III. RESULTS

Headspace analysis revealed the presence of four chemical compounds in the fermented milk beverage added with *S. aromaticum* EO during storage for 28 days (Table 1). These results show that the milky matrix of the beverage did not interfere with the presence of bioactive compounds in the oil.

Table 1. HS-GC-MS analysis of the dairy beverage after 1, 14 and 28 days of preparation with the addition of clove essential oil (Syzygium aromaticum).

N°	[a]RT	Compounds	[b]Structure	[e]MF	Characteristic ions (m/z)	Samples detected
1	37,0	Eugenol		$C_{10}H_{12}O_2$	164 (M^+100), 149(36), 137(20), 133(19), 131(19), 104(20), 103(32), 91(27), 77(30), 55(12)	Clove essential oil (control), all analyzed
2	37,6	Copaene		$C_{15}H_{24}$	204(M^+ 24), 161(100), 119(91), 105(89), 93(43), 92(23), 91(39), 81(22), 77(18), 55(12)	Clove essential oil (control), all analyzed
3	39,2	β-Caryophyllene		$C_{15}H_{24}$	204(M^+20), 189(43), 175(15), 121(35), 120(46), 119(50), 109(20), 107(53), 106(35), 105(72)	Clove essential oil (control), all analyzed
4	40,3	α-Humelene		$C_{15}H_{24}$	204(M^+10), 147(20), 122(9), 121(32), 119(12),109(13), 107(20), 105(15), 94(14), 93(100)	Clove essential oil (control), all analyzed

[a]Retention time in minutes; [b]Structure; [e]MF: Molecular formulae. Information obtained from the NITS 2.0 library.

According to Lambert et al. (2020) [23] the main constituent of the EO of *S. aromaticum* is eugenol corresponding to about 61% of the chemical composition. In addition, β-Caryophyllene and α-Humelene compounds are found in smaller amounts of 19.95% and 2.87%, respectively. Chaieb et al. (2007) [24] detected 36 EO compounds from *S. aromaticum*, in which eugenol (88.58%) traces of copaene were found in higher concentration and quantities (<0.01%). Other studies also describe eugenol as the most common bioactive compound in the EO of *S. aromaticum* [2,13].

The effects of *S. aromaticum* EO on the microbiological indicators of the fermented dairy beverage are represented in Figure 1. According to these results, the minimum quality requirements of dairy beverage for total coliforms (Figure 1A) and thermotolerant coliforms (Figure 1B) were maintained, as recommended by Brasil (2005) [25]. The lactic acid bacteria count (Figure 1C) remained above the values of 106 CFU/g, indicating that the oil concentrations did not interfere with the viability of these microorganisms.

Figueiredo et al. (2019) [17], evaluating fermented dairy beverages with pulp from cerrado fruits, found viable lactic cell values greater than 106 CFU/mL at 21 days of storage. According to Kechagia et al. (2013) [26] the minimum concentration of 106 CFU/g of viable cells is generally accepted for probiotic products. In this sense, the results show that the dairy beverage with EO of *S. aromaticam* is a potential probiotic product.

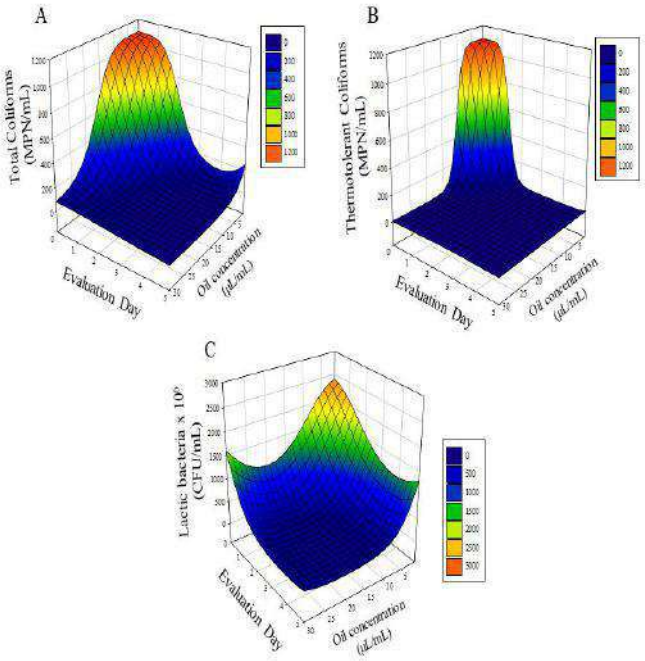


Fig.1. Effect of S. aromaticum EO concentration on microbiological parameters of fermented milk beverage. Total coliforms (MPN/mL) (A), Thermotolerant coliforms (MPN/mL) (B) and Lactic acid bacteria (CFU/mL) (C). Evaluation day: 1= 1st day of storage; 2= 7th day of storage; 3= 14th day of storage; 4= 21st day of storage; 5= 28th day of storage.

Regarding the effect of *S. aromaticum* EO on the physicochemical parameters of the fermented milk beverage, the results are shown in Figure 2. The syneresis values (Figure 2A) ranged from 8 to 26% during storage. Syneresis is an important factor in consumer acceptance of the product. This phenomenon is characterized by the contraction of the gel network resulting in decreased viscosity and gel strength [27].

A value of 25.33% of syneresis in a fermented dairy beverage with cajá-manga pulp was found at 14 days of storage [28]. According to Aportela-Palacios et al. (2005) [29] ideal syneresis values should be below 39%. Taking this into account, the syneresis results (Figure 2A), of the present study, show that the addition of EO from *S. aromaticum* does not cause a high increase for this parameter in the dairy beverage, thus being within the ideal values defined by Aportela-Palacios et al. (2005) [29].

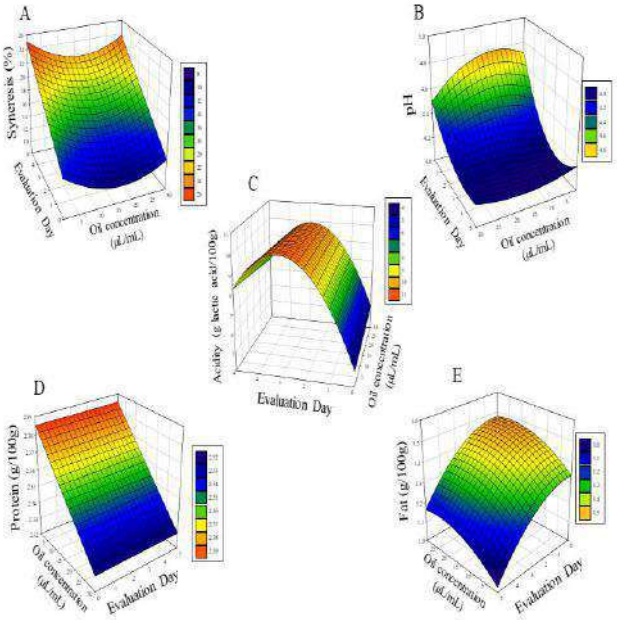


Fig.2. Effect of S. aromaticum EO concentration on the physicochemical parameters of the fermented milk beverage. Syneresis Index (%) (A), pH (B), Acidity (g lactic acid/100g) (C), Protein (g/100g) (D) and Fat (g/100g) (E). Evaluation day: 1= 1st day of storage; 2= 7th day of storage; 3= 14th day of storage; 4= 21st day of storage; 5= 28th day of storage.

The pH values (Figure 2B) ranged from 4.06 to 4.55, being within the appropriate pH range (3.6 to 4.6) for post-processing condition of lactic acid bacteria [30]. Regarding acidity (Figure 2C) the values ranged from 0.66 to 0.95 g of lactic acid/100g. Souza et al. (2020) [28], studying the physicochemical stability of a dairy beverage fermented with cajá-manga pulp, observed pH values ranging from 4.18 to 4.31 and acidity between 0.81 to 0.80%, during storage for 14 days.

The protein values (Figure 2D) observed for dairy drinks were within the acceptable range established by Brasil (2005) [25], which recommends minimum values of 1.7 g/100g of protein for dairy drinks. Dias et al. (2013) [31], evaluating a symbiotic fermented dairy beverage, found a protein value of 1.86 g/100mL of the product. According to Day (2016) [32] proteins are important macronutrients and make up around half of the dry weight of the human body. Accordingly, Cho and Jones (2019) [33] reinforce that proteins are an essential nutrient for the development and maintenance of human beings, in addition, they are considered an alternative in the development excellent food matrices.

Regarding the fats (Figure 2E) the levels varied between 1.0 and 1.5 g/100g of the product. However, fats are nutrients that cannot always be considered as a

negative attribute in food products. According to Luca (2019) [34], fats are important macronutrients, being responsible for providing 35% of total caloric intake, especially in the form of triacylglycerols (TGs). In addition, they provide calories, essential fatty acids (EFA) and contribute to the palatability of foods.

IV. CONCLUSION

The addition of *S. aromaticum* EO at concentrations of 10, 20 and 30 µL/mL in fermented milk drinks helped to preserve the microbiological and physicochemical quality of the product during storage. In addition, the milk matrix does not interfere with the presence of bioactive chemical compounds in the essential oils. However, it is essential to investigate higher EO dosages of *S. aromaticum* in dairy beverages. In addition, sensory tests must be carried out to verify the acceptance and influence of the addition of *S. aromaticum* EO on the flavor of the products.

ACKNOWLEDGEMENTS

We thank the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior Brasil (CAPES) - Finance Code 001, Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Ministério da Educação/ Secretaria de Educação Superior (MEC/SESu) - EDITAL PROEXT 2015 and Pro- Reitoria de Pesquisa da Universidade Federal de Minas Gerais (PRPq-UFMG), for supporting our research.

REFERENCES

[1] Ali A, Rahut DB. Healthy Foods as Proxy for Functional Foods: Consumers' Awareness, Perception, and Demand for Natural Functional Foods in Pakistan. Int. J. Food Sci. 2019; 1-12. Available from: https://doi.org/10.1155/2019/6390650

[2] Radunz M, Trindade MLM, Camargo TM, Radunz AL, Borges CD, Gandra EA. et al. Antimicrobial and antioxidant activity of unencapsulated and encapsulated clove (*Syzygium aromaticum*, L.) essential oil. Food Chem. 2019; 276:180-186. Available from: https://doi.org/10.1016/j.foodchem.2018.09.173

[3] Silvestre WP, Livinalli NF, Baldasso C, Tessaro IC. Pervaporation in the separation of essential oil components: A review. Trends Food Sci Technol. 2019; 93:42-52. Available from: https://doi.org/10.1016/j.tifs.2019.09.003

[4] Simas DLR, Amorim SHBM, Goulart FRV, Alviano CS, Alviano DS, Silva AJR. Citrus species essential oils and their components can inhibit or stimulate fungal growth in fruit. Ind Crops Prod. 2017; 98:108-115. Available from: https://doi.org/10.1016/j.indcrop.2017.01.026

[5] Baser KHC, Buchbauer G. Handbook of Essential Oils: Science, Technology, and Applications, 2º edition. CRC Press 1128 p., 2015.

[6] Worwood VA. The complete book of essential oils and aromatherapy, revised and expanded: Over 800 natural, nontoxic, and fragrant recipes to create health, beauty, and safe home and work environments. USA: New World Library, 2016.

[7] Abbes C, Mansouri A, Landoulsi A. Synergistic effect of the lactoperoxidase system and cinnamon essential oil on total flora and Salmonella growth inhibition in raw milk. J. Food Qual. 2018; 1-6. Available from: https://doi.org/10.1155/2018/8547954

[8] Abboud M, El-Rammouz R, Jammal B, Sleiman M. In-vitro and in-vivo antimicrobial activity of two essential oils *Thymus vulgaris* and *Lavandula angustifolia* against *Bovine Staphylococcus* and *Streptococcus mastitis* pathogen. Middle East J. Agric. Res. 2015; 4:975-983. Available from: https://www.curresweb.com/mejar/mejar/2015/975-983.pdf

[9] Zhao X, Shi C, Meng R, Liu Z, Huang Y, Zhao Z. et al. Effect of nisin and perilla oil combination against *Listeria monocytogenes* and *Staphylococcus aureus* in milk. Journal of Food Science and Technology, J. Food Sci. Technol. 2016; 53:2644-2653. Available from: https://doi.org/10.1007/s13197-016-2236-6

[10] Benchaar C, Greathead H. Essential oils and opportunities to mitigate enteric methane emissions from ruminants. Anim. Feed Sci. Technol. 2011; 166-167:338-355. Available from: https://doi.org/10.1016/j.anifeedsci.2011.04.024

[11] Jemaa MB, Falleh H, Saada M, Oueslati M, Snoussi M, Ksouri R. *Thymus capitatus* essential oil ameliorates pasteurization efficiency. J. Food Sci. Technol. 2018; 55:3446-3452. Available from: https://doi.org/10.1007/s13197-018-3261-4

[12] Mishra AP, Devkota HP, Nigam M, Adetunji CO, Srivastava N, Saklani S. et al. Combination of essential oils in dairy products: A review of their functions and potential benefits. Food Sci. Technol. 2020; 133: 110116. Available from: https://doi.org/10.1016/j.lwt.2020.110116

[13] Cortés-Rojas DF, Souza CRF, Oliveira WP. Clove (*Syzygium aromaticum*): a precious spice. Asian Pac J Trop Biomed. 2014; 4:90-96. Available from: https://dx.doi.org/10.1016%2FS2221-1691(14)60215-X

[14] Ryu B, Kim HM, Woo J-H, Choi J-H, Jang DS. A new acetophenone glycoside from the flower buds of *Syzygium aromaticum* (cloves). Fitoterapia. 2016; 115:46-51. Available from: https://doi.org/10.1016/j.fitote.2016.09.021

[15] Santamarina MP, Roselló J, Giménez S, Blázquez MA. Commercial *Laurus nobilis* L. and *Syzygium aromaticum* L. Merr. and Perry essential oils against post-harvest phytopathogenic fungi on rice. Food Sci. Technol. 2016; 65:325-332. Available from: https://doi.org/10.1016/j.lwt.2015.08.040

[16] Farias PKS, Silva JCRL, Souza CN, Fonseca FSA, Brandi IV, Martins ER, Azevedo AM, Almeida AC. Antioxidant

activity of essential oils from condiment plants and their effect on lactic cultures and pathogenic bacteria. Ciênc. Rural. 2019; 49:e20180140. Available from: http://dx.doi.org/10.1590/0103-8478cr20180140

[17] Figueiredo JSB, Santos GLM, Lopes JPA, Fernandes LB, Silva FN, Faria RB. et al. Sensory evaluation of fermented dairy beverages supplemented with iron and added by Cerrado fruit pulps. Food Sci. Technol. 2019; 39:410-414. Available from: https://doi.org/10.1590/fst.32616

[18] APHA - American Public Health Association. Compendium of methods for the microbiological examination of foods. Amer Public Health Assn, 5º ed., 995 p., 2015.

[19] AOAC - Association of Official Analytical Chemists. Official Methods of Analysis, Gaithersburg, Md.: AOAC International, 2000.

[20] Amaya-Llano SL, Martínez-Alegría AL, Zazueta-Morales JJ, Martínes-Bustos F. Acid thinned jicama and maize starches as fat substitute in stirred yogurt. LWT - Food Sci Technol. 2008; 41:1274-1281. Available from: https://doi.org/10.1016/j.lwt.2007.08.012

[21] Aguiar MCS, Silvério FO, Pinho GP, Lopes PSN, Fidêncio PH, Ventura SJ. Volatile compounds from fruits of *Butia capitata* at different stages of maturity and storage. Food Res. Int. 2014; 62:1095-1099. Available from: https://doi.org/10.1016/j.foodres.2014.05.039

[22] Adams RP. Identification of essential oils components by gas chromatography mass spectroscopy. 4.ed. Illinois: Allured Publishing Corporation, Carol Stream, 804 p., 2012.

[23] Lambert MM, Campos DR, Borges DA, Avelar BR, Ferreira TP, Cid YP. et al. Activity of *Syzygium aromaticum* essential oil and its main constituent eugenol in the inhibition of the development of *Ctenocephalides felis felis* and the control of adults. Vet. parasitol. 2020; 282:109126. Available from: https://doi.org/10.1016/j.vetpar.2020.109126

[24] Chaieb K, Hajlaoui H, Zmantar T, Kahla-Nakbi AB, Rouabhia M, Mahdouani K, Bakhrouf A. The chemical composition and biological activity of clove essential oil, Eugenia caryophyllata (*Syzygium aromaticum*, *L. Myrtaceae*): A short review. Phytother Res. 2007;21:501-506. Available from: https://doi.org/10.1002/ptr.2124

[25] Brasil. Ministério da Agricultura, Pecuária e Abastecimento. Instrução Normativa n. 16, de 23 de agosto de 2005. Regulamento Técnico de Identidade e Qualidade de Bebidas Láctea. Diário Oficial [da] República Federativa do Brasil, Brasília, 24/08/2005, Seção 1, p. 7, 2005.

[26] Kechagia M, Basoulis D, Konstantopoulou S, Dimitriadi D, Gyftopoulou K, Skarmoutsou N, Fakiri EM. Health benefits of probiotics: a review. ISRN Nutrition. 2013; 1-7. Available from: https://dx.doi.org/10.5402%2F2013%2F481651

[27] Vareltzis P, Adamopoulos K, Stavrakakis E, Stefanakis A, Goula AM. Approaches to minimize yoghurt syneresis in simulated tzatziki sauce preparation. Int. J. Dairy Technol. 2016; 69:191-199. Available from: https://doi.org/10.1111/1471-0307.12238

[28] Souza, H. F.; Borges, L. A.; Lopes, J. P. A.; Carvalho, B. M. A.; Santos, S. H. S.; Almeida, A. C. et al. Elaboration, evaluation of nutritional information and physical-chemical stability of dairy fermented drink with caja-mango pulp. Ciênc. Rural. 2020; 50:e20190644. Available from: https://doi.org/10.1590/0103-8478cr20190644

[29] Aportela-Palacios A, Sosa-Morales ME, Vélez-Ruiz JF. Rheological and physicochemical behavior of fortified yogurt, with fiber and calcium. J. Texture Stud. 2005; 36: 333-349. Available from: https://doi.org/10.1111/j.1745-4603.2005.00020.x

[30] Reis SM, Mendes GRL, Carvalho Mesquita BMA, Lima WJN, Durães Pinheiro CAF, Ruas FA. et al. Development of milk drink with whey fermented and acceptability by children and adolescents. J. Food Sci. Technol. 2021; 58(7):2847-2852. Available from: https://doi.org/10.1007/s13197-021-05003-w

[31] Dias MLLA, Salgado SM, Guerra NB, Livera AVS, Andrade SAC, Cruz Ximenes GN. Phisicochemical, sensory, and microbiological evaluation and development of symbiotic fermented beverage. Food Sci. Technol. 2013; 33:805-811. Available from: https://doi.org/10.1590/S0101-20612013000400030

[32] Day L. Protein: Food Sources. Encyclopedia of Food and Health, AgResearch Ltd., Palmerston North, New Zealand, 2016.

[33] Cho YH, Jones OG. Assembled protein nanoparticles in food or nutrition applications. (1st ed.). Advances in food and nutrition research. Adv Food Nutr Res. 2019;88:47-84. Available from: https://doi.org/10.1016/bs.afnr.2019.01.002

[34] Luca L. Fats: Nutritional and Physiological Importance. Encyclopedia of Food Security and Sustainability. 2019; 2:302-306. Available from: https://www.sciencedirect.com/science/article/pii/B9780081005965221434

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.10

Management Model for Small-Scale Dairies in the State of Bahia

Antonio Fernando Teixeira da Silva[1], Dr. Cristiano Vasconcelos Ferreira[2], Renelson Ribeiro Sampaio[3], Amanda MayumiTeramitsu Yamada[4]

[1]Centro Universitário SENAI CIMATEC, Salvador, Bahia, Brasil
E-mail: adm.fernandoteixeira@gmail.com
[2]Universidade Federal de Santa Catarina, Brasil
E-mail:cristiano.v.ferreira@ufsc.br
[3]Centro Universitário SENAI CIMATEC, Salvador, Bahia Brasil
E-mail: renelson@fieb.org.br
[4]Universidade Federal de Santa Catarina, Brasil
E-mail: amandamayumiii.AM@gmail.com

Received: 09 Apr 2022,

Received in revised form: 01 May 2022,

Accepted: 09 May 2022,

Available online: 19 May 2022

***Keywords*—Competitiveness, knowledge, management, milk, agro-industrial system.**

Abstract *— Dairy farming plays a crucial role in Brazilian agribusiness and contributes to the country's employment and income generation. Moreover, the state of Bahia is the largest consumer market for dairy products in the northeastern region of Brazil. On the other hand, it has been observed that rural producers have low productivity and competitiveness. In addition, there is a need to implement mechanisms to support the competitiveness of agribusinesses and the production sector from the perspective of food chains, based on the evaluation of factors related to intangible resources, given their importance to the economy. In this scenario, this article aims to present a Management Model for Small-Scale Dairies in the context of the Milk Agro-industrial System of Bahia (SAG Leite). To this end, we visited companies and rural producers and applied the Intellectual Capital Statement – Made in Europe model (InCaS) to evaluate the maturity level of the actors involved. To conclude, we present the Management Model for Small-Scale Dairies, which involves (i) stakeholders; (ii) information and knowledge; (iii) methods, tools, and technology; (iv) indicators and results; and (v) processes.*

I. INTRODUCTION

Agribusiness accounts for 21% of Brazil's Gross Domestic Product (GDP). It is one of the cornerstones of the country's economy and constitutes the so-called "Green Belt." Dairy farming stands out as the fourth most important economic sector in the national ranking, with US$ 10 billion in total annual revenues, according to the Census of Agriculture by IBGE (2017) [1], which makes the country a key player in the global commodities market.

In 2017, Brazil had the largest cattle herd globally, with 232 million head. Indeed, agricultural production (60% of which comes from dairy farming) is the basis of the economy of 90% of the country's municipalities (IBGE, 2017) [1]. However, production costs and inferior quality hinder the global competitiveness of Brazilian milk (Monteiro, 2020) [2].

According to Zacarchenco, Van Dender, and Rego (2020) [3] and the Union of Dairy Industries and Products Derived from Milk (Sindileite) (2018) [4], there is a trend toward the consumption of dairy products with high nutritional density, probiotics, prebiotics, fiber, and low fat and lactose.

The opening of the Chinese market for Brazilian milk powder and cheese has led to a need to improve the relationship between producers and plants, as reported by G1 (2019) [5] and the Brazilian Dairy Producers Association (Abraleite) (AGROemDIA, 2019) [6].

Also based on the 2017 Census of Agriculture by IBGE and the Federation of Industries of the State of Bahia (FIEB), the state produces about 40% of the milk in northeast Brazil and is the largest consumer market for regional dairy products. This scenario reflects the economic imbalance caused by the low productivity and competitiveness of the state's dairies, which needs to be analyzed and corrected.

The first problem concerns the imbalance between demand and supply in the commodities market, which, in turn, requires increased productivity.Another issue is the lack of mechanisms to support agro-industry competitiveness and parameters to measure the level of development of the relations between the production chain and the market.

In this context, this article aims to analyze the context of Bahia's Milk Agro-industrial System (from now on,"SAG Leite") and propose a Management Model for Small-Scale Dairies operating in the state. Primary data were collected through interviews conducted with dairy producers and plants. In addition, a questionnaire based on the InCaS instrument (Intellectual Capital Statement) was adapted to the reality of SAG Leite in order to diagnose it and measure its level of development.

Then, a proposal for the Management Model was prepared, based on the generation of knowledge and under the monitoring of indicators and/or parameters determined from the European concept of Initiative for Sustainable Productive Agriculture (INSPIA).

II. THE COMPETITIVENESS OF BRAZIL'S MILK AGRO-INDUSTRIAL SYSTEM

According to the concept of Davis & Goldberg (1957) [7], agribusiness is "the sum total of all operations involved in the manufacture and distribution of farm supplies; production operations on the farm; and the storage, processing, and distribution of farm commodities and items made from them." The rural complex is a corpus of specialized, independent entities linked to rural production. Agro-industrial systems also refer to "agribusiness," systems, chains, complexes, clusters, supply chains, and productive arrangements.

Among the agro-industrial systems, SAG Leite stands out for its long tradition of livestock farming, its importance for human nutrition, and the socio-economic impact of its economic activity. It features a standard design that shows the input suppliers (feed, for example), the *dentro da porteira* ("farm inputs") modality of production, the transportation, the dairy plant (processing and packaging), the distribution, and the consumers, as shown in Figure 1.

Fig.1 – Milk Agro-industrial System (SAG Leite)
Source: Rodrigues-Enriquez, Alor-Hernández & Sanchez-Ramires in ResearchGate(2015) [8]

Agro-industrial systems must be addressed in terms of their relationships and knowledge sharing to construct a management model that leads to competitiveness.

According to Zylbersztajn (1995), in an agro-industrial system, it is paramount to adopt a coordination structure responsible for minimizing costs, including the transaction costs necessary to drive the economic system and the prices to be charged. This coordination structure is based on market conditions, public policies, cooperative actions, joint ventures, and industry-producers integration and can facilitate or hinder the promotion of mechanisms to meet consumer demands based on the transmission of information and the reduction of transaction costs through quality control and production incentives.

High transaction costs indicate that the governance structure is carried out by the market with no contracts. Economic inefficiency occurs because the actors are independent and there are no economies of scale and scope; that is, prices alone fail to help coordination. If all the actors have the same perception of competitiveness, income will increase for all (ZYLBERSZTAJN, 1995) [10].

The industry is the driving force of value addition and has expanded its role and performance as a dynamic factor of the agro-industrial system. Therefore, it emerges as a natural actor to coordinate the chain and be in charge of the transaction costs of the economy, as proposed by Zylbersztajn (1995) [10], when answering a question by Coase (1988) [11]: "Why is not all production carried on by one big firm?".

The dairy industry is one of the most regulated sectors in the economy, which increases production costs. Therefore, it is crucial to reduce transaction costs so that the agro-industrial system can be competitive by considering the three competitive strategies pointed out by Porter (1986), namely cost leadership, differentiation and focus).

Distribution is the closest link to the consumer and points to information and trends, such as replacing products with low aggregation for those with higher added value (yogurts and dairy drinks, for example). In addition, one must consider cultural, economic, and socio-demographic characteristics. When projecting the results of the SAG Leite (which has oligopsony characteristics) from the viewpoint of market competition (which is an indispensable factor for the success of any enterprise), it is paramount to share information (feedback) with all agro-industrial components in the opposite direction of economic transactions.

As for competitiveness in agribusiness, the ongoing transformations have resulted in profound implications for organizations and production agents, among which we highlight the international trade intensity, the decreased protection for regional and national economies, and the pace of scientific and technological development, which, in turn, enables the dissemination of knowledge.

Iafelice (2021) [14] analyzed the concept of Davis & Goldberg (1957) [7] by comparing it with the current reality (referred to as the "New Form"). The author noted that after World War II, the expansion of global agricultural trade and the increase in productivity implied the use of agrochemicals, non-renewable fuels, technology, and specialization of supply chain actors on a larger scale. In addition, that study pointed to the increased interference of the financial system in the commodity market and the opening of the Chinese and European markets (we must consider that China First has been around for 5,000 years). The author also addressed the consequences of the COVID-19 pandemic, highlighting the need to employ competence, intelligence, diligence, and resilience to reorganize the world's agricultural production (especially the Brazilian one) amid an emerging scenario of rules, trends, possibilities, and resulting limitations.

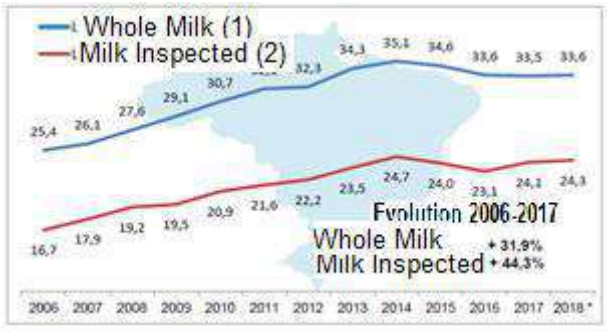
The effect of innovation in SAG Leite must be analyzed. Gunday et al. (2009) [13] dealt with the innovation and the performance of companies (or Agro-industrial Systems) and considered that "innovation is broadly seen as an essential component of competitiveness, embedded in the organizational structures, processes, products and services within a firm" (GUNDAY et al., 2009) [13]. In the scope of SAG Leite, innovation has been imposed by competition (from the introduction of differentiated products), putting pressure on profit margins and leading, in turn, to the need to increase sales volume through efficient distribution.

In this scenario, the competitive advantage for SAG Leite will derive from an adequate definition of the Management Model, which focuses on results and/or processes (PUCRS Online, 2020) [15].

According to the IBGE Census (2017) [1], since the 2000s, Brazilian milk production has reached 34 million liters/year. This resulted from the increase of investments in genetics, feeding, and logistic infrastructure for product conservation and the implementation of stricter legislation, all of which forced the improvement of quality and leveraged the amount of processed milk, according to Chart 1.

An important parameter is the lack of uniformity in productivity per cow/year reached in the largest producing states in Brazil, which reveals the lack of management homogeneity. Interestingly, the productivity, especially in the southern states of Brazil, is similar to that obtained by Uruguay and New Zealand, which are major players in the world market. However, there is a potential for growth in the other states, highlighting the importance of structuring and articulating the various actors.

Chart 1 – Brazil: evolution of national milk production (in billion liters)



(1) Municipal Livestock Survey; (2) Quarterly Milk Survey

Source: IBGE, 2017 [1]

We must emphasize the semi-extensive management system, typical of Brazil, which resorts to little feed supplementation during dry seasons and periods. The few producers assisted by rural extension adopt more modern exploitation techniques such as the storage of concentrated volume or green fodder (such as silage), irrigation, and pasture rotation. The use of feed supplementation (or the adoption of the confinement system) contributes to increasing costs and investments, consequently reducing the competitiveness of the farm.

Farm technology impacts the qualified supply of products. The difference between the volume produced and the volume processed is an aspect that deserves highlighting and is a direct consequence of the lack of quality of raw milk.

In 2017, the Brazilian dairy industry had a production capacity of around 24 billion liters per year, far above the volume effectively milked and processed, according to IBGE's Census of Agriculture; in other words, the sector operates at idle capacity.

III. PRIMARY RESEARCH ON THE MILK AGRO-INDUSTRIAL SYSTEM IN BAHIA

To diagnose the reality of dairy farming in Bahia from the perspective of the Milk Agro-industrial System (SAG Leite), a questionnaire was elaborated to be answered by producers and agribusiness representatives as follows:

a) Indústria Campanella Alimentos Ltda (Palmas de Monte Alto, in the microregion of Guanambi, in the Center-South of Bahia):

Campanella Alimentos Ltda started its activities in 1996, with the distribution of cold cuts, through a commercial representation established in Salvador, Bahia. In 2001, the company inaugurated the dairy plant to produce derived products such as cheeses, yogurts, drinks, sweets, and pasteurized milk.

Aiming at the sustainable development of the communities, the Campanella group provides technical support to the producers of associations and dairy basins in the region of Palmas de Monte Alto and neighboring municipalities under no integration regime.

Raw milk (90%) comes from family agriculture and is collected in trucks equipped with isothermal tanks. The raw material goes through a mapping process and quality control in the company's laboratory, which has reducedmilk acidity (before, only 20% of the milk received was used, but now only 10% is discarded).

To expand commercialization, a showroom was set up to sell products, mainly cheese. In addition, the planting of grapes to produce wine and add value to cheeses has been encouraged, and investments have been made in the technical improvement of workers and suppliers.

As for competitiveness, the owner of this company pointed out the lack of collaboration among dairy plants, considering the need to improve productivity in the field and the quality of the milk, given the region's potential.

b) Fazenda e Granja CarinhoLtda – Laticínios Bahia (Carinho Farm, BR 122 Highway, km 7, Pindaí, in the microregion of Guanambi, in the Center-South of Bahia):

Fazenda e Granja CarinhoLtda (Laticínios Bahia) was established in 1993 and has 35 employees. It works with milk produced by small producers in the region.

The agro-industry plant can receive 11,000 liters of milk per day on average but processes 7,000 liters in the dry season and operates at full capacity during the rainy season. At the time of this study, it paid producers US$0.40 per liter of milk. The farm has its personnel to regulate plant production.

Even though there are no formal integration contracts with small producers, the company provides technical assistance through an agronomic engineer who visits the properties and teaches producers how to plant grass and forage crops more suitable to the region, such as *andu* beans, in order to improve the animals' nutrition.

Due to the high costsin SAG Leite, particularly the inputs, the company installed a photovoltaic energy generation system.

Bahia dairy products are considered of decent quality and very competitive. However, the businessman in charge understands that a state policy for technical assistance and genetic improvement must be implemented, such as the one adopted by the Municipality of Pindaí, which provides high standard matrices and technical guidance on the farms.

c) Cooplar – Cooperativa de Lagoa Real Ltda (Lagoa Real, in the Center-South of Bahia):

Cooplar is a successful case in a very dry region, characterized by poor soils and inappropriate natural vegetation, requiring milk to be produced on a supplementary feeding basis.

The cooperative has 160 active members and participates in the Federal Government's *Fome Zero* program. This means that it must process the milk collected for consumption in the municipality after processing by the dairy plant.

The agro-industry canprocess 15,000 liters of milk per day, but its current output is 3,000 liters, reinforcing the need to expand production at the field level and the milk quality. Thus, as the genetic consistency of the herds is low, an improvement program must be put in place. Thus, Cooplar has selected breeds that best adapt to the dry characteristics of the region and disseminated the practice of artificial insemination (although at low intensity).

As for supplies, a 60-kilo sack of corn costs U$ 22.00, and a sack of cottonseed costs U$ 0.54. On the other hand, producers are paid $0.35 per liter of milk, which hampers production, even when they count on the subsidy offered by the *Fome Zero* program. Collecting milk on farms raises costs even higher. A few producers get the milk from the farm to the plant in inadequate storage and transport conditions. It is worth mentioning that some middlemen work collecting the milk in the region.

Cooplar makes the farm viable due to its lean administrative structure and efficient management that contributes to cost reduction, allowing the company to manufacture products well accepted in the market. We should also point out that through the *Fome Zero* program, the dairy plant receives around U$ 0.19 per liter of milk processed and delivered to the municipalities.

Expansions have been made in the plant, such as the acquisition of machinery and trucks, with resources totaling U$ 400,000, allocated from the *Bahia Produtiva* program organized by the World Bank to improve milk production. In addition, funding has been requested to hire a veterinarian to provide technical assistance services.

d) Coopag-Cooperativa de Produção Agropecuária de Jiló e Região Ltda (Várzea Nova, Piemonte da Chapada Diamantina):

Coopag is the largest agro-industry in the region of Várzea Nova and Miguel Calmon, between the municipalities of Jacobina and Morro do Chapéu. It has a daily reception capacity of 16,000 liters and contributes to closing the productive chain in such a poor and arid region.

Coopag's products are made with selected raw materials, go through rigorous control, and their quality is recognized in the market.

The fact that small cheese dairies are not certified by the *Sistema de InspeçãoEstadual* ("State Inspection Service," SIE) prevents them from being more aggressive in the market. As small producers are forced to sell their products to large dairy plants that buy milk in the region at very low prices, such as Betânia and Canastra, production becomes unviable due to high costs.

In this scenario, a strong feature of Coopag is the approximation with the region's small producers, which allows providing technical assistance and supporting the production and the collection of the product.

The dairy has a project to expand the structure for cheese production using funds granted by the *Bahia Produtiva* program. A strategy that has been successfully implemented is the purchase of fruit from regional suppliers to produce yogurts and pulps.

e) Indústria Leitíssimo S/A (Jaborandi, West Region):

The result of a meticulous work of almost 20 years, carried out by New Zealand entrepreneurs with expertise in dairy farming, Leitíssimo is based on the border between Goiás and Bahia and has stood out in the market for the quality of its product (Leitíssimo, 2020, and Globo Rural, 2020) [16] and [17].

At first, the breeding cows were genetically adapted to the tropical climate and selected from crossbreeding (artificial insemination) with the "KiwiCross" breed. This allowed a high average daily productivity without supplementary feeding, thusreducing production costs. The farm has an infrastructure focusing exclusively on field exploration, with irrigated pickets from a center pivot.

According to the farm manager, the highlights at the field level are:

- Low labor turnover, which increases involvement with the production and fosters continuous learning.
- A unique herd (selected and trained on the farm), free of tuberculosis, brucellosis, and other zoonoses, which increases productivity (milk is not collected off the property) and a competitive edge as to its lineage.
- The strategic location of the farm, at an altitude of 800 meters and surrounded by a natural reserve (75% of the total area), which provides isolation from other farming activities, reducing contagion and ensuring the control of the production process by adhering to health surveillance standards.

The production model is similar to that in New Zealand, where the high incorporation rate of technological improvements differentiates dairy farming from that practiced in other countries. In New Zealand, milk is produced on fertile land, with abundant water, in the field, and an adapted cattle herd based on the KiwiCross breed, resulting from the crossing and genetic adaptation of small Dutch cattle and Jersey breed. The production is carried out entirely in the field and results in a large volume of high-quality milk (with high solids content) and a reduced unit cost, which, in turn, increases the country's competitiveness worldwide.

f) Rural Producer "A," from Candiba:

The farm structure is adequate, has a reasonable level of mechanization and automation, and is equipped with a mechanical milking machine.

The producer uses complementary feed based on seed (bought in Barreiras, at U$ 0.40 per kilo), mixed with silage stored in large volume (seven silos ensure the feed during the dry season).

The animals have achieved an adequate level of genetic consistencydue to continuous selection. The farm adopts artificial insemination and natural mating using high standard bulls born from mothers and grandmothers selected for their high-yielding capacity.

The business operates as a family farm. The producer has a satisfactory level of knowledge but no controls. The management is performed instinctively and must be improved to contribute to the farm's efficiency.

The commercialization is assured by a partnership with Da Vaca dairy in Guanambi, which collects the milk stored in the expansion tank (including the region's production).

g) Rural Producer "B," from Barreiras (West Bahia):

The operations are based in a small property with less than 100 hectares, with five (5) employees and 50 breeding cows producing about 350 liters. The facilities, machinery, vehicles, and equipment are adequate, and the producer adopts adequate controls and computerized processes.

The producer acquires knowledge through the internet, is not a cooperative member, is not integrated with agribusinesses, and is paid according to the volume produced (no formal contract). The milk produced on this farm has 4.18% of solid content and is stored in expansion tanks.

According to the producer's view, the productive chain has relative competitiveness, and a positive change in the profile of dairy production in the region has been detected. However, he stresses the need for government intervention to improve productivity, as he considers technical assistance insufficient.

IV. ANALYSIS OF INFORMATION REGARDING THE BAHIA MILK SUPPLY CHAIN

Bahia's SAG Leite accounts for 4% of Brazil's gross agricultural production and is the largest milk producer in the Northeast (accounting for approximately 40% of the entire region), mainly due to the exploitation of the Cerrado biome in the Western Region. In 2017, agribusiness accounted for 24% of the state's GDP and 37% of exports, still according to the Census.

Bahia is one of the largest consumer markets in the country's Northeast region, and its demand is concentrated in the Metropolitan Region of Salvador. The state consumes more milk than it produces since the internal demand totals 1.2 billion liters/year; however, the supply reaches only 858 million liters/year (77.3 million of which are produced in the state's western region). In the state, 77.8% of the agricultural establishments are run by family farmers (the largest contingent in the country), who occupy 32.2% of the cultivated lands and typically have limited skills and education; moreover, their productivity is hampered by the lack or complete absence of technical assistance. That is, the farms are dispersed and misaligned and do not maintain loyal relationships with agribusinesses or processing cooperatives (IBGE, 2017).

Regarding the edaphoclimatic conditions, the state presents a diversity of biomes (*Cerrado*, Atlantic Forest, and *Caatinga*). However, agriculture and cattle-raising in Bahia operate largely in the semi-arid region and are, therefore, subject to the effects of drought.

According to IBGE (2017), producers in Bahia have low productivity because they use outdated technology and adopt inadequate prophylactic and sanitary practices. As a result, their production is very low compared to world averages, given the difficulty of enhancing farming techniques and the challenges posed by edaphoclimatic occurrences (such as the drought), which interfere by reducing profitability margins. For Lacki (1996) [9], producers make mistakes regarding factors and apply inadequate technologies. This, in turn, means that their unit costs are unnecessarily high and hurt their competitiveness.

In the processing stage, even having the power to determine the prices to be paid to producers, the agro-industries (dairy farms and plants) resort to imports due to the low productivity at the field level, thus implying a decrease in competitiveness caused by the inherent costs. Most agro-industries are small, family-based, and informal, such as the cheese dairies. Many are not particularly concerned about hygiene standards or raw materials control, nor are they inspected or comply with the sanitary legislation in force. Therefore, their competitiveness is low and requires incorporating technology to differentiate their product portfolio, add value, segmentcustomers, and reach other markets.

As for the know-how required to create conditions that can impact agro-industrial competitiveness, all research, bibliography, and experience come from and are targeted at the reality of the South/Southeast of Brazil, which is completely different from that of the Northeast.

For example, the west of Bahia receives much more sunlight than other regions, increasing green fodder production. For this reason, differently from the South and Southeast regions, where 30 pickets are used in rotational grazing, in Barreiras, it is possible to operate with 24 pickets (20% less).

Most cattle ranchers have low schooling and limited access to information and technical assistance. According to the IBGE (2017), 78% of Bahia's rural lands are used for agriculture and cattle ranching, 70% of the small

producers completed elementary school, and 80% do not receive regular visits from extension agents.

To mitigate this situation, the Brazilian Agricultural Research Corporation (Embrapa) created the *BaldeCheio* ("Full Bucket") program in 1998, based on rural extension and a strong emphasis on training. The technicians linked to *BaldeCheio* mentor producers, thus creating cooperation and commitment between producers and technicians while considering the profile of each actor involved. In Bahia, the Bahia Produtiva program has been changing the reality of small farms and milk producers. The program inverts the priority, taking the focus off dairy plants and redirecting it to the expansion of the production that will supply them.

The beneficiaries of *BaldeCheio* can take the production to the next level. For example, it has been found that 80% of participant farms have come to produce 100 liters/day in an extensive regime, increasing the production by 30% in the first months and 100% in the first year. This technical supervision must go on. When technical assistance is interrupted, the producer returns to the starting point on almost all occasions.

Another very important change in the west region is the introduction of associativism culture, which results in the organization of small producers into community associations and cooperatives, under the tutelage of the *Bahia Produtiva/AliançaProdutiva* programs, managed by the state government and funded with resources granted by the World Bank.

The program has allowed hiring a manager for the central cooperative in Barreiras and extension agents and technicians to work with the associations. The professional management combined the actions of the cooperative and associations, allowing the collective commercialization of milk with small dairies and increasing the small producers' bargaining power. In addition, the growth in production volume due to technical assistance allows the installation of concentrators that remove the excess water from milk; this, in turn, allows producers to sell the surplus to large dairy plants operating in other places and therefore reduces production costs. The association also facilitates collective purchases, thus reducing costs.

Furthermore, overseas enterprises have installed operations in the *Cerrado* biome and introduced innovative technology locally. An example of this is the Leitíssimo company, which is run by New Zealand entrepreneurs who settled in the town of Jaborandi about 15 years ago and adapted the production techniques used in the New Zealand dairy industry to the conditions of the *Cerrado*. However, their focus was different, and they set out to achieve a low cost per head instead of a high yield per animal.

Leitíssimo is the major enterprise in the region (which is characterized by the presence of small dairy plants). However, it will probably attract other entrepreneurs in the future since the conditions that the west offers to make it **Brazil's final dairy frontier.**First, however, small agribusinesses and producers must improve their efficiency by focusing on technology and management.

While Brazilian producers strive to increase their yields per hectare, Leitíssimo works with low average production, around 15 to 20 liters/head/day, in a pasture regime, using Tifton grass and corn and mineralization, and focuses on reducing product unit costs.

As for industrialization, differently from the traditional UHT technology employed by Brazilian dairies to process milk in carton packs, Leitíssimo produces long-life milk bottled in black film packs to prevent photooxidation and uses no preservatives. This method increases the quality of the product and adds more value to it. Furthermore, since their focus is to reduce the product unit cost, when the market is not very receptive, the surplus is sold to Piracanjuba, a large plantin the state of Goiás.

As for pricing, there is a concern in organizing the agro-industrial system in the region, and this has been achieved through professional meetings, seminars, and knowledge dissemination.Indeed, an initiative developed and managed for more than 20 years by the University of Maringá called ConseLeite was created from one of these meetings.ConseLeite is a software program that suggests a fair price to milk producers based on algorithms and confidential information provided by agro-industry companies (i.e., the industrialization cost) and producers' associations (i.e., the milk production cost). The companies do not have to pay the suggested price but have typically adopted it as a baseline. The gradual implementation of this methodology in Bahia represents an approximation between the industry and producers, which has boosted the search for efficiency.

Since they are closer to consumers, retailers have the highest profitability in the SAG Leite chain. Besides working at minimal risk, the large chains price the products and manage to obtain a profit margin of around 40%, compared to 20% by agro-industry companies and 10% by producers. This indicates that producers must join forces with plants, especially small and medium-sized ones. Therefore, the expansion of the use of ConseLeite may contribute to making the whole chain more efficient and shows the need to intervene in the medium and long terms through government policy. Indeed, pro-active producers and dairy plants have tried to achieve this, particularly through the Federation of Agriculture and Livestock of Bahia, which has spearheaded the efforts.

The timing is favorable to forward this regulation request to the Legislative Assembly and the State Government, considering that the milk production chain is one of the most important in Bahia and has great social appeal. Furthermore, the deficit between consumption (1.2 billion/liter/year) and production (less than 1 billion/liter/year) urges such initiatives.

As for the primary information collected, we can highlight the following key points:

- Both producers and plants must reconsider their view on the participation in associativism, as they lack a greater understanding of its challenges and benefits;
- There is an opportunity to integrate producers and agribusinesses to exchange experiences and know-how;
- There is a difference in perception regarding the competitiveness of SAG Leite, according to the producers' and plants' views;
- Regardless of productivity, the price paid per liter of milk is determined exclusively by the industry and solely considers the volume collected;
- There is practically no integration between producers and agro-industries, and only a lateral buying and selling relationship is maintained;
- In terms of technology, producers store their products in expansion tanks or cooling systems;
- Most of the know-how acquired by producers comes from internet research and training courses;
- In turn, the agro-industries typically rely on the internet andcourses and extension activities.
- It is worth noting the difficulty in providing rural extension services to producers in Bahia. The geographic extension, the lack of technicians, and the low schooling of the producers are barriers to achieving these goals.
- The family farmers are dispersed and misaligned in the process and do not have loyal relationships with the agro-industries or processing cooperatives.
- Dairies must make greater efforts to conquer the market and maintain their competitiveness. The adoption of innovative practices by agro-industries is incipient.
- The processing segment is characterized as an oligopoly and consists of medium and small enterprises. It relies on raw materials delivered by small producers in the state and imported powdered milk and pays low prices to raw milk producers.

In summary, the engagement in innovative practices in the dairy agro-industrial scenario in Bahia is limited or non-existent. This attests to the enormous potential for improvement in the scope of the issues addressed herein. The circumstances point to the need to propose a management model that contributes to leveraging the competitiveness of the dairy agro-industrial system in Bahia.

The need for the agribusiness to continue to provide ongoing support to the production link is evident, allowing the dissemination of knowledge and incorporating good practices throughout the Agro-industrial System.

V. USING THE INTELLECTUAL CAPITAL STATEMENT INSTRUMENT (INCAS) TO BUILD THE MANAGEMENT MODEL

To help to design a management model targeted at small dairies in Bahia, considering the need for knowledge incorporation, we resorted to the InCaS methodology, developed by the German pilot project Wissensbilanz – Made in Germany (led by Fraunhofer IPK, based in Berlin) and by the European pilot project "InCaS: Intellectual Capital Statement – Made in Europe." The methodology can be understood as an Intellectual Capital Statement (InCaS), an instrument to assess, develop, and report on an organization's intellectual capital and systematically monitor critical success factors.

Mertins and Will (2009)[18]analyzed the degree of importance of the critical factors for intellectual capital (IC) perceived by companies and what the structure of IC in an organization would be, supported by human (HC), structural (SC), and relational (RC) capital.

The starting point of the IC verification process is the vision of a given organization and its strategy, considering the possibilities and risks found in the business environment, according to Figure 2 (Mertins& Will, 2009) [18].

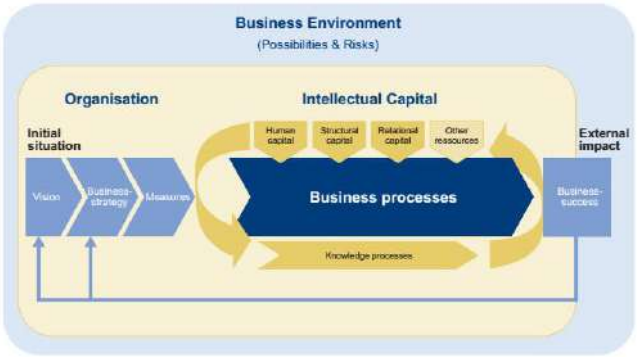


Fig.2. Representation of the business environment proposed by the European Commission's Directorate-General for Research, 2010.

Source: Mertins& Will (2009) [18]

To develop a catalog of requirements for ICS certification, the consortium reviewed various ICS guidelines for companies in Europe and their correlated auditing activities, based on a comparative analysis of non-financial reporting frameworks by OECD.

Intellectual capital (IC) refers to the collective knowledge acquired from the organizational and personal routines and the relationships of a given organization (Stewart, 1997) [19]; (Bontis, 2002) [20]. Moreover, intellectual capital is a valuable resource that organizations need to develop to achieve sustainable competitive advantages (Chen, 2008) [21].

The term intellectual capital (IC) was coined by Stewart (1991)[22], who defined it as "the sum of an organization's resources encompassing collective tacit knowledge, human skills, experience and any intellectual resource that can contribute to value creation for the organization" (Brooking, 1997) [23].

Along these lines, several authors have proposed other definitions for IC. According to Brooking (1997) [23], IC consists of intangible assets that allow a given organization to operate by introducing the combination element. According toEdvinsson (1997) [24], IC consists of the improvement capabilities of human beings, the structural capital, the expertise, the relationships, know-how, and other intangible assets. For Stewart (1997) [25], IC is "the sum of knowledge, intellectual property and experience held by everyone in a company, and which is used to create a competitive edge." It refers to the intellectual assets (knowledge, information, intellectual property, and experience) that can be harnessed to create wealth.

Bontis (1998) [26] categorizes intellectual capital into three interrelated primary components: Human, structural and relational capital, which are described as follows:

- **Human capital**: refers to the human factor in organizations, such as knowledge, skills, competencies, experience, and attitude. Furthermore, Roos and Jacobsen (1999) [27] added innovation and people's talents to the list. Human capital cannot be owned, it can only be rented (Edvinsson& Malone, 1997) [28]. Thus, the loss of human capital can threaten organizations because their talents, skills, and tacit knowledge will be lost (Roos et al., 1997) [29].
- **Structural capital**: refers to the learning and knowledge acquired in everyday activities, which is employed as the support infrastructure for human capital (Kong & Thompson, 2009) [30]. The list of items that make up structural capital is long and includes empowerment, organizational capacity, physical systems, quality, the scope of computerized systems, corporate image, database, organizational concepts, intellectual property, patents, trademarks, and copyrights (Silveira & Selig, 2001) [31]that may create value for organizations (Bontiset al., 2000) [32].
- **Relational capital** refers to organizations' formal and informal relationships with external stakeholders. In addition, it unveils the perceptions they have about these organizations and the knowledge exchange between both (Bontis, 1998) [26]. Relational capital is important for an organization because it multiplies value creation by connecting human and structural capital with external stakeholders (Ordonez de Pablos, 2004) [33].

An important aspect pointed out by Roos et al. (1999) [34] is that the way the IC is constituted for a given organization may not be the same for another. Thus, considering the context of this article, the IC of the milk agro-industrial system is different from the IC of a company in the metal-mechanic sector, for example. What matters is that IC provides the best possible value to organizations by combining, using, interacting, aligning, and balancing the three previous components and managing the flow of knowledge between them.

In this sense, considering the scope of this article, an InCaS model was developed for the various actors involved in the system and is characterized as follows:

- **Agro-industries**: the companies operating in the segment by producing the dairy products;
- **Producers**: the farmers who produce milk;
- **Other players**: associations, public and private agents that are part, whether active or not, of the milk production chain;

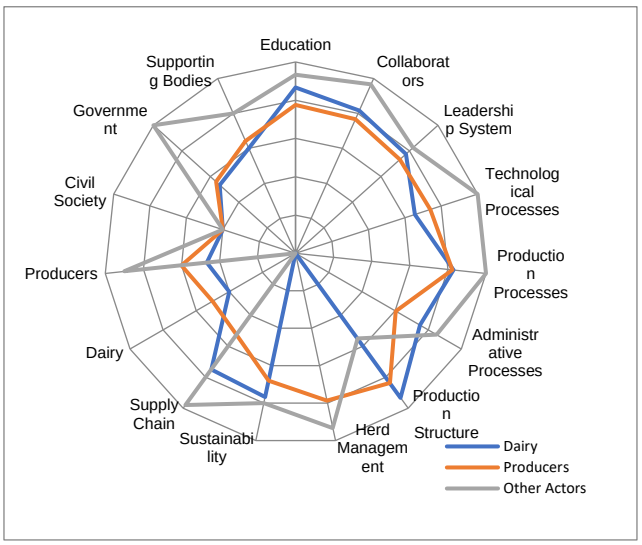
For each of these actors, the human, relational, and structural capitals were considered, organized as follows:

- **Human capital (HC)** – the education, employees, and leadership system dimensions were considered;
- **Structural capital (SC)** – technological, production, and administrative processes were considered, along with production structure, herd management, and;
- **Relational capital (RC)** – the production chain, the agro-industries, producers, civil society, the government, and support agencies were considered.

Thus, a questionnaire was structured and subsequently applied with the participation of various actors. Answers were obtained from a total of five (5) players from the

agro-industrial sector, six (6(from the production sector, and 2 (two) from other sectors. Chart 2 shows the results for the three segments.

Chart 2. Result of the capital assessment for the various actors.



Source: Prepared by the authors.

The charts reveal a few crucial points, as follows:

- **Education (HC)** – There is an opportunity to improve the educational level of producers. This involves the development of technical knowledge, training, and qualification of these employees and their level of education.
- **Collaborators (HC)** – The relationship with the collaborators working in the industry and the field is well developed.
- **Leadership system (HC)** – Although it was reported that these systems have a good overall level, the interviews and the practices identified in the scope of this study show that there is potential for them to advance. This item comprises the valuing and recognition of professionals, the critical analysis of overall performance, leadership, and knowledge dissemination.
- **Technological processes (SC)** – The use of technology in the agro-industrial system is deficient, both among producers and agro-industries. These involve the development of new technologies, products, and raw materials.
- **Production processes (SC)** – Although it was reported that they have a good overall level, the interviews and the practices identified show potential to improve the production process in terms of quality control, storage policy, processing, and transportation.
- **Administrative processes (SC)** – There is an opportunity to improve strategic planning, as well as selling and buying, marketing, financial, and control processes.
- **Production structure (CS)** – Both farmers and the agro-industries reported that the structure is adequate (machinery, equipment, facilities, and milk delivery location).
- **Herd management (CS)** – Farmers claimed to have a good command of and adopt adequate herd management practices.
- **Sustainability (SC)** – There is an opportunity for improvement in this aspect for bother producers and the agro-industrial sector in terms of waste, energy, and water management.
- **Supply chain (SC)** – There is potential for improvement in the relationship between the actors in the supply chain (producers, agro-industries, and the wholesale and/or retail distribution sector) to exchange information and improve distribution channels.
- **Agro-industries (RC)** – These are highly likely to integrate with the other actors, particularly regarding technology transfer and fostering a better financial buyer-supplier relationship.
- **Producers (RC)** – The producers need to adopt loyalty practices in the delivery and relations with associations and cooperatives associated with the milk production activity.
- **Civil society (RC)** – There is a possibility of expanding the relationship with civil society.
- **Government (RC)** – In the view of both producers and agro-industries, the government should grant more subsidies for the production chain.
- **Supporting Bodies (RC)** – There is potential to increase the relationship with institutions, class associations, and entities, as well as financial, research, and development institutions.

In summary, considering the description of the milk agro-industrial system scenario, the interviews conducted with the different actors of the production chain in the state of Bahia, while considering the results of the InCaS model analysis, allowed the structuring of a management model targeted at small dairy plants based in the state of Bahia.

VI. MANAGEMENT TARGETED AT COMPETITIVENESS BASED ON THE ACCUMULATION OF KNOWLEDGE

Considering that the low level of technical knowledge and the conducting of business pose challenges to the competitiveness of the dairy agribusiness in the state of Bahia, it becomes evident that the guidelines developed for the implementation of a management model must be grounded in this perspective.

Since the 1990s, the perspective of the Knowledge and the Learning Economies has contributed to advancing the idea that the competitiveness of companies and countries depends heavily on creative and innovative technological capabilities. The accumulation of technological capabilities must overcome the contradictions imposed by the market (the so-called trade-offs) in the search for the aforementioned paradigm shifts and innovations. Studies have been conducted to develop models (whether they are supported or not by metrics) that aim to register how and to what extent the production of knowledge in organizations occurs. Indeed, according to Nonaka & Takeuchi and Leonard-Barton, the accumulation of knowledge increases competitiveness in organizations. The SECI model of knowledge dimensions (or the Nonaka-Takeuchi model) focuses on analyzing endogenous learning. Moreover, the competencies model for developing organizations focuses on the basic competencies or set of technical and managerial systems and skills,given the need to tackle the internal rigidity that inhibits innovation.

Figueiredo (2009) [35] proposed investigating the technological learning processes and mechanisms used by companies to build and accumulate their capabilities. The author examined three learning mechanisms in light of specific metrics: "(i) intra-firm; (ii) inter-firm; and (iii) intra-organizational." The author also defined **technological capability** (or knowledge base) as "a set of resources of a cognitive nature. It is an intangible asset that defines its performance in the market and what is possible to accomplish through production (of goods and services) and innovation activities" (ROOS et al., 1999) [34].

Nonaka and Takeuchi (2008) [36] conceived the Knowledge Spiral Model (of the SECI Model) to show the process of interaction between explicit knowledge and tacit knowledge by representing the process of knowledge creation in organizations from the observation of the dynamics of innovation in Japanese companies.

The elements presented in Figure 3 are the cornerstones of knowledge creation:

- **Socialization** (from tacit knowledge to tacit knowledge): sharing experiences (mental models and technical skills) to create tacit knowledge.
- **Externalization** (from tacit knowledge to explicit knowledge): articulation of tacit knowledge into explicit knowledge (metaphors, analogies, hypotheses, or models).
- **Combination** (from explicit knowledge to explicit knowledge): the systematization of concepts into an explicit knowledge system (involving exchanges through documents, meetings, phone calls, social media).
- **Internalization** (from explicit knowledge to tacit knowledge): incorporation of explicit knowledge into tacit knowledge (or "learning by doing").

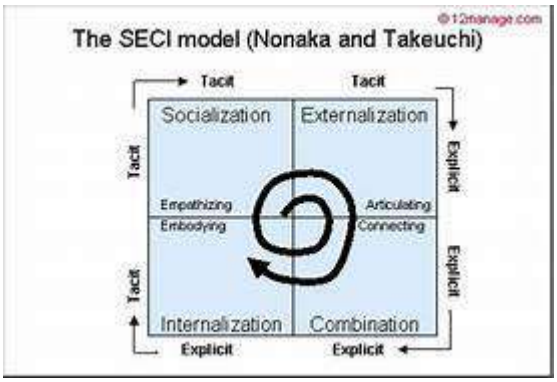


Fig.3: SECI Model

Source: Adapted from Nonaka and Takeuchi (2008) [36].

Leonard-Barton (1998) [37] advocates that organizations, besides being "financial institutions," are "knowledge institutions." The creation process is characterized by a dynamic that comprises search and selection rhythms, exploration and synthesis stages, cycles of divergent thoughts, and convergence steps.

Tacit knowledge is paramount to the process of generating innovation in terms of the **divergence** (the social component, influenced by dialogue) and **convergence** of the knowledge creation process (the coordination of tacit knowledge), according to Leonard-Barton and Sensiper (1998) [38].

In generating and diffusing activities, new knowledge is incorporated into the firm's assets and categorized into four groups, as follows (Leonard-Barton, 1998) [39]:

- **Integrated, shared problem-solving** (present): The integration of employees aimed at problem-solving leads to new knowledge, which must be managed and disseminated throughout the organization.

- **Implementation and integration of new technologies and technical processes** (internal): Team spirit prevails over individual ownership of ideas.
- **Testing and prototyping** (future): Experimentation is an opportunity for knowledge development and acquisition.
- **Importing knowledge from outside the firm** (external): The search for innovative technologies is to be carried out systematically and carefully.

Leonard-Barton and Sensiper (1998) [40] illustrated the dynamics of the process based on the development funnel proposed by Clark and Wheelwright, according to Figure 4.

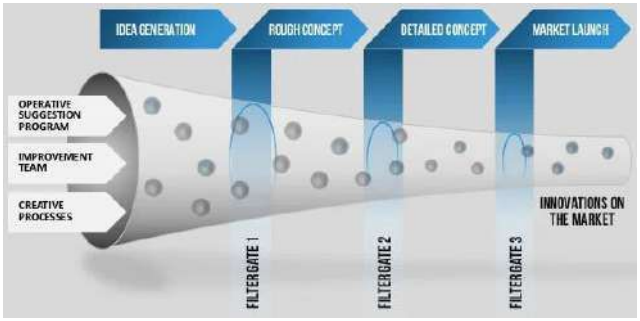


Fig.4: Incremental cycles of the innovation funnel model

Source: Adapted from Leonard-Barton and Sensiper (1998) [40].

Core capabilities are built up over time and cannot be easily copied or imitated. They include technological knowledge and activities that positively differentiate the firm from its competitors (Leonard-Barton, 1998) [39].

The enabling elements of the knowledge creation process in this model are divided into four major groups, namely

- **Physical systems**: software, hardware, and machinery;
- **Management systems**: educational, incentive, and rewards plans should guide the strategic use of resources and foster the accumulation of knowledge in the physical systems and the group;
- **Knowledge and skills:** The retention of diversified staff, rich in "personalized qualifications."
- **Corporate Values**: outline the general standards of behavior and concepts.

The managerial level of the organization, responsible for fostering knowledge diffusion and intra-organizational relationships, is treated as a source of external knowledge in their model (Leonard-Barton, 1998) [39].

Nonaka and Takeuchi's conceptual framework focuses on a dynamic model anchored in the social interaction between tacit and explicit knowledge and is responsible for expanding knowledge quantity and quality.

For Leonard-Barton (1998) [39], activities (and not financial goals or rewards, individual or group qualifications) are what create the skills of a firm. The activities incorporated in the individual create the context necessary for the firm's competitive advantage to be superior and are required in order to retain strategic technological skills. The ability to manage knowledge creation processes so that the company differentiates itself from its competitors is characteristic of managers who manage to make companies develop and sustain competitive advantages.

Nonaka and Takeuchi and Dorothy Leonard-Barton's knowledge creation and diffusion models are complementary and differ from economic and organizational theories. The authors present a view of how organizations can understand their processes better, manage them, and act as facilitators and organizers of the continuous flow of knowledge among collaborators. The development of favorable environments in the search for competitive edges provides a more efficient way to direct the efforts for innovation and competitiveness, according to Zack (1999) [41].

VII. ASSUMPTIONS FOR THE CONSTRUCTION OF THE MANAGEMENT MODEL FOR SMALL-SCALE DAIRIES IN THE STATE OF BAHIA

Given the above, the proposition of the Management Model for Small-Scale Dairies in the State of Bahia must consider a series of observations identified based on interviews with the different players in the dairy chain and the literature review. The key points are listed below:

- **Distribution** – Information and consumption trends for dairy products.
- **Industry** – Dynamic link or the driving force for adding value. Low value-added products have lost market share in all social classes, to the detriment of increased consumption of premium products (yogurts and dairy beverages). The industry determines the prices to be paid to producers.
- **Small Agro-industries** – In this case, the concern with hygiene and raw materials control stands out given the legislation in force. There are many small-scale businesses, such as family and informal enterprises (such as cheese dairies).

- **Producers** – They have low productivity, rely on outdated technology, and adopt unsatisfactory prophylactic and sanitary practices. They must tackle edaphoclimatic occurrences and present low profitability margins in their production, much due to the high product unit costs, which, in turn, reduces competitiveness.
- **Coordination Structure** – The determining factors of coordination are market conditions, public policies, cooperative actions, joint ventures, and the difficulty in integrating industry and producers. These factors pose challenges for promoting mechanisms to meet consumer demands. Adequate dissemination of information would contribute to reducing transaction costs through quality control and production incentives. All actors must have the same perception of how to maintain the competitiveness of SAG-Leite in the market.
- **Transaction costs** – If these are too high, they indicate that the governance structure is exclusively market-based, with no formalization of contracts. Since the actors are independent and there are no economies of scale and scope, this leads to economic inefficiency. Prices alone do not help coordination.
- **Applicable laws** – They must be strictly observed; they provide for the production and commercialization of products for human consumption.
- **Capacity building** – The degree of capacity building of the players involved in the process is low.

We suggest the adoption of a Management Model to outline the overall strategy and allow value generation prior to tailoring them to meet the needs of the chain players and leverage the sector. Thus, some assumptions were outlined and detailed as follows:

- **Assumption 1 – The elements of the management model:** The model consists of players, processes, information, knowledge, methods, tools, technology, indicators, and results.
- **Assumption 2 – The model's view**: The core element of the model is the milk producers, who are also responsible for cooling the raw milk and transporting it from the farm to the plants or for the occasional sale to the final consumer.
- **Assumption 3 – Chain players:** In the proposed model, the following actors will be considered: (i) the agro-industry, i.e., the companies operating in the segment by processing and producing dairy products; (ii) producers, or the farmers that produce raw milk; (iii) associations and class entities; (iv) public and private agents that are part, whether active or not, of the milk production chain, such as financial, research and development institutions (EMBRAPA, SENAI, SENAR, SEBRAE, Banks, among others); (v) Municipal, State and Federal Governments.
- **Assumption 4 – Chain processes:** The model will consider management (strategic planning, human resources, purchasing, sales, marketing, finance, and controls), production (products, by-products, quality control, storage policy, processing, and transportation), and technology processes (innovation and development of products, service, and processes). These processes have been established based on the InCaS approach.
- **Assumption 5 – Information and knowledge:** Primary research has shown that player must expand their access to information and knowledge. The basis of this assumption is the approach advocated by Nonaka and Takeuchi's (1995) SECI Model [42].
- **Assumption 6 – Methods, tools, and technologies:** The development and implementation of methods, tools, and technologies to support the competitiveness of agribusinesses will assist the advancement of the competitive relationships between production chains and the market in light of the concepts laid down by the InCaS Model;
- **Assumption 7 – Indicators and results:** The best arrangement of the elements of the management model aims to balance the supply and demand for dairy products to increase the productivity of the agro-industries, especially as they are the players in charge of coordinating the production chain;
- **Assumption 8 – Management principles:** The management model incorporates the fundamental principles of administration (planning, organization, direction, and control), mobilizing the stakeholders to search for excellence.

Figure 5 illustrates the relationship between the constituent elements of the Management Model for Small-Scale Dairies in the State of Bahia, which was developed based on the assumptions above.

Given this scenario, taking the constituent elements as a basis and reinforcing that the model should be developed in the view of the producers, we understand that according to the management model proposed herein, producers relate to the actors, carry out the management, administration, and technology processes, and rely on methods, tools, and technologies to support the processes. The players measure and manage indicators and results. Furthermore, regarding knowledge, producers socialize, externalize, internalize, and combine information and knowledge, according to Figure 6.

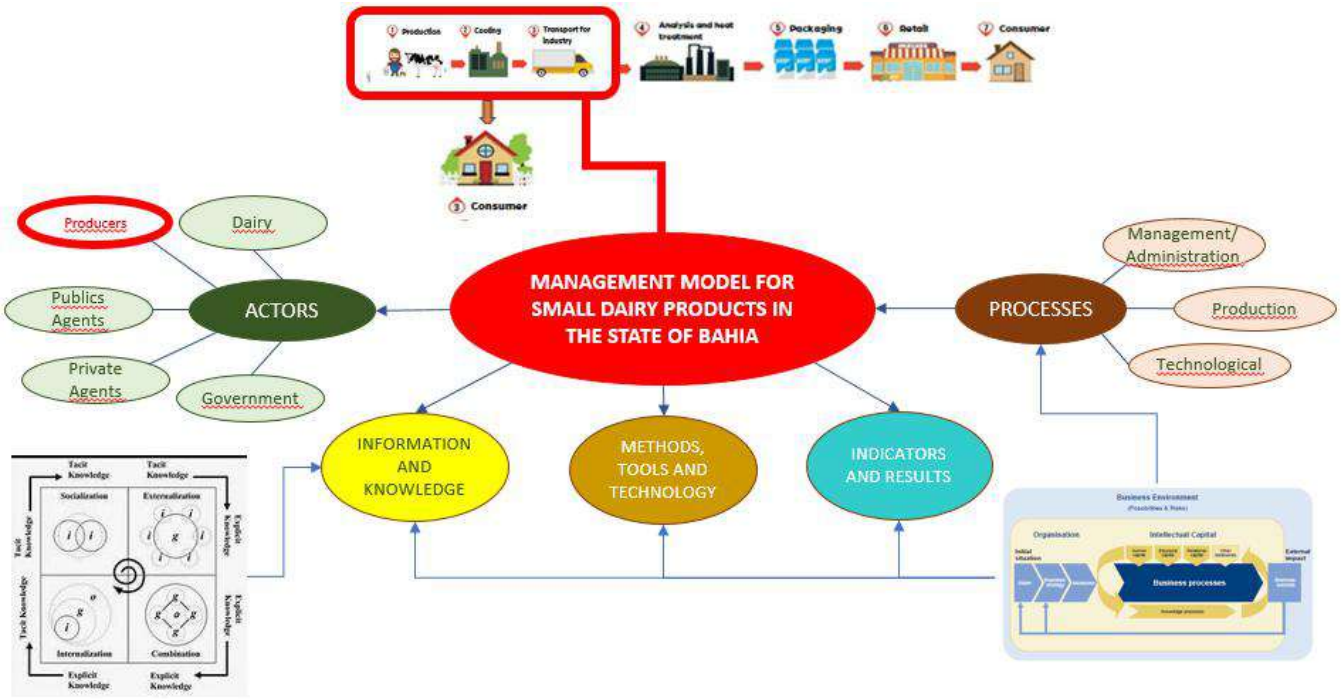


Fig.5 – Relationship between the elements of the Management Model for Small-scale Dairies in the State of Bahia, based on the assumptions.

Source: Authors

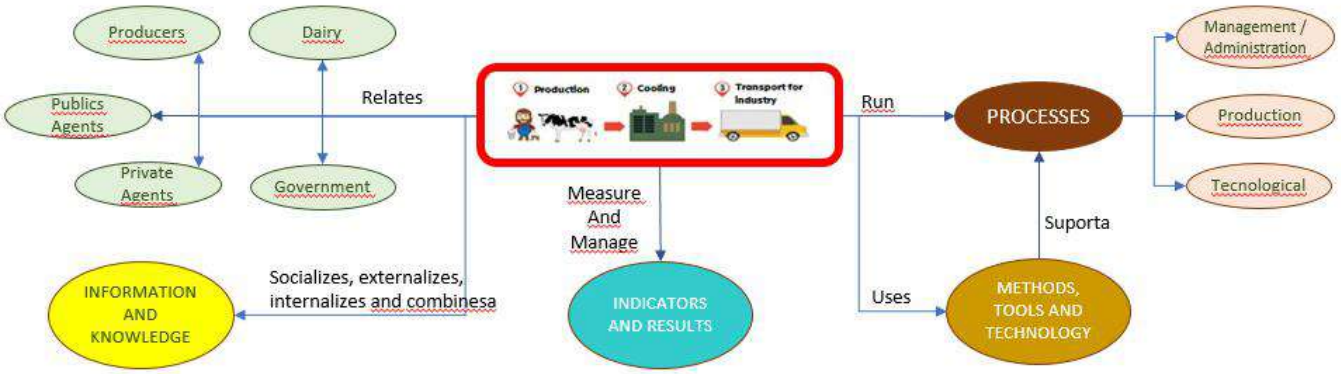


Fig.6 – Producers' perception of the Management Model

Source: Authors

Thus, the Management Model for Small-scale Dairies in the State of Bahia is presented below from a small business perspective. To this end, and considering a vision of the future, we propose some actions based on the interviews with the players involved, the InCaS model, the knowledge accumulation model, and the literature review, in general, namely (i) establish relationships with players; (ii) carry out the processes and rely on the methods, tools, and technology; (iii) socialize, externalize, internalize and combine knowledge; and, (iv) measure and manage the results.

Regarding **the relationship with players**, agro-industries, producers, public and private agents, and the government are considered. Table 1 in the appendix summarizes the actions planned for the relationship of small-scale dairies with the chain players. The bases to outline such information were the interviews with the participants involved, the InCaS model, and the literature review.

As for **process management**, the proposed actions are presented in Table 2 in the appendix.

When it comes to **methods, tools and technologies**, we can state that the ones available in the literature, as well as those commonly employed in the market, can be applied, such as SWOT analysis (strengths, weaknesses, opportunities, and threats), business plans, 5W2H, Balanced Scored Card, Canvas Business Model, Canvas Project Model, PDCA Cycle, BCG Matrix, GUT Matrix (Severity, Urgency, and Tendency), Flowchart, Signoff Sheets, Histogram, Control Charts, Scatter Diagrams, Risk Analysis and Management, Nonconformity Management, Indicator Management, among others.

Finally, regarding **socialization, externalization, internalization, and knowledge combination**, and based on Nonaka and Takeuchi's (1995) approach [42], the information that reflects the consumption tendency and the production bottlenecks must flow normally among all the links of the productive chain, providing an environment of competitiveness in the agro-industrial system. Thus, Table 3 presents some of the actions that make up the management model of the milk chain.

VIII. INDICATORS FOR THE ASSESSMENT OF SUSTAINABLE RESULTS

Finally, regarding indicators and results, we suggest using the approach proposed by INSPIA (Initiative for Sustainable Productive Agriculture).

Since it is an activity that depends on and strongly impacts natural resources (soil, water, carbon emissions), dairy farming must promote sustainable management practices. Sustainability monitoring is based on economic, social, and environmental indicators.

Therefore, INSPIA aims to establish an index to measure these aspects among European farmers, promoting a series of Good Management Practices (GMPs) to protect and improve the agricultural environment.

These GMPs can be implemented to improve the performance of the production chain as a whole under the coordination of the agro-industries, which have come to have their environmental practices indicators regulated by law from the perspective of environmental business management.

Some indicators can be highlighted, such as the rational use of water, the respect for the mandatory environmental reserve quotas, the non-use of pesticides, hormone-free feeding, etc.

The technical assistance team is the party in charge of disseminating this knowledge and requirements among milk producers.

IX. CONCLUSION

This paper does not exhaust the discussions about the competitiveness of the productive milk chain in the state of Bahia. On the other hand, it succeeds in presenting a management model that provides more rational use of human, technical and financial resources.

It is important to emphasize that the points presented in the model were extracted from the specialized literature and the practices adopted in plants and farms. They were also inspired by the needs and expectations detected during visits to plants and agricultural producers.

The model shows that it is necessary to adopt an integrated action involving several players with specific and articulated roles. The engagement of those responsible is vital for the structure of the capitals outlined by the InCaSmodel and the indicators and results presented by INSPIA.

REFERENCES

[1] IBGE (2017). CensoAgro IBGE 2017. Retrieved April 22, 2020, from https://censos.ibge.gov.br/agro/2017.

[2] Monteiro, D. (2020). O gigante mercado de laticínios: oportunidades encontradas na exportação dos derivados do leite. Retrieved September 27, 2021, from https://www.xportjr.com.br/post/o-gigante-mercado-de-laticinios-oportunidades-encontradas-na-exportação-dos-derivados-do-leite.

[3] Zacarchenco, P. B.,VanDender,A.G.F. &Rego, R. A. (2020). Brasil dairy trends –1.ed. Campinas: ITAL.

[4] Sindileite (2020). Laticinistas afirma que a produção cresceu em 2018. Retrieved April 22, 2020, from http://www.sindicatodaindustria.com.br/noticias/2018/10/72,129602/laticinistas-afirmam-que-a-producao-cresceu-em-2018-durante-o-9-encontro-baiano-dos-laticinistas.html.

[5] G1 (2019). China abre mercado para produtos lácteos do Brasil. Retrieved November 4, 2020, fromhttps://g1.globo.com/economia/agronegocios/noticia/2019/07/23/china-abre-mercado-para-produtos-lacteos-do-brasil.ghtml.

[6] AGROemDIA, (2019). Leite: Exportar para China pode ajudar, mas relação com laticínios precisa mudar. Retrieved July 27, 2019, fromhttps://agroemdia.com.br/2019/07/27/leite-exportar-

para-china-pode-ajudar-mas-relacao-com-laticinios-precisa-mudar/.

[7] Davis, J. H. & Goldberg, R. A. (1957). A concept of agribusiness. Boston, Harvard University.

[8] ResearchGate (2015). Supply chain knowledge management. A linked data-based approach using SKOS. Retrieved January 31, 2022, fromhttps://www.researchgate.net/publication/290456716_Supply_chain_knowledge_management_A_linked_data-based_approach_using_SKOS/link/56a7fd6608ae860e0255a9cf/download

[9] Lacki, P. (1996). Desenvolvimento agropecuário: da dependência ao protagonismo do agricultor.Brasília: FAO.

[10] Zylbersztajn, D. (1995). Estruturas de Governança e Coordenação do Agribusiness: Uma aplicação da Nova Economia das Instituições. Tese de Livre Docência em Administração. São Paulo, Faculdade de Economia, Administração e Contabilidade/USP.

[11] Coese, R. (1988). "TheLighthouseinEconomics",inTheFirm,TheMarketandthe Law.Chicago:UniversityofChicagoPress:Chapter2.

[12] Porter, M. (1986). Estratégia competitiva. Ed. Campus, Rio de Janeiro.

[13] Gunday, G., Ulusoy, G., Kilic, K. &Alpkan, L. (2009). Effects of innovation types on firm performance.

[14] Iafelice, A. (2020). Agronegócio criado em 1957 versus nova forma atual e futura. Retrieved March 26, 2021, from http://www.ideaonline.com.br/conteudo/agronegocio-criado-em-1957-versus-nova-forma-atual-e-futura-por-antonio-iafelice.html.

[15] PUCRS Online (2020). 3 modelos de gestão e como aplicar na sua empresa. Retrieved November 11, 2020, from https://www.xerpa.com.br/blog/modelos-de-gestao/ e https://blog-online.pucrs.br/public/modelo-de-gestao/.

[16] Leitíssimo (2022). Linha do Tempo. RetrievedJanuary 31, 2022, fromhttps://leitissimo.com.br/linha-do-tempo-timeline/.

[17] Globo Rural (2010). Leite kiwi-baiano. Retrieved January 31, 2022, from https://revistagloborural.globo.com/Revista/Common/0,,EMI161262-18283,00-LEITE+KIWIBAIANO.html.

[18] Mertins, K. & Will, M. (2009). Strategic relevance of Intellectual Capital in European SMEs and sectoral differences. InCaS: Intellectual Capital Statement – Made in Europe.

[19] Stewart, T. A. (1997). Intellectual Capital: The New Wealth of Organization. 1a Edição ed. New York: [s.n.].

[20] Bontis, N. (2002). National intellectual capital index: Intellectual capital development in the Arab Region, Institute for Intellectual Capital Research, Ontario.

[21] Chen, Y. (2008). The positive effect of green intellectual capital on the competitive advantages of firms. Journal of Business Ethics v.77, n.3, p. 271–286.

[22] Stewart, T. (1991). Brainpower, Fortune, v. 123, p. 44-50.1991

[23] Brooking, A. (1997). El Capital Intelectual. El Principal Activo de las Empresas delTercer. Milenio. PaidósIbérica S. A., Barcelona

[24] Edvinsson, L. (1997). Developing intellectual capital at Skandia. Long Range Planning, v. 30, n. 3, p. 366–373,

[25] Stewart, T. (1997). Intellectual Capital: The New Wealth of Organizations. Currency Doubleday, New York.

[26] Bontis, N. (1998) Intellectual Capital; an Exploratory Study That Develops Measures and Models. Management Decision, 36, 63-76.

[27] Roos, G. & Jacobsen, K. (1999). Management in a complex stakeholder organisation, Monash Mt. Eliza Business Review, Vol. 2 No. 1, pp. 83-93.

[28] Edvinsson, L. & Malone, M.S. (1997). Intellectual Capital Realizing Your Company's True Value by Finding Its Hidden Brainpower. Harper Business, New York.

[29] Roos, J., Roos, G., Dragonetti, N. C. &Edvinsson, L. (1997). Intellectual capital: navigating the new business landscape. Londres: Macmillan Press.

[30] Kong, E. & Thompson, S. B. (2009). An intellectual capital perspective of human resource strategies and practices. Knowledge Management Research in Practice. v. 7, p.

[31] Silveira, J. & Selig, P. (2001). Mensuração do capital intelectual x avaliação de empresas. VII Congresso del Instituto Internacional de Costos. Annals: Cruzando fronteras: tendencias de ContabilidadDirectiva para elSiglo XXI.

[32] Bontis, N., Chua, C. K., W. & Richardson, S. (2000). Intellectual capital and business performance in Malaysian industries. Journal of intellectual capital, v. 1, n. 1, p. 85-10.

[33] Ordonez de Pablos, P. (2004). The importance of relational capital in the service industry: the case of the Spanish banking sector. International Journal of Learning and Intellectual Capital, v.1, n. 4, p. 431-440. 2004.

[34] Roos, G., Bainbridge, A. & Jacobsen, K. (2001). Intellectual capital analysis as a strategic tool. Strategy and Leadership. V. 29, n. 4, p. 21–26,

[35] Figueiredo, P. (2009). Acumulação de Capacidade Tecnológica em Organizações de Serviços Intensivos em Conhecimento. In: P. Figueiredo, *Gestão da Inovação – Conceitos, Métricas e Experiências de Empresas No Brasil*, 1st ed. LTC, Capítulos 1, 2 e 8.

[36] Nonaka, I. &Takeuchi, H. (2008). Gestão do Conhecimento. São Paulo: Bookman.

[37] Leonard-Barton, D. (1998). Nascentes do Saber. Criando e Sustentando as Fontes de Inovação. Rio de Janeiro, FundaçãoGetúlio Vargas.

[38] Leonard-Barton, D. &Sensiper, S. (1998). The role of tacit knowledge in group innovation. California Management Review, Berkeley, v.40, n.3, p.112-127.

[39] Leonard-Barton, D. (1998). Nascentes do Saber. Criando e Sustentando as Fontes de Inovação. Rio de Janeiro, FundaçãoGetúlio Vargas.

[40] Leonard-Barton, D. &Sensiper, S. (1998). The role of tacit knowledge in group innovation. California Management Review, Berkeley, v.40, n.3, p.112-127.

[41] Zack, M. H. (1999). Developing a Knowledge Strategy, California Management Review, Spring 1999, Vol.41, No. 3, p.125-145.

[42] Nonaka, I. & Takeuchi, H. (1995). The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation. New York: Oxford University Press.

Table 1. Managing relationships with Milk Agro-Industrial System (SAG Leite) players

Productive Chain	• The relationship between players in the production chain must be formal, and the commitments must be fulfilled. • Create product distribution channels that contribute to expanding and developing the productive chain. • Allow open communication and technology transfer that favor the development of all links in the production chain. • Price milk according to a Sectorial Chamber while considering product quality.
Agro-industry	• Establish a strategy that sets profit concentration limits per client to diversify sales and actions that can boost the organization's business activities. • Agro-industries should transfer technology to producers to qualify the activity through technicians and/or companies, at their expense or through partnerships.
Producers	• Establish that producers have formal contracts to deliver their products to the agro-industries that are partners in improving productive activities. • Create conditions for producers to participate in associations or cooperatives to improve their agricultural production.
Civil Society	• Generate value for society by reducing rural flight, generating jobs, or strengthening the domestic market.
Government	• Create programs in the various spheres of government that provide subsidies to rural producers, including increment and purchase of production so that rural families can settle in one place.
Support Agencies	• Establish mechanisms for institutions, professional associations, and entities to create and keep open communication and technology transfer lines, thus favoring the development of all links in the productive chain. • Financial institutions should grant credit lines with subsidized interest rates to boost the development of dairy activities, including new investments in technological innovation. • Scientific and technological research institutions should promote strategies adherent to the dairy chain innovation. • Provide a structure of technical assistance (training, technology transfer) that improves livestock farming conditions at the field level, thus contributing to the competitiveness of the productive chain. • Educational institutions should make available regular and extension courses aimed at training technicians, producers, entrepreneurs, and workers in general, thus contributing to the development of the dairy chain.

Table 2. Managing processes with Milk Agro-Industrial System (SAG Leite) players

MANAGEMENT AND ADMINISTRATION PROCESSES	
Human Resources	• Define the processes, tasks, and protocols to be followed by workers and collaborators. • Encourage the adoption of structures with functional characteristics to foster improvement, specialization, and teamwork based on flexibility and valorization. • Encourage workers and collaborators to seek innovation in processes and methods to increase the efficiency and quality of processes and products. • Provide training, perform preventive maintenance, dispose of unused/occupied materials and tools, and provide PPE and CPE. • Comply with labor legislation in the scope of your rights and duties. • Design a career plan and grant bonuses for workers. • Structure a leadership system where all workers are motivated and managed by their respective leaders. • Providing workers with the opportunity to engage in management, creation, and use of knowledge within the organization.
Management	• Implement horizontal organization charts to favor greater integration between the structure of the organization and the actors involved through an increased degree of autonomy, flexibility, and informality, mitigating transaction costs and providing conditions to meet demands. • Adopt organization charts that consider the following functions Relationship with the market, especially producers; Collecting (focusing on the product to be collected); Production, focusing on technology and innovation; and Distribution (incorporating adequate logistics for the absorption of the production by the market). • Develop a business strategy plan and disseminate it among workers. • Develop an inventory policy (inputs, raw materials, and finished products) in light of the planned strategy. • Carry out the sales and purchase plan by standardizing contracts to reduce informational costs and eliminate the specificities of contractual relations. • Draft formal sales contracts with after-sales support and product quality traceability. • Establish a marketing strategy that keeps pace with the organization's goals. • Define a specialized account manager whose in line with the company's goals. • Implement a computerized system to manage all processes. • Allow the information that reflects the consumption tendency and the production bottlenecks to flow normally between all links in the productive chain, thus providing a competitive environment to the Agro-Industrial System. • Creating open communication and technology transfer that favor the development of all links in the production chain. • Regulating milk pricing through a Sectorial Chamber while considering product quality.
Processes	• Invest in modern, high-tech machinery, vehicles, and equipment with assured maintenance and automated processes that ensure and improve the quality of milk production and/or transformation. • Create installations that comply with the safety and sanitary norms in force, providing adequate shelter, hygiene, and feeding conditions, mineralization, and plenty of water.

TECHNOLOGICAL PROCESSES	
Products	• Develop new products such as strategies, portfolio management, processes, market research, people, and performance metrics.
	• Agro-industries should transfer technology to producers so as to qualify the production through technicians and/or companies, at their expense or through partnerships.
Processes	• Invest in Livestock 4.0 technologies, such as the automation of milking, handling, and artificial insemination. • Monitor milk quality through surfaces and microbiological analysis to safely carry out all production processes. • Control milk hygiene through handling; analyzing the physicochemical composition of milk, and performing mandatory tests: temperature check, alizarol test, cryoscopy index, density test, fat content measurement, alkaline phosphatase, and peroxidase test, measuring dry extract and fat-free dry extract, and adding acidity neutralizers and microbial growth-inhibiting agents. • Apply technology to comply with the time limit for each process while preserving product quality and following the established standards. • Standardize the transportation from the field to the tank so that producers watch the necessary tank precautions and follow the normative instructions. • Cool the milk to a temperature around 4ºC in the first two hours after milking, pack the product in expansion tanks, and, when collected from farms, in bulk, in isothermal tank trucks. These trucks must transport the product directly to the industry platform, under the industry's supervision. • Provide grazing land suitable for the number of cows (proper forage carrying capacity). The choice of varieties should consider the volume of green fodder produced and the topography. Pasture should be fertilized, maintained, irrigated, and managed. • Create product distribution channels that contribute to growing and developing the productive chain. • Agro-industries should transfer technology to producers so as to qualify the activity through technicians and/or companies, at their expense or through partnerships.
PRODUCTION PROCESSES	
Herd	• Carry out a management adjustment and food plan targeted at milk production's needs, with a complete and balanced diet consisting of a mixture of roughages (silage, hay, chopped green grass), concentrates (energy and protein-rich), minerals and vitamins. • Adopt a synchronization program and daily observation of the estrus cycles according to the heifers' age and employ artificial insemination. • Incorporate veterinary scientific innovations to promote animal health and improve milk quality. • Rely on an intensive system, in the case of a herd of good genetics under adequate management. • Employ technology to ensure genetic selection, aiming to preserve the traits, breed standards, and a predominant blood degree or dairy bloodline.
Sustainability	• Implement composting systems by reusing residues and selling the compost for organic production, thus adding value to the dairy chain. • Implement a renewable energy system (water, sunlight), identify how energy is used in production processes, and ration/optimize non-renewable energy use.

Table 3 – Managing knowledge with Milk Agro-Industrial System (SAG Leite) players

Socializing knowledge	• Create and share tacit knowledge, from direct experience, from individual to individual. • Promote group activities with the participation of people involved in the productive chain, informal sessions and brainstorms, customer interactions, and workshops to share improvement opportunities, best practices, and experiences, among others. • Design a technological architecture to manage the creation and use of knowledge within the organization.
Externalizing knowledge	• Disseminate tacit knowledge through dialogue and reflection, from individual to group. • Prepare instructional materials such as handouts, primers, websites, and applications to improve productivity and the relationships between people involved in the productive chain. • Provide and encourage workers to obtain specialized technical knowledge. • Design a technological architecture to manage the creation and use of knowledge within the organization.
Internalizing knowledge	• Create mechanisms so that producers can learn and acquire new tacit knowledge, from organization to individual. For example, courses, workshops, etc., can be organized. • Invest in specific training. • Enable the organizations to experience the practical result of new knowledge; that is, to develop operational knowledge. • Design a technological architecture to manage the creation and use of knowledge within the organization.
Combining knowledge	• Systematize and apply explicit knowledge and information from group to organization. • Develop resources to prototype and apply real models deriving from the knowledge creation process. • Design a technological architecture to manage the creation and use of knowledge within the organization.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.11

Construction of a Classifying Technology for Geriatric Emergency Care for Caregivers of the Elderly

José Ronaldo Teixeira de Sousa Júnior[1], Ismaelino Mauro Magno Nunes[2], Caritas Lena de Almeida Ducan[3], Vania Cristina Ribeiro Brilhante[4], Tanise Nazare Maia Costa[5], Renata Campos de Sousa Borges[6], Lauany Silva de Medeiros[7], Daniele Lima dos Anjos[8], Genislaine Ferreira Pereira[9], Milena Coelho Fernandes Caldato[10]

[1]Pharmaceutical. Professional Master's degree in health educations – Medical Educations - University Center of Pará. Pharmaceutical Administrative Leader of Unimed General Hospital. Belém, Pará, Brazil
Email: ronaldosousajr@gmail.com
[2]Biomedical. PhD in tropical diseases by the Pará Federal University. Professor at the State Center of the State of Pará. Belém, Pará, Brazil.
Email : mauromagno@cesupa.br
[3]Nurse. Specialization in Quality Management by the Albert Einstein Institute. Hospital manager of the National Confederation of Medical Cooperatives (Unimed). Belém, Pará, Brazil.
Email: duncan.caritas@gmail.com
[4]Doctor. PhD in tropical diseases by the Pará Federal University. Adjunct Professor at the Federal University. Belém, Pará, Brazil.
Email: vania.brilhante@unimedbelem.com.br
[5]Doctor. Master in Health Teaching in the Amazon from the University of the State of Pará. Professor of the Medicine course at the University Center of Pará. Belém, Pará, Brazil.
Email: tanise.costa@unimedbelem.com.br
[6] Nurse. Master in Health Education in the Amazon (ESA). PhD student, Professional Doctorate Program in Health Education in the Amazon (ESA). Professor at the State University of Pará (UEPA). Tucuruí, Pará, Brazil.
Email: renatasousa88@hotmail.com
[7]Nurse, State University of Para (UEPA). Tucuruí, Para, Brazil.
Email: lauanymedeiiros@gmail.com
[8]Nurse. Master in Health Education in the Amazon (ESA). Professor at the State University of Pará (UEPA). Tucuruí, Pará, Brazil.
Email: anjo.daniele@hotmail.com
[9]Nurse, Specialist in Oncology, Machado de Assis School of Technology. Assistant nurse in the municipality of Tucuruí-Pa. Tucuruí, Para, Brazil.
Email: genislaine_fp@hotmail.com
[10]Doctor, doctor in clinical endocrinology at Federal University of São Paulo. Permanent member of the faculty in the Stricto Sensu Postgraduate Program, Belem, Para, Brazil.
Email: milenacaldato@hotmail.com

Received: 01 Apr 2022,
Received in revised form: 01 May 2022,
Accepted: 08 May 2022,
Available online: 19 May 2022

Abstract *— To develop a printed classifier instrument to guide geriatric emergency care for caregivers of the elderly. This is a literature review of the last 10 years, aiming to elucidate the theme and thus, based on the information obtained, build the printed instrument for the geriatric public. Therefore, this work took place in two stages, the first being the search for articles on online search platforms and the second the construction of the proposed technology. The applicability of educational instruments in health is of paramount importance, even for those who do not have training in the area, as is the reality of many caregivers in the country, so the*

Keywords* — *Elderly Caregivers, Geriatrics, Health Education, Risk Classification.

instrument built was based on colors already used for a better understanding of the tool. It is concluded that the applicability of the tool is easy to understand and can help in the assessment and decision-making of caregivers, thus favoring care, adequate prognosis and in a timely manner for the elderly.

I. INTRODUCTION

Professional caregivers of the elderly is currently an emerging occupation worldwide, although in Brazil, according to the Brazilian Institute of Geography and Statistics (2018), in the year 2060, the number of elderly people over 65 years old should triple and represent 25.5% of the Brazilian population. However, studies show that evaluation and diagnosis difficulties by health professionals are motivated by multiple comorbidities, changes in mental status and communication difficulties presented by the elderly in emergency situations (Mish et al, 2014; Santos et al, 2016).

According to Figueiredo et al, (2021), the long-term caregiver at home is not qualified enough to offer services to the dependent elderly, nor to assist and care for fragile lives. In addition, the occupation is not yet regulated and the caregiver's role diversion to domestic activities is common. In this way, population aging is one of the biggest challenges for contemporary public health, since the elderly consume more health services, for example, the increase in hospital admissions and the length of bed occupancy (Lima & Veras, 2013).

Given the facts, Emergency Care Units (UPA) are commonly sought by the elderly however, this displacement is not always necessary, which contributes to the capacity in health units. In this way, as a proposal to reduce and meet this demand, the National Humanization Policy (PNH) and QualiSUS were created, which included classifying screening of patients, seeking to prioritize care according to the severity of the case and no longer in order of arrival. (Silva & Gutierrez, 2018).

A safe, comprehensive and effective model of care for urgent care is the Manchester System. Structured in flowcharts that represent patient's main complaint and composed of discriminators that contain the patients' signs and symptoms, listing clinical priorities by severity, and with a maximum term for care. Inspired by this system, several devices were created in order to improve the quality of services provided to the elderly (Manchester Triage Group, 2010).

According to Chumbinho (2018), when they built a digital blog aimed at caregivers and family members of elderly people with Alzheimer's, they admitted that informational support technologies are of great importance, as they help in the state of health and in the staging of disorders. Therefore, the acquisition of skills in assistive technologies for the caregiver are tools that guide the resolution of work demands and cooperate with their resolving role. For this, advisors must mediate knowledge in a didactic way for application in their routine and thus reduce work overload and stress. In this constant, Melo et al. (2017), this situation is observed in more than 42% of caregivers, consequently, the provision of an effective informational instrument provides a positive impact in reducing caregiver stress.

In this perspective, the present study proposed the construction of a printed instrument that classifies signs and symptoms of risk to mediate geriatric emergency care for caregivers of the elderly and thus facilitate decision-making through risk prioritization according to the event severity. In addition, technology must optimize medical care and cooperate for preventable life-threatening procedures.

II. MATERIALS AND METHODS

This is a descriptive literature review aimed at the construction of a care and educational technology linked to the Professional Master's Graduate Program in Health Teaching-Medical Education at the University Center of the State of Para (CESUPA). According to Nietzsche et al. (2005) aims to recognize the need for geriatric emergency care for caregivers of the elderly, developed in the period from 2020 to 2021.

The product is intended for those who work as “elderly caregivers”, regardless of the length of time in the occupation, providing care in homes and/or hospitals with or without remuneration. Therefore, for the framework of the study, the following steps were carried out:

The first stage provided the theoretical support for the construction of the product through a literature review, whose objective was to identify the available scientific material referring to geriatric risk syndromes, the occupation of caregivers of the elderly and the technologies available in the respective databases. Virtual Health Library (BVS), Scielo, Cochrane and Pubmed with a time frame of the last 10 years.

The search descriptors were: Elderly Caregiver; Technology in Care Classification; Risk rating; Seniors. In the possibility of crossing the information and filtering, the Boolean operators "AND" and "OR" were used in the databases and filters for tracking articles in Portuguese, Spanish and English, available in full and free of charge and respecting the period of 10 years. . The search for the material followed the following steps: Identification of articles in scientific databases; Reading the titles of the studies as an inclusion criterion; Reading abstracts; Read the articles in full.

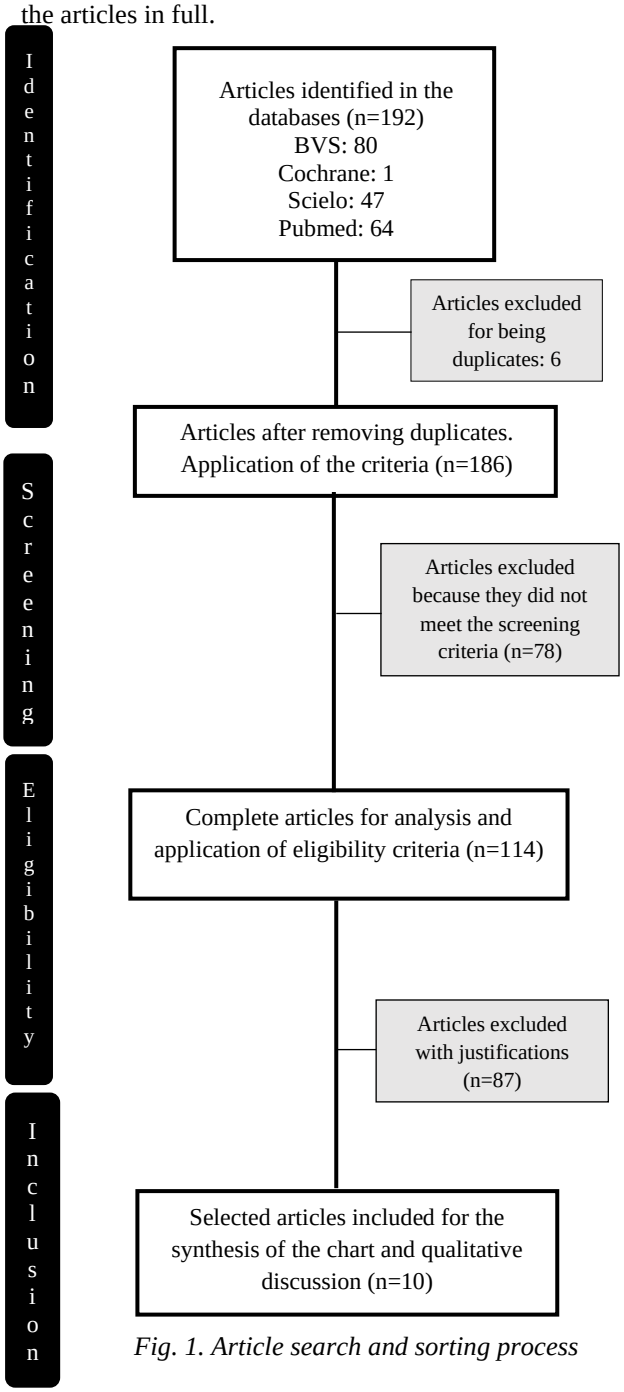


Fig. 1. Article search and sorting process

For the exclusion criteria, duplicate articles, productions such as experience reports, narrative and integrative reviews were removed. Below is the flowchart referring to the stages of identification, selection and inclusion of articles by database and the total number of studies included at the end of the survey.

Subsequently, the second stage was carried out, which consisted in the operationalization of the construction of the technology for risk assessment, in which the following protocols were taken into account: Manchester, Trauma Guideline and the Reception Protocol with Risk Assessment and Classification of the Ministry of Health. These protocols were used because they present attributes that corroborate the objective of the study, such as classification by colors according to the priority of the service and because they present access to an objective and didactic reading that is easy to understand.

In sequence, there was the elaboration of the proposal, directed to be used as a health education tool according to the Manchester risk classification and the Classification Protocol of the Ministry of Health.

III. RESULTS

In the table below are organized the studies that evaluated the applicability of educational technologies in health and operational protocols that help in the decision-making of the elderly caregiver.

Table 1. Applicability and performance evaluation of educational technologies and operational protocols that guide caregivers' decisions.

Authors	Title	Aim	Type of study	Main results
O'Caoimh et al. (2016)	Measuring the effect of carers on patients' risk of adverse healthcare outcomes using the caregiver network score	To examine the association between caregiver type and the caregiver network subtest of the Risk Screening Community Instrument (RISC), a five-point Likert scale scored from one ("can manage") to five ("absent/responsibility ")	Observational Cohort	Most patients had a primary caregiver (582/779; 75%), who was their child (200/582; 34%). The highest incidence of adverse outcomes occurred when state-provided care was the only support; and lower when the service was private. The need for institutionalization was observed in high-risk caregivers, when compared to low-risk ones; this association was stronger for the perception of difficulty in managing issues in the medical domain and associated with death.
Papa et al. (2020)	Review and selection of online resources for carers of frail adults or older people in five european countries: mixed-methods study.	The study aimed to review and select apps and websites that offer useful functionality for informal caregivers of frail or elderly adults in 5 European countries..	Qualitative and quantitative exploratory study	After searching 224 resources, 38 resources (38/224, 17.0%) were specifically aimed at caregivers, addressing the management of health disorders and focusing mainly on neurodegenerative diseases. It was observed that caregivers had no prior knowledge of any resource specifically aimed at caregivers, the main barriers to the use of resources were the low digital capacity of caregivers and the reliability of health-related apps and websites.
Schölz-Dorenbos et al. (2012)	Validation study of the prototype of a disease-specific index measure for health-related quality of life in dementia	To develop and validate the prototype of a dementia-specific HRQoL index measure: Dementia Quality of life Instrument (DQI), as a first step in assessing the health status of dementia.	Qualitative and quantitative cross-sectional study	Differences in classification and classification behaviors were small. Mood was rated (≥3.3) and rated (≥8.2) as the most, Orientation as the least important (rating ≤2.6, value 7.5) was the health domain for dementia
García-Arango et al. (2021)	Predictive validation of a functional classification method in older adults	Assess the predictive validity of a functional classification (FC) method on the use of emergency services and hospitalization, mortality and costs with elderly health care.	Retrospective cohort study	The risk of death (odds ratio [OR]: 1,767, 3,411, 8,525), hospitalization (OR: 1,397, 2,172, 3,540), and a high cost of health care (OR: 1,703, 2,369; 5,073) increased as there was a deterioration. in the FC classification, classes 2B, 3 and 4, respectively. The predictive model for the death outcome showed good discrimination (C statistic = 0.721) and calibration (HL statistic = 10,200; P = 0.251).
Lusardi et	Determining Risk	Firstly, to assess the	Systematic	Five history questions, 2 self-report measures,

al. (2017)	of falls in community dwelling older adults: A systematic review and meta-analysis using posttest probability	predictive ability of history questions, self-report measures, and performance-based measures to assess the risk of falling in community-dwelling older adults by calculating and comparing post-test probability (PoTP) values to individual test/measures. Second, to assess the utility of cumulative PoTP for combination measures.	review with meta-analysis	and 5 performance-based measures may have clinical utility in assessing fall risk based on cumulative PoTP. They are currently the most proven functional measures to determine an individual's risk of falling.
Sanchis-Soler et al. (2021)	Reduced caregiver overload after supervised training in pluripathological and palliative elderly	To know the relationship between the level of independence of a group of multiple and palliative clinical-pathological elderly (PCA-P) and the burden of their caregivers, after a multicomponent training program adapted to the home environment	Longitudinal study of quantitative type	The BI improved with supervised training ($p<0.05$) and remained or fell slightly, although not significantly, increasing autonomy. These improvements were accompanied by a reduction in caregiver burden, with similar dynamics, especially in caregivers in the <79 years and non-walking group.
Netto & Petraroli (2020).	Modeling a system for telemonitoring of elderly people with a chronic condition based on biotelemetry	To present the results of the application of a modeling proposal for a platform based on biotelemetry that is capable of acting in the detection of intervention points or levels of application of preventive measures in the health-disease process of the elderly with a chronic condition	Qualitative cross-sectional study	Operational protocols to guide measurement parameters and support self-care, in addition to increasing the elderly's sense of security. As a direct consequence, there was an improvement in the treatment outcomes. It is understood that the implementation of this type of system can reduce the number of trips to the emergency room and possible hospital admissions, in addition to avoiding unnecessary medical examinations..
Baixinho & Dixe (2017)	Team practices in the prevention of falls in institutionalized elderly:	The study aimed to build and determine the psychometric characteristics of the scale of practices and	Literature review and observational study	The team discussion on preventive measures is not always maintained, allowing different elements of the team to value different measures. The scale has good psychometric characteristics and can be used in research and

	Construction and validation of a scale	behaviors of teams in managing the risk of falling in institutionalized elderly people.		clinical practice to assess the practices and behaviors of teams in managing the risk of falls in institutionalized elderly people.
Mamani et al. (2019)	Elderly caregivers: knowledge, attitudes and practices about falls and their prevention.	To investigate the knowledge, attitudes and practices of informal caregivers of the elderly about falls and their prevention	Descriptive cross-sectional study	The study points out that more than half of the participants are aware of falls and identify them as a problem, as well as point out some risk factors and prevention measures. More than half of the caregivers are not favorable to the prevention of falls. Finally, it is concluded that caregivers know about falls and their prevention, but superficially.
Ceccon et al. (2021)	Aging and dependence in Brazil: Sociodemographic and care characteristics of older adults and caregivers	To identify sociodemographic and care characteristics of dependent elderly people, formal caregivers and family members in cities in different Brazilian regions.	Cross-sectional study	Burden, illness and social problems were found among family caregivers. Black women without formal employment, little or no training for the role and low remuneration predominated among formal caregivers and care was associated with household chores.

Based on the theoretical contribution of the analyzed studies, the construction of the educational care technology entitled: Geriatric Riscograma was graphically structured in the form of a disk, organized through the clinical situations of the elderly and clinical classifications according to the priority of care: Immediate care (red color)) Service in up to 60 minutes (yellow color) and Minor urgency (green color). They were classified as the need for immediate care when the elderly person has difficulty breathing and articulation of words, tachycardia and altered state of consciousness. Burns, presence of abdominal pain, minor dyspnea and headache were included as a need for hospital care within 60 minutes. In the classification of minor urgency, those who present with injury, diffuse abdominal pain, minor headache, psychiatric symptoms and diarrhea. For each clinical situation group, decision-making is suggested to the caregiver.

The graphic diagramming of the technology was built in the two-dimensional vector drawing program for graphic design corel draw version 2018 by corel corporation, a color gradient with nuances of red, yellow and green was used to represent the highlight of information such as classification, symptoms and behaviors required by the caregiver. We opted for dimensions of 15 cm in diameter, that is, 7.5 cm in radius, made for printing on rigid material of the plastic type and waterproof adhesive, aiming at the durability and ease of cleaning the technology.

IV. DISCUSSION

According to the survey of the studies of this literary review, the contribution and the power of the caregiver of the elderly in the necessary care that favor the good prognosis of those who depend on help in their care routine are undoubted. Therefore, taking into account the findings of the study by O'Caoimh et al. (2016), the absence of a professional linked to the health area increased the incidence of adverse effects in the geriatric patient, especially in the caregiver's perception of managing health problems that required specific information from the medical area related to the risk of death. This fact is associated with probable theoretical and practical insecurities that have been consolidated over time in their professional life, and if remedied, should provide more effective decision-making in life-threatening situations.

Caregivers still need training and qualification with regard to technological resources and access to health sites. In the study by Papa et al. (2020), who investigated the proportion of technological resources aimed at caregivers of the elderly with specific neurodegenerative diseases, only 17% included this group of professionals and most of the population of caregivers studied did not even have prior knowledge of any technological resource. Although the virtual scenario demonstrates greater accessibility to applications through smartphones, for example, resistance from some groups is noticeable.

Therefore, the construction of physical tools such as classifying disks for various health problems can reduce the negative impacts of the technological inability of caregivers and even the elderly accompanied. Furthermore, for Scholzel-Dorenbos et al. (2012), it is important to agree on the level of knowledge about clinical signs and symptoms related to dementia, and in this way they admit that this assessment is insufficient in the leveling of health knowledge of the caregiver of the elderly.

Likewise, the functional classification of the patient at the time of reception at the health institution is undoubtedly irreproachable, as it gathers information that helps in directing them to specific care. In the absence of functional or outdated classification, health and death costs increase. Therefore, functional classifications can encourage the construction of informational and educational technologies for caregivers. As an example, the tool produced by Lusart et al. (2010), who, through information on the natural history of the disease, patient self-report and performance-based measures, demonstrated clinical utility in the assessment of the risk of falling through cumulative points (scores) and are currently the most proven functional measures for determine the individual risk of falling (García-Arango et al, 2021).

In addition, caregivers have work overload, especially in the groups of elderly people over 79 years of age and those who do not walk. According to Sanches-Soler et al. (2021), patient autonomy can improve when training on palliative health care is provided at the patient's home, in addition to improving autonomy and reducing the caregiver's workload. In this way, the operational protocols that guide the safety of the elderly and, therefore, improve treatments, reduce the number of visits to health institutions, reduce the need for unnecessary exams, in the same way, the exposure of the patient to the hospital environment and, therefore, less cost to health services (Netto & Petraroli, 2020).

Baixinho & Dixe, (2017), admit that there is no consensus and standardization of prior knowledge about the physical risks of the elderly in their routine, and there are professionals who are unfavorable to preventive measures against the risk of falling. Thus, risk assessment models are necessary among professionals who work with the elderly, since most of the body of professionals is formed by women with low schooling in which there is physical and mental overload, diseases and social problems. are also among the caregivers. Additionally, black women without formal employment, with little or no training for the role and low pay still predominate (Mamani et al, 2019; Ceccon et al, 2021).

Therefore, there is a real need for facilitating proposals in the classification of daily geriatric risk situations, which, although growing, there are still few studies that aim to build informational products for caregivers of the elderly, such as the construction of a facilitator disk geriatric risk classification. Thus, the technology proposed in this study aims to offer direct and indirect benefits in the short and long term, respectively. In summary, the construction of the product should improve the quality of life of the elderly, by favoring prognostic factors for health and providing professionals with better results in the care provided.

V. CONCLUSION

The need for technologies that facilitate care and universal are of paramount importance in the process of evaluating symptoms and classification in the urgency to maintain the patient's health, the elderly population in the country is constantly growing and with a gradual inversion of the age pyramid that has been occurring in the world. Therefore, the development of technologies and tools that are easy to understand and handle, aimed at the elderly population, is irrefutably necessary.

REFERENCES

[1] Ayerbe, L. et al. (2013). Natural history, predictors and outcomes of depression after stroke: systematic review and meta-analysis. *Br J Psychiatry*, 202(1): 14-21.

[2] Little, C. L, & Say, M. A. (2017) Practices of teams in the prevention of falls in institutionalized elderly: construction and validation of a scale. *Text & Context-Nursing*, 26(3): 1-10.

[3] Ceccon, R. F. et al. (2021). Aging and dependence in Brazil: sociodemographic and care characteristics of older adults and caregivers. *Science & Public Health*, 26:17-26.

[4] Lead, V. F. (2018). The definition of the professional profile of the domestic worker: skills and personal traits. Dissertation: *University Institute of Lisbon*, Lisbon, 52.

[5] Couto, A. M. et al. (2016). Experiences to be a family caregiver of dependent elderly in the home environment. *Revista da Rede de Enfermagem do Nordeste*, 17(1): 76-85.
[6] Figueiredo, M. L. F. (2021). Formal caregivers of dependent elderly people at home: challenges experienced. *Science & Public Health*, 26:37–46.
[7] García-Arango, V. et al. (2021). Predictive validation of a functional classification method in older adults. *Panamerican Journal of Public Health*, 45: e15.
[8] Lima, C. M. F. & Veras R. (2013). Public health and aging. *Public Health Notebooks*, 19(3).
[9] Lusardi, M. M. et al. (2017). Determining risk of falls in community dwelling older adults: a systematic review and meta-analysis using posttest probability. *Journal of geriatric physical therapy*, 40(1): 1.
[10] Macena, W. G. et al. (2018). Physiological changes resulting from aging. *Mosaicum Magazine*, 27: 223-238.
[11] Mamani, R. N. A. et al. (2019). Elderly caregivers: knowledge, attitudes and practices about falls and their prevention. *Brazilian Journal of Nursing*, 72: 119-126.
[12] Manchester Triage Group. (2010) Manchester risk classification system: risk classification in urgency and emergency. Belo Horizonte. *Brazilian Risk Classification Group*, 210p.
[13] Melo, L. A. et al. (2017). Socioeconomic, demographic and regional factors associated with population aging. Brazilian *Journal of Geriatrics and Gerontology*, 20(4): 494-502.
[14] Misch, F. et al. (2014). Impact of observation on disposition of elderly patients presenting to emergency departments with non-specific complaints. *Plosone*, 9(5): 1-7.
[15] Netto, A. V & Petraroli, A. G. (2020). Modeling a system for telemonitoring of elderly people with a chronic condition based on biotelemetry. *Journal of Health Informatics*, 12(1): 17-23.
[16] O'Caoimh, R. et al. (2016). Measuring the effect of carers on patients' risk of adverse healthcare outcomes using the caregiver network score. *J Frailty Aging*, 5(2): 104-10.
[17] Papa, R. et al. (2020). Review and selection of online resources for carers of frail adults or older people in five European countries: Mixed-methods study. *JMIR mHealth and uHealth*, 8(6): e14618.
[18] Sanchis-Soler, G. et al. (2021). Reduction of caregiver burden after supervised training in pluripathological and palliative elderly. *Notebooks of Psychology of Sport*, 21(1): 271-281.
[19] Santos, M. T. et al. (2016). Elder-friendly emergency services in Brazil: necessary conditions for care. *Journal of the USP School of Nursing*, 50(4): 592-9.
[20] Schölzel-Dorenbos, C. J. M. et al. (2012). Validation study of the prototype of a disease-specific index measure for health-related quality of life in dementia. *Health and quality of life outcomes*, 10(1): 1-11.
[21] Speake, D. (2013) Detecting high-risk patient with chest pain. *Emergency Nursing*, 11(5): 20-32.
[22] Silva, H.S. & Gutierrez, B. A. O. (2018). Education as an instrument of change in the provision of care for the elderly. *Educar em Revista*, 34(67): 283–296.
[23] Thim, T. et al. (2012) Initial assessment and treatment with the Airway, Breathing, Circulation, Disability, Exposure (ABCDE) approach. *Int J Gen Med*, 2(17): 117-21.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.12

Technologies as Tools for Quality Management in Health Services

Luciana Martins Ribeiro[1], Pamela Nery do Lago[1], João Eduardo Pinho[1], Aline da Silva Fernandes[1], Marília Antônia de Paula[1], Carla de Oliveira Arcebispo[1], Marlene Simões e Silva[1], Vinícius Martins Machado[1], Juliana da Silva Mata[1], Ronaldo Antônio de Abreu Junior[1], Ana Paula Caetano Pereira[1], Andréia Elias da Cruz Nascimento[1], Natália Borges Pedralho[1], Adriana Von Sperling Viana[1], Chaiene Cristina de Figueiredo[1], Renata Castro Mendes[1], Carla Renata dos Santos[1], Bianca Cristina Silva Assis Santiago[1], Dayana Cristina Ferreira[1], Carolina Costa Pinto[1], Ronaldo Gomes Rodrigues[1], Raquel Resende Cabral de Castro e Silva[1], Renata Cristina Rocha Batista[1], Maria Emília Lúcio Duarte[1], Luna Flávia dos Santos[2], Maria Ivanilde de Andrade[3], Yasmin Cristine Sousa de Moraes[4], Fabiana Ribeiro da Silva Braga[5], Hirlla Karla de Amorim[5], Rita de Cássia Almeida Sales[5], Karla Patrícia Figueirôa Silva[5], Maria Virgínia Pires Miranda[6], Raiane Almeida Silva[6], Eliseu da Costa Campos[7], Tatiana Lamounier Silva[7], Gisela Pereira Xavier Albuquerque[8], Kelly Monte Santo Fontes[9], Diana Carla Ferrari[10], Lana Rose Cortez de Farias[11], Siomara Jesuina de Abreu Rodrigues[12], Paula Moraes Rezende[13], Jessé da Silva Alexandrino Júnior[14], Ítalo Freire Cantalice[14], Fernando Henrique da Silva Costa[14], Amanda Araújo Brandão[14], Eugênio Barros Bortoluzi[14], Pedro Henrique Santos Oliveira[14], Laura Helena Velasco Moreira[15], Ira Caroline de Carvalho Sipoli[16]

[1]Clinical Hospital of the Federal University of Minas Gerais (HC-UFMG), Belo Horizonte, Brazil.
[2]Pontifical Catholic University of Minas Gerais, Betim, Brazil.
[3]Lagoa Santa City Hall, Lagoa Santa, Brazil.
[4]University of the Amazon, Ananindeua, Brazil.
[5]Clinical Hospital of the Federal University of Pernambuco, Recife, Brazil.
[6]Dr. Washington Antônio de Barros Teaching Hospital of the Federal University of Vale do São Francisco, Petrolina, Brazil.
[7]Clinical Hospital of the Federal University of Triangulo Mineiro, Uberaba, Brazil.
[8]University Hospital Complex of the Federal University of Pará, Belém, Brazil.
[9]University Hospital of the Federal University of Sergipe, Aracaju, Brazil.
[10]State University of Mato Grosso, Cuiabá, Brazil.
[11]Ana Bezerra University Hospital of the Federal University of Rio Grande do Norte, Santa Cruz, Brazil.
[12]Faculty of Health of Human Ecology and the Faculty of Education of Minas Gerais, Belo Horizonte. Brazil.
[13]University Hospital of the Federal University of Juiz de Fora, Juiz de Fora, Brazil.
[14]Faculty of Applied Social Sciences, Campina Grande, Brazil.
[15]Federal University of Mato Grosso do Sul, Campo Grande, Brazil.
[16]University Hospital of Brasilia, Brasília, Brazil.

Received: 09 Apr 2022,
Received in revised form: 01 May 2022,
Accepted: 09 May 2022,

Abstract**—** *Since World War II, there has been a concern related to the quality standard of industrial production. Adapting to the reality of the health sector, it sought to improve the management of the quality of its services, aiming, in addition to satisfying its internal and external*

Available online: 19 May 2022

Keywords: ***Health, Quality, Technology.***

customers, the safety of its patients. The objective was to settle how technologies influence the quality management of the health sector today. Thus, this article presents as a methodology a bibliographic research in which a literature review of the last five years was carried out in scientific articles, analyzed in the months of November and December 2021, using the following descriptors: technology, health and quality. As a result, it can be seen that technologies are important allies of management in health services, providing patient safety, systematization, organization and agility in processes, reducing workload and reducing costs for the organization. However, it is essential that managers are attentive to develop training and adherence strategies for professionals responsible for feeding the computerized systems, in order to guarantee the quality of information and the achievement of the intended results.

I. INTRODUCTION

Thinking about the quality of the services provided, regardless of the area of activity, involves organizational efforts in order to mobilize the entire team, since to offer a satisfactory final result, the work goes through the institution's top management to those who work at the end, in the contact directly with the customer.

When talking about quality management, Lago [1] points out that:

> It is essential to guide the processes and redirection of energy within the management, for the fact that when the consumer purchases a product or a good, even if unconsciously, this choice is based on a "cost-benefit" relationship. This is no different for the health sector, as the client seeks affordable prices and quality in the care provided.

In the health sector, in addition to the desired quality, it is a service that is directly linked to the life of the individual, and that often if the service provided is not adequate and unsatisfactory, it can be fatal for the client involved. In this sense, all possible efforts must be made to deliver the best.

Technologies add an important source of support in all care processes, ensuring patient safety and systematization, organization and agility in the actions and services provided.

Given this context, this paper aims to discuss how technologies influence the quality management of the health sector today.

II. METHODOLOGY

This is a qualitative, exploratory, bibliographic research, in which a literature review of the last five years was carried out on scientific articles in the Virtual Health Library database, analyzed in November and December 2021, using use the following descriptors: quality, health and technology. 900 articles were found, of which 28 were directly related to the theme. After applying the eligibility criteria: three most relevant studies for each descriptor, full text, in Portuguese and indexed, the abstracts were read and the studies that met the theme related to the object of study were selected. They were thoroughly read in full to effectively absorb their content. Discussions related to the five most relevant articles will be presented here.

III. RESULTS AND DISCUSSION

3.1 Quality Management in Health

Considering that we are experiencing a moment in which clients are much more demanding and aware of their rights in relation to their own health, mainly because they have more access to information than in the past, one must think about "a change in managerial posture, involving all sectors of the organization with a focus on excellence" [1].

To achieve the expected results in terms of quality management, it is important to emphasize that:

> Quality management in healthcare is an area in constant growth, which absorbs changes in the competitive and demanding market. Institutions are no longer understood only as places of prevention and care for patients and begin to be seen as organizations that need management and focus on the patient [1].

Technologies together with other valuable tools such as quality indicators, accreditation seal, diagrams, scales and various graphs can and should help managers to develop strategies for organizations to achieve the expected results. It is important to emphasize that these tools can be incorporated into computerized systems, generating decisive data and information. They serve as an anchor for

quality management in health, directly contributing to the effectiveness of the implemented actions.

Quality management can make use of numerous resources that information systems provide, these when "well designed and organized are crucial for the decision-making process in health, as they provide data and knowledge about the real need of the assisted population, helping in the planning of managerial actions and in the decision-making process of professionals [...]" [2].

3.2 Technologies and their Influence on the Health Sector

According to Salomi and Maciel [3] "as in any other organization, in a hospital, both Information Technology (IT) and Information Systems (IS) permeate the various hierarchical and functional levels", playing a fundamental role in various scenarios.

The IS, when applied to the health area, provides multiple technological resources that, in addition to care management, allow the implementation of barriers to the occurrence of adverse events, thus acting directly on patient safety and qualification of the care provided [4].

Patients are accompanied by different professionals: doctors of different specialties, psychologists, nurses, physiotherapists, social workers, nutritionists, among others. In this context, there is a major problem of communication between all these professionals, which is historically rooted in health services. At this point, technologies come to alleviate many of these communication failures, as it is currently possible to enter all information relevant to the treatment of patients in electronic medical records systems and, thus, any professionals will be able to access this information in real time, preventing the same are lost in papers that were once so commonplace.

Study developed by Ferreira [4], corroborates stating that "control and access to all care and procedures through the computerized system are a resource that is easily available, due to the practicality to view patient information and all actions related to the care provided".

Another important scenario in which the IS is inserted is in the control of medications, helping the professional in prescribing, dispensing, checking and administering medications, greatly reducing the possibility of errors in medication administration, forming real barriers to the occurrence of adverse events involving medications, unfortunately so common in the routine of health services.

> Healthcare IT systems, such as electronic health records and computerized medical order entry, have the potential to improve quality and reduce costs. In general, they are designed to improve communication between different providers within a healthcare organization. In addition, these technologies facilitate the implementation of goals and the use of decision support tools, which can be particularly valuable in preventing errors in processes [3].

In the same study by Salomi and Maciel [3] it was found that "for patients, the most obvious benefit was the speed of care. [...] the technology facilitated the perception of the waiting times to which each patient was subjected until being seen".

Another aspect that can be approached from the perspective of the patient, concerns a major change that is currently perceived in the level of information and access of these to Internet services. In this context, Malik [5] explains that access to the network:

> [...] does not mean really good quality information. The most difficult thing for different users is to discriminate what is useful, what is useless and even what is outdated or wrong. The patient having access to the results of his exams can be good, but he does not have the technical competence to interpret them alone, nor with the help of existing websites. In the same way, collecting lists of symptoms does not help to configure a diagnosis, confronting healthcare professionals with information collected online does not facilitate the introduction of a therapy [...].

Given this scenario, it is essential that there is a process of training professionals to deal with these very common situations, and awareness of patients who, when seeking information from dubious sources, create expectations that are often exacerbated and negative, generating unnecessary anxiety and discomfort.

Technologies are very useful and welcome in health when well used. As an example, in countries where telemedicine (e-health) is widely used, there is already a gain in time in patient care, thus reducing the workload on professionals, service costs are lower, generating savings for the organization, which can invest in other demands. Professionals feel more secure and satisfied with their work, have lower absenteeism and turnover rates, reflecting the improvement in the quality of patient care. Undoubtedly, this brings more security to professionals and patients.

Complementing the above, Malik [5] notes that:

> In Brazil, telemedicine is defined as a national system for assistance and education, involving teaching/reference institutions and primary and secondary services. It has been proven to be an

> efficient tool for increasing access [...]. It guarantees economy and risk reduction for the system, for professionals and for patients, reducing the need for displacements.

However, it is important to emphasize that for the use of telemedicine, training of those involved is necessary, so that its implementation "must be combined with appropriate changes in the processes and in the organization, guided by duly qualified people" [3].

To ensure reliable information, it is essential that the professionals who feed the system are able to do so, that they actually appropriate the necessary knowledge for this action. At this point, management plays a fundamental role, seeking improvement strategies, directing the organization to the best possible decision-making. It can therefore be said that technologies are true tools to transform the provision of care.

In addition, leaders must pay attention to the issue of professionals' adherence to the use of technologies, so that they internalize the use of technologies as a normal and daily work tool. It is also important to note the need for a contingency plan in case the computerized system becomes unavailable.

IV. CONCLUSION

Technologies play an important role in supporting health organizations, guiding the decisions of managers so that the final result is quality of services provided, internal and external customer satisfaction, reduction of work overload, agility in service, cost reduction. , among others.

In terms of the patient, the main benefit observed is the speed of care, as the change observed with the implementation of technologies is quite significant.

However, managers need to develop training strategies and employees' adherence to the use of technologies, so that reliable information is obtained based on the data fed by the responsible professionals. This is the only way to guarantee the quality of the information so that the expected results are achieved.

REFERENCES

[1] Lago, P. N. et al. (2020). Gestão da Qualidade em Saúde. In: Saúde e Ciência: a máquina da evolução humana. Belém, PA: Neurus.

[2] Silva, A. R., Oliveira, T. M., Lima, C. F., Rodrigues, L. B., Belluci, J. N., & Carvalho, M. G. O. (2016). Sistemas de informação como instrumento para tomada de decisão em saúde: revisão integrativa. Revista de Enfermagem UFPE on-line, v. 10, n. 9, p. 3455-3462. Retrieved from https://periodicos.ufpe.br/revistas/revistaenfermagem/article/view/11428.

[3] Salomi, M. J. A., & Maciel, R. F. (2016). Gestão de documentos e automação de processos em uma instituição de saúde sem papel. J. Health Inform., v. 8, n. 1, p. 31-38. Retrieved from http://www.jhi-sbis.saude.ws/ojs-jhi/index.php/jhi-sbis/article/view/387.

[4] Ferreira, A. M. D., Oliveira, J. L. C., Camillo, N. R. S., Reis, G. A. X., Évora, Y. D. M., & Matsuda, L. M. (2019). Percepções dos profissionais de enfermagem acerca do uso da informatização para segurança do paciente. Revista Gaúcha de Enfermagem, v. 19, esp.: e20180140. Retrieved from http://www.scielo.br/pdf/rgenf/v40nspe/1983-1447-rgenf-40-spe-e20180140.pdf.

[5] Malik, A. M. (2016). Gestão da qualidade e segurança do paciente: ações e resultados. Revista Baiana de Saúde Pública, v. 40, supl. 1, p. 86-97. Retrieved from https://pesquisa-eaesp.fgv.br/sites/gvpesquisa.fgv.br/files/arquivos/17_2668-1-15392-2-10-20170923_1.pdf.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.13

Identity and Diversity an issue in Management

Francisco das Chagas Lopes, Walber Gonçalves de Souza, Rosane Gomes de Oliveira, Wederson Marcos Alves, Aline Mattos Peruch Rigoni, Pedro Henrique Santos, Anselmo do Amor Divino Souza and Daniel Rodrigues Silva

Received: 08 Apr 2022,

Received in revised form: 26 Apr 2022,

Accepted: 01 May 2022,

Available online: 19 May 2022

***Keywords*— Diversity management, diversity, Identity, Stereotype.**

***Abstract*—** *The proposal to understand the management of diversities in view of the talents found includes understanding the identities of both employees, the organization and the manager himself. Their beliefs and stereotypes can be impediments to organizational growth and loss of talent that are essential to the company's smooth running. The manager's emotions must be regulated as to his personal security in relation to himself and the environment. Having a good management of diversities will make a big difference in competitive markets. Since school management also begins to be seen in the same way as company management, curriculum changes are important in order to implement training focused on the organization's needs, in view of its vision, values and mission. Continuing education appears as a strategy for creating new management models.*

I. INTRODUCTION

The anthropological differences recorded throughout the history of the human being denote evolutionary processes that range from its ontogenetic structure to living in society. To maintain itself as a species, man sought means of adaptation. Since the most distant times, this survival movement has directed every step of men in order to preserve themselves in the face of all the mishaps that are inflicted on them.

If before it was necessary for tribe A to fight against tribe B and defeat it so that it could perpetuate its dynasty today, both tribes are part of the same village and for the survival of all the concept of differences needs to be approached not as a problem; and if for the permanence of the species it is necessary to have some war, these peculiarities of each one can become like a war instrument against the extinction and, to manage these questions it is necessary that there is (continuing the analogy to the tribal context) the intervention of the chiefs .

As seen within the global marketing process, the issue of diversity is advantageous for those who “open their eyes” to this issue, as it expands the conditions to win in the competition of national and international markets that are increasingly diverse,(MYERS, 2003). On the other hand, homogeneity can bring competitive disadvantages.

Thus, in order to broaden the discussion on the topic of diversity, this work seeks to verify how its management should occur in view of its challenges and new technologies in the different current social contexts and the mediating role of management in this process, given that every day, within the organizational context, there is a mix of talents in groups that deviate from that traditional view of employees with standardized characteristics, aiming at respect for equality in difference and individualization of treatments:

> Based on the argument of the need to correct perverse consequences of the past, minorities and marginalized or socially vulnerable groups began to be contemplated with compensatory public policies and affirmative actions, in which two aspects stand out: respect for equality in difference and the individualization of treatments.(CARVALHO EJ, 2013).

It is clearly perceived that in the face of all globalized action, in all areas of human existence, a management model in which certain premises in relation to

diversity are set aside would be a setback in social achievements. And the education that stands as a door to the world has a great responsibility to foster new behaviors, as was the case of Hong Kong, South Korea, Singapore and Taiwan where "education was used intentionally to promote social cohesion and social cohesion". sense of national identity".(WILSON, 2011).

II. DEVELOPMENT - LITERATURE REVIEW

2.1 IDENTITY

Human beings have peculiar ways of presenting themselves, of living in society, of representing their social roles. This is part of their social nature and their cultural, ethnic or religious context has to be taken into account since all this served so that each one, within their own history, could form their personal identity.

> The formation of identity goes through a range of feelings and rational and irrational decisions in the choice of personal investments that the subject makes for his identification. Subjectivity suggests our understanding of our self. It is what allows explaining why a subject clings to a peculiar identity.(MIRANDA, 2012)

On the other hand, there are organizations that also have their own history and that have gone through a construction of their own identity and that, when they receive a collaborator, have the implicit idea that he needs to have his identity reconstructed, especially when there is a need for change:

> It is through this sharing of reality that the identities of individuals in organizations are constructed, by communicating to members, in a tangible way, a set of norms, values and conceptions that are taken for granted in the organizational context. When defining the social identity of individuals, what is intended is to guarantee productivity, through harmony and maintenance of what has been learned in coexistence. It is important to emphasize that these identities often need to be rebuilt, when the company is faced with situations that require changes.(FERNANDES, 2006)

The junction of this group of identities (company and employees) forms a set of information that can be used for organizational growth. When a company is looking for a collaborator, it excels in establishing the profile that suits the position, that is, someone with the personality to meet the requirements of the peculiar issues of the functions.

Therefore, once,(CARVALHO M., 2012), considers that the dualism of social identity and personal identity is no longer the focus, and due to the individual's socio-cultural changes, a dynamic intersection that involves the subject's entire environment is considered, it is important to have a new look for the management's behavior towards the organization and its employees, considering their points of convergence, with all their qualities and diversities with those of the company, that is, people management would be intrinsically linked to identity management.

2.2 MISCELLANEOUS IDENTITIES

The functional character of an organization is delimited by its rules that are implicitly inserted in its structural scope. These internal instructions are what form the company's identity; it is for these qualities that one becomes known, loved, or hated.

Managing diversity, within such a broad market in which every day it is necessary to stand out in some way to attract and keep customers, is seen as a differential that gives companies competitive advantages, giving new characteristics to their identity:

> For companies, one of the advantages of managing diversity is that it works as a strategy to maintain competitiveness in the context of globalization, in which markets are extremely diverse.(CARVALHO EJ, 2013).

So, within a corporate environment, there is the management of the organization's identity, of the employee's identity, without taking a look at the identity of its customers and, also, the manager's own identity.

2.3 THE EMOTION MANAGER

This being understood, now comes the development of the manager's understanding of his own personality demands regarding emotional regulation within the company's cultural transformation process in the face of the needs of the market in which it is inserted.

> Emotion in management, therefore, is essential to measure the relationship between flexibility, democracy and autocracy present within organizations, which are vectors of a system that must be well coordinated so that they become a system that can instill people to work better. its human perception and motivation.(OLIVEIRA, 2011)

Psychologist Rogério Martins, pondering why, even knowing that change is something inevitable and present in human history, this still frightens certain people:

> The answer, however, is both simple and complex. confused? For that's exactly what the processes of change cause in our lives: a sense of duality. All

> this because what is involved are our emotions. No matter how rational and logical the person is, he will feel fear and fear of what he does not know. For some this is a stimulus and so they risk more. For many this paralyzes. It feels like an anesthetic. Fear takes over and makes your reactions one of resistance.(MARTINS, 2012).

Thus, the growing approach to diversities is a factor of change that can affect the manager with some psychic defense mechanism, such as resistance. It is, therefore, imperative that you have your emotional and cognitive conditions properly regulated and restructured, so that you are not a saboteur of the assimilation process when you are faced with competences, for example, technological, in people who flee from their Shiboleth.[1]("shibboleth") peculiar, which does not meet your personal expectations.

2.4 SCHOOL MANAGEMENT AND TECHNOLOGIES

Social strata stand out for their unique conditions that involve needs that companies seek to satisfy and "The new information and communication technologies (NICT) and the growing human diversity in the most urbanized societies are fulcrums - perhaps the most important - generators of change in all social domains".(CARDOSO, 2001)

Education management was seen as a separate form in terms of administration, however, there is a need for the manager to see it as other companies that seek to adapt to changes in the sense of always favoring their customers are understood. Therefore, the curriculum for education comes up with a proposal to be guided more by aspects of citizenship, proposing a review:

> [...] the clear orientation of the curriculum for education for citizenship and for the principles and values that support it; the explanation of the essential competences, at the end of basic education, which guide the exercise of this citizenship; hence, the focus on the social effects of the curriculum's products and, for all this, the strong challenges to curricular flexibility and transversality. In other words, this revision proposal, if carried out successfully, is more reformist than the curriculum reform of the early 1990s. What is essential now is to act in relation to the conditions for carrying out such a curriculum; Bear in mind that this review calls, above all, for changes focused on the processes and ideological attitudes of the main people responsible for managing the curriculum, in particular, teachers.(CARDOSO, 2001).

The proposal to insert management with a critical pedagogy shows that changes need to be understood without so much rigidity, which is not just change for the sake of change, but that this change is ideological despite the understanding of the process as something dynamic "attentive and permanent to changes in the information society and its projection into their professional daily lives"(CARDOSO, 2001).

In a globalized culture where what happens in one country quickly reflects on the other, in a positive way, technologies can serve as an instrument for disseminating information and training in which those management models that still perpetuate a repetition of prejudiced patterns are restructured to meet the emerging demand in relation to the adequate use of human competences for education:

> The continuing education of education professionals (directors, pedagogues, teachers and others) is a strategic condition for updating and promotion that, consequently, contributes to improving the quality of teaching/learning and the creation of new management models. This condition can be fulfilled quickly and extensively through technology, through the use of TV, video and computer resources and in the creation of virtual information and knowledge production networks.(SILVER, 2002)

The different segments of the sciences and all the means that involve work or human action have, in some way, influences of technology, information and communication. This is a fact. And management may or may not excel when given due attention.

III. CONCLUSIONS

As the perspective that involves the smooth running of a company permeates the consent of the manager, it is understood that his emotional condition has a character of primordial influence. Their sense of security and their stereotyped view can alter their perception of a changing scenario that involves the acceptance of competences found in people with standards that go against their beliefs in relation to diversities.

[1]Linguistic apparatus used to differentiate the members of the Gileadite and Ephraimite Tribes. Because of the famous episode quoted in the Bible (Judges 12:6) the term "shibboleth" came to designate any expression that can serve to characterize the way of speaking in a certain region or state.
SOURCE:https://focoartereal.blogspot.com/2013/02/xibolete-denuador.html

The great and greatest social changes, undertaken by technologies and diversity, drive measures of attention to the subject that involve people's interest in terms of their real needs; this, linked to the objectives of the companies and the change of perception, necessarily, needs to undergo a modification of the manager's internal beliefs. And when these changes occur, school management will have structural conditions to also implement curricular changes, since these have, primarily, ideological fillings, which would be the Gordian knot.[2]of school management.

REFERENCES

[1] CARDOSO, C. (November 2001). The challenges of diversity and new technologies. Access on May 10, 2020, available at A Página da Educação: https://www.apagina.pt/?aba=7&cat=107&doc=8565&mid=2

[2] CARVALHO, EJ (2013). CULTURAL DIVERSITY AND SCHOOL MANAGEMENT: SOME POINTS FOR REFLECTION. Accessed on April 28, 2020, available at Universidade Estadual de Maringá: http://periodicos.uem.br/ojs/index.php/TeorPratEduc/article/view/20181/10527

[3] CARVALHO, M. (Jan./Jun. 2012). THE CONSTRUCTION OF IDENTITIES IN THE SCHOOL SPACE. Accessed on May 7, 2020, available at UNISC - Revista Revisão e Ação, Santa Cruz do Sul, v.20, n1, p.209-227: https://online.unisc.br/seer/index.php/reflex/article/viewFile/2161/2521

[4] FERNANDES, KR (2006). The process of construction and reconstruction of the identities of individuals in organizations. Accessed on 5/7/2020, available in Revista de Administração Contemporânea, 10(1), 55-72: https://www.scielo.br/scielo.php?script=sci_arttext&pid=S1415-65552006000100004

[5] MARTINS, R. (October 1, 2012). The leader and his role as a manager. Accessed on May 9, 2020, available at TRF5 - JUS: https://www.trf5.jus.br/downloads/O%20lider%20e%20seu%20papel%20como%20gestor%20de%20mudancas.pdf

[6] MIRANDA, D.d. (December 28, 2012). The construction of the identity of the army officer. Accessed on May 7, 2020, available at PUC-Rio: https://www.maxwell.vrac.puc-rio.br/21902/21902_3.PDF

[7] MYERS, A. (2003). The Value of Racial Diversity in Business. Accessed on April 28, 2020, available in Afro-Asian Studies, Year 25, nº3, p. 483-515: http://www.scielo.br/pdf/eaa/v25n3/a05v25n3.pdf

[8] OLIVEIRA, R. (August 3, 2011). Emotion in Management. Access on May 9, 2020, available at Administrators: https://administradores.com.br/artigos/a-emocao-na-administracao

[9] SILVER, CL (2002). SCHOOL MANAGEMENT AND TECHNOLOGIES . Access on May 10, 2020, available at VIRTUAL.UFC: http://www.virtual.ufc.br/cursouca/modulo_3b_gestores/tema_05/anexos/anexo_5_tics_na_gestao_escolar2010_Carmem Prata.pdf

[10] WILSON, SE (2011). Education opens the door to a better world. Accessed on April 29, 2020, available in PUCRS Electronic Journals: http://revistaseletronicas.pucrs.br/ojs/index.php/faced/article/view/8853

[2]The Gordian knot was a knot whose history dates back to the 8th century BC It refers to a very great difficulty to be solved.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.14

Proposal to Combat Violence against Women from Women's Social and Financial Emancipation

Suelen Cipriano Milhomem Dantas[1], Nyedja Rejane Tavares Lima[2], Elayne de Araújo Pereira[3], Ramisson Corrêa Ramos[4], Nathalia do Vale Carvalho de Araújo[5], Ana Alice Torres Sampaio[6], Irlene Veruska Batista da Silva[7], Mariana Queen Cardoso da Silva[8], Ana Caroline Amorim Oliveira[9], Luciano da Silva Façanha[10]

[1]Mestranda em Cultura e Sociedade do Programa de Cultura e Sociedade (PGCult) da Universidade Federal do Maranhão (UFMA), São Luís, Maranhão, Brasil. ORCID: https://orcid.org/0000-0001-6317-4372 . E-mail: suelen.dantas@ufma.br.
[2]Mestranda em Cultura e Sociedade do Programa de Cultura e Sociedade (PGCult), Universidade Federal do Maranhão (UFMA), São Luís, Maranhão, Brasil. ORCID: https://orcid.org/0000-0002-7780-5152. E-mail: nyedja.lima@discente.ufma.br.
[3]Mestranda em Cultura e Sociedade do Programa de Cultura e Sociedade (PGCult), da Universidade Federal do Maranhão (UFMA), São Luís, Maranhão, Brasil. ORCID: https://orcid.org/0000-0002-2452-9617. E-mail: elayne.araujo@discente.ufma.br.
[4]Mestrando em Cultura e Sociedade do Programa de Cultura e Sociedade (PGCult), Universidade Federal do Maranhão (UFMA), São Luís, Maranhão, Brasil. ORCID: https://orcid.org/0000-0001-7781-0405 . E-mail: ramisson.correa@discente.ufma.br.
[5]Mestranda em Cultura e Sociedade do Programa de Cultura e Sociedade (PGCult), da Universidade Federal do Maranhão (UFMA), São Luís, Maranhão, Brasil. ORCID: https://orcid.org/0000-0002-9902-4138. E-mail: nathalia.araujo@discente.ufma.br.
[6]Mestranda do Programa de Cultura e Sociedade (PGCult), Universidade Federal do Maranhão (UFMA), São Luís, Maranhão, Brasil. ORCID: https://orcid.org/0000-0002-1181-454X . E-mail: torres.ana@discente.ufma.br.
[7]Mestranda do Programa de Cultura e Sociedade (PGCult), da Universidade Federal do Maranhão (UFMA), São Luís, Maranhão, Brasil. ORCID: https://orcid.org/0000-0001-6361-0197 . E-mail: irlene.veruska@discente.ufma.br.
[8]Mestranda em Cultura e Sociedade do Programa de Cultura e Sociedade (PGCult), da Universidade Federal do Maranhão (UFMA), São Luís, Maranhão, Brasil. ORCID: https://orcid.org/0000-0003-1056-0143 .E-mail: queen_ebano@hotmail.com.
[9]Professora Adjunto III do Curso de Licenciatura em Ciências Humanas/Sociologia e do Programa de Pós-Graduação em Cultura e Sociedade (PGCult), Universidade Federal do Maranhão, São Luís, Maranhão, Brasil. ORCID: https://orcid.org/0000-0002-9337-6335 . E-mail: oliveira.ana@ufma.br.
[10]Professor do Departamento de Filosofia e do Programa de Pós-Graduação em Cultura e Sociedade (PGCult), Universidade Federal do Maranhão, São Luís, Maranhão, Brasil. ORCID: https://orcid.org/0000-0003-1178-4018 . E-mail: luciano.facanha@ufma.br.

Received: 11 Apr 2022,
Received in revised form: 01 May 2022,
Accepted: 06 May 2022,
Available online: 23 May 2022

***Keywords*— Violence against women, gender violence, autonomy, financial emancipation, public policies.**

***Abstract*—** *The present study aims to bring reflections about violence against women (MVC), in order to reduce these indexes, it is necessary to seek theoretical gender reference, promotion of gender equality and Brazilian public policies already developed to combat MVC, based on a brief historical incursion. The method used was a bibliographic survey with literature review obtained in articles, course completion papers, theses and dissertations on the Google Scholar platform and statistical data updated in sources such as the Brazilian Public Security Forum (FBSP), Intelligence in Research and Consulting (IPEC), the latter, in their reports published between the years 2019 to 2021. Thus, in the research conducted, it was observed that education about gender, emancipation, emotional autonomy, financial and equity are effective alternatives in coping with the problem rooted in Brazilian society.*

I. INTRODUCTION

Statistics show that, in number, women are the majority of the population in Brazil, according to data from the Brazilian Institute of Geography and Statistics (IBGE), (year 2013), whose total Brazilian population at the time was 201,032,714 inhabitants, of which approximately 103.5 million women (51.4% of the population). Based on this, why be treated as a "minority" or your "minority" agendas?

It is important to point out that this research is based on a decolonial point of view, that is, from the study from the study from potentiating the voice and visibility to the subalternized and oppressed peoples who for a long time were silenced. To this end, one will drink from sources such as the authors Rita Segato (2003 and 2017), Joan Scott (1995), Débora Diniz (2020), Aníbal Quijano (2005), among others, aims to bring reflections about the problem: "How to face gender violence (against women) in contemporary times, effectively?". In an attempt to answer this question, a bibliographic survey of the authors and authors mentioned will be used, as well as a literature review of articles, course completion papers, publications in journals and dissertations on the *Google Scholar* platform, as well as statistical data updated and published by the Brazilian Public Security Forum (FBSP), Research intelligence and Consulting (IPEC), from 2019 to 2021.

The interest is justified from the moment that, being a woman, the author, researches for more than a year, the reason that violence against women does not decrease over time, although Brazil has the laws considered "more innovative" related to the case. Therefore, we sought to build reflections from the subject, therefore, the sections will deal with: gender; promoting gender equity; violence against women; the public policies used to face this problem and, at the end, will present (or attempt) to solve the problem.

Thus, it is expected that this work will contribute to future research and effectively so that women, men and society see much more than dua, female or male bodies, but beings endowed with values, strength and capacity.

II. THE SOCIAL MARKER OF GENDER

The social gender marker is an essential feature for this research, given the need to analyze the socioeconomic, political, cultural differences between men and women, in the Manichean (dual) and patriarchal society, which are still reproduced in contemporary times, as perceived on the inequalities of the sexual division of labor and social relations (including "power relations")[1]. This is said mainly because of the permanence of this type of "colonial patriarchal doctrine" in the political, social and economic structure of countries that were exploited as colonies, according to Aníbal Quijano (2005), an author who attributed the expression "coloniality of power" to this junction of capitalism and eurocentrism[2] as systems that reflect, in female bodies, the diminished or annulled subjectivities, with different roles and tiny values before men.

This sexual division also begins in the primary social nucleus, the family, in which women are assigned a secondary life, adjuvant, but essential in some criteria: reproduction, maintenance of the house, care for the husband, children (these being invisible functions), as a consequence of the macho, misogynistic, Eurocentric culture imposed on cis women (Diniz, 2020); while trans women are relegated to social abandonment, violence and intentional deaths (Benevides and Nogueira, 2020).

To man, it would be up to public life, important, independent, protagonist, provider, with prerogatives. From this inequality and non-division (since women would have an overload of responsibility and work), discussions about women's struggle were theorized. Therefore, gender studies were, in its beginning, linked only to women, however, this theory is neutral and pertinent also to men, since they are parts of the same social structure (Diniz, 2020).

That is, the studies mentioned aim to reflect and promote discussions that enable women, assign roles to them, are active in the community of experience, independent, that can resist unequal environments and fight for their rights. Therefore, the emergence of these studies was called "gender studies" in the 1990s,

[1]"Power relationship" explains that this is a category from the Foucaultian lexicon Michel Foucault, a contemporary philosopher who developed the understanding of power relations. A scholar on power, in order to identify subjects acting on subjects, he said that power is omnipresent, not only in an institution (State), but in social relations. Therefore, in order to understand the category of Foucauldian lexicon, in his work The Order of Discourse, Foucault states that, in societies, there is recurrently an unevenness between the discourses that are said and those that are at the origin of new speech acts that take them up, transform them or repeat them. This happens in texts already known culturally, such as legal, literary, religious, among others, as many are the resumption of what has already been said.

[2] A doctrine that, a priori, locates individuals in a genealogy that determines them to an immutable origin. It promotes the justification of existing inequalities, of capitalism as a world system; from a place where individuals can be racialized, certain backward countries and the peoples who inhabit them are primitive within the aforementioned economic system.

establishing itself with emphasis on feminism[3] (Casagrande and Carvalho, 2006).

Consequently, the concept of gender is beyond the dualistic biological differences of sex. Although this differentiation is important, because it was in this that the starting point was given for the construction of the social role of women, the term focuses on the culturality impregnated from the sexed bodies. Researcher Joan Scott (1995) states that gender is one of the ways of indicating how social construction is an entirely ideological product, about the predetermined roles of men and women, basically, "a social category imposed on a sexual body" (1995, p. 75). In this same treadmill, more recently (2006), Heilborn defines what gender would be:

> Gender is a concept that aims to point to the non-continuity of physical sex and social sex, and that has been used by various fields of knowledge. The expected behavior of a person of a given sex is the product of social conventions about gender in a specific social context. Moreover, these ideas about what is expected of men and women are produced relationally (Heilborn, 2006, p. 03).

As noted by Heilborn (2006), the stereotypes, sexualization and superficiality attributed to the theme, made public policies remain based only on reproduction and care. Therefore, Joan Scott (1995) treats that gender is primarily a way of resignifying power relations from the oldest, such as cultural symbols that attribute characteristics; they create male and female patterns and are generally used in religious doctrines; segregator sexual perception of the labor market, among others.

Gradually, women, in their social coexistence, in the most varied roles played (mother, daughter, professional, practitioner of religion, neighbor) realized that the treatment offered to them was differentiated, discriminated, therefore, it was necessary to reflect on and seek improvements in their living conditions, work and the like. Therefore, the concept of gender and equity between entities is not limited to sex, however, it encompassed class, race/ethnicity, age and the relationships between human beings. Therefore, in these unequal culturally structured relationships, there is also the distribution of authority among individuals, based on stereotypes, and this process produces a distortion, segregation. And even the situation of inequalities experienced by women is aggravated by socioeconomic precariousness (Casagrande and Carvalho, 2006).

What is perceived in the literature studied so far is that, if there were institutionalization of struggles for the eradication of poverty, there would be a more just and egalitarian society, promoting the disruption of cycles of poverty, hunger, socioeconomic vulnerability throughout the generations and equality between genders; however what we see is the juggling between domestic work (invisible) and paid work (formal or informal); the burden of this work with the raising of children, of family members; in addition to women's incomes being focused, in large part, on survival (health, education and spending on children) much more than the same expenses recorded by men. Therefore, it is essential that public policies be emphasized in the domestic and financial life of women and their families, as a way to provide a quality of life, their emancipation and not just a survival.

III. VIOLENCE AGAINST WOMEN

Heloani (2005) treats that violence is an inherent condition of the human being, being relevant to research their present forms in societies and that also reflect on the social relations of power. However, violence does not originate in individuals, but is generated (as well as gender) by a social system.

Alves, Moreira, Oliveira and Naatividade (2020) mention that violence is like a disruption of the victim's integrity, whether physical, psychic, sexual and moral, and, in general, these modalities of violence occur together, thus reverberating in a power relationship between aggressor and victim: "Whatever form assumed by aggression, moral violence is always present" (Saffioti, 2015, 75). Therefore, it says that the relations of gender and power inequality are the origin of violence against women (MVC), from the historical, social and cultural construction of the female and male role (Schraiber et al., 2005).

From the 1960s on, the feminist movement promoted the reinvtion of women's rights and debated the naturalization of the culture of violence. The MVC was considered a public and global problem, from which, legislation, research, public policies and services emerged and were gradually implemented (Schraiber et al., 2005; Souza & Sousa, 2015). Feminism contributed, from its

[3] Feminism is a social, political and philosophical movement that began in the 19th century, with the aim of proposing equal rights between men and women through female empowerment, absent from patriarchal patterns or rooted in society. The French philosopher, writer and professor Simone Beauvoir was one of the representatives of modern feminism, author of the book "The Second Sex" (1949) and the famous phrase: "No one is born a woman, they become a woman" (emphasis added).

authors (like Joan Scott, bell[4] hooks), for the understanding that inequalities between men and women are reflexes of social relations through the social markers of class, race and sex (Scott, 1995).

It is known that these relationships are established in an asymmetric, subordinate way, where arbitrariness, oppression, hierarchy and violence (physical, psychological, moral, patrimonial) are reproduced. Therefore, VCM calls for state actions, social movements, the implementation of gender education, among other alternatives in order to empower women in whatever spheres (public and private).

3.1 Brazilian public policies and violence against women progress together

The records of contemporary Brazilian public policies for women occurred primarily in the public security areas, through the Specialized Police Stations in Women's Care (DEAM's), created in 1985 (Couto and Gomes, 2012). It should be worth noting that the conception of gender as a social and historical construct, helped public policies in the implementation of the decentralization of services offered to women: there was the dissemination of campaigns and prevention and awareness programs to combat gender inequality; promoting socio-financial autonomy; fostering and strengthening the institutionalization of actions in federal, state, district and municipal public authorities; qualification of public officials who received these women; development and dissemination of gender studies.

Pertinent to justice and the legislature, there is the innovative publication of federal law No. 11,340/2006, known as "Maria da Penha"[5], that brought great progress to the confrontation of the MVC, creating mechanisms aimed at preventing, punishing domestic and family violence against women (Brazil, 2006).

It is noteworthy that the aforementioned law modified the penalty of the offender (it was decided to maintain the male gender, because mostly, the author is a man with intimate bond of affection to the woman /victim) for punishment with imprisonment. From the implementation of the law, public policies were turned to the creation of Women's Reference and Social Assistance Centers; Specialized prosecutors; shelters; "dial 180" and Non-Governmental Organizations (NGOs) overtaxing and enforcing policies for women; justifying the fact that MVC affects the most diverse dimensions of women's lives, causing social, physical, financial and psychological consequences (Hanada, H.; D' Oliveira, A. F. P.; Schraiber, L.B., 2010).

However, mVC-related crimes continued to occur. Every day, it is seen that the first public institutions to be sought are the police, in order to find an immediate solution, largely, of repression and/or protection (Pasinato and Santos, 2008). This occurs as a reflection of a public policy absent from priority social assistance, in which public security takes the lead. Under another bias, despite the creation of institutions, publication of care manuals, recent legislation in Brazil – Maria da Penha Law (n. 11.340/2006), Feminicide Law (n. 13.104/2015) and the Sexual Importation Law (n. 13.718/2018) – the numbers of MVC have not decreased.

In a recent disclosure, the Brazilian Public Security Forum (FBSP), a non-governmental organization and Intelligence in Research and Consulting (IPEC), a company originating from the Brazilian Institute of Public Opinion and Statistics (IBOPE), held in 2019[6], they released staggering numbers: of 897 women interviewed, 536 women have been victims of physical aggression every hour in the last year; 76.4% of women who suffered violence, claim that the aggressor was someone known, this represented a growth of 25% compared to 2016; 66% suffered some kind of harassment in the last year (year 2018); black women have a higher level of victimization than those who declare white or brown; 27.4% of Brazilian women reported that, aged 16 years or older, they suffered some kind of violence in the last 12 months (representing approximately 16 million women), see the infographic below.

[4] bell hooks - Gloria Jean Watkins is the birth name of bell hooks, born in 1952 in Hopkinsville, Kentucky, southern United States. The choice of the alias bell hooks is a tribute to his great-grandmother Bell Blair Hooks, known for her courage in telling the truth. The lowercase letter is on purpose and is intended to focus on the strength of your writing and not on her person.

[5] "lei Maria da Penha": Law n. 11.340/2006 was named in honor of Maria da Penha Maia Fernandes, who fought for twenty years to see her aggressor arrested. She suffered numerous assassination attempts, delays in the processing and judgment of the case relating to the case, and, only with the help of NGOs, was she able to send her case to the Inter-American Commission on Human Rights (OAS), which, for the first time, accepted a report of domestic violence. Just like that, her ex-husband was arrested (year 2002) and the aforementioned Commission ordered Brazil to create adequate legislation for this type of violence.

[6] Quantitative research with a personal flow point approach. Nationwide sample (total: 2,084 interviews) representative of the universe of the Brazilian adult population aged 16 years and over. Interviews conducted in 130 municipalities, between February 4th and 5th, 2019. Self-completion module with questions applied only to women (897 respondents). Margin of error of plus or minus 2.0 points in the national sample and 3.0 plus or minus points in the sample of the self-completion module. Source: Datafolha and Brazilian Public Security Forum.

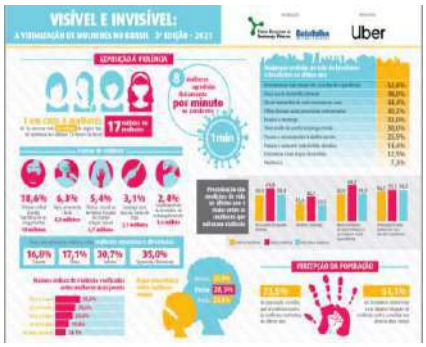


Fig.1: "Visível e Invisível, 3a edição". Fonte: FBSP, 2021.

It is noteworthy that, in the context of the Covid-19 pandemic (decreed by the WHO on 11.03.2020), gender-based violence against girls and women was aggravated by factors such as: "social isolation, mental health impairment, eventual mourning, overload of domestic care and financial difficulties" (Lima et al., 2021 apud Pasinato, 2020). Also in this context, it is observed that there was a decrease in the official records of complaints (Lima et al. apud Bueno et al., 2021). For comparison with the report mentioned above and what was published in 2021 (same methodology used): 1 out of 4 women reported having suffered violence; of these women, 61.8% had their family income decreased; 78.3% were black (black or brown); 72.8% suffered aggression from acquaintances. It should be emphasized that, in both surveys, whether from 2019 or 2021, there is no information about questions or whether the interviewees considered themselves as transgender women, as continued in the infographic below.

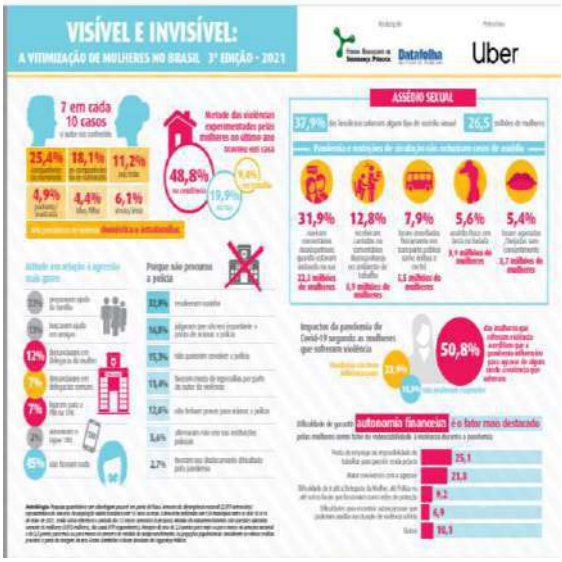


Fig.2: "Visível e Invisível, 3a edição". Fonte: FBSP, 2021.

Moreover, another reason for the promotion of Vcm is still patriarchy[7] impregnated in society, and obviously in institutions (occupied by social beings), such as in the judiciary. Examples of this in a decision of the 5th Criminal Chamber of the Court of Justice of Rio Grande do Sul, whose court decision was for the acquittal of a driver, denounced for rape by the passenger, because, according to the collegiate body: "the victim put himself in a situation of risk, because he had consumed alcohol on the day of the event" (Maier and Segobia, 2020, p. 06).

Or, when in the examination of the appeal no. 0000311-97.2014.8.26.0099, judged by the Court of Justice of São Paulo, in addition to acquitting the defendant accused of the same crime, the judge exara that "the defendant certainly did not leave unpayable marks on the victim, because it, shortly after, began to relate to a man of 28 years, of which he was pregnant even before the hearing" (Maier and Segobia, 2020, p. 07).

Therefore, with these findings, it is necessary to leave in search of solutions to the problem.

IV. FINANCIAL AUTONOMY AND SOCIAL EMANCIPATION: PREPONDERANT FACTORS FOR COPING WITH VIOLENCE AGAINST WOMEN

It is worth noting, according to CAVALCANTE (2012), regarding gender relations, that men and women are not the result of a biological destination, but above all, of social constructions. That is, it would be two social groups involved in a specific social relationship: sex. These have a material basis - work - and manifest themselves through the sexual division of labor, thus, society cannot be thought only from social relations, but equally and simultaneously, from the connections with the relations between the sexes of this same social system.

When discussing female work articulated with the gender category, men and women are brought up in productive and reproductive spaces and it is understood that gender relations bring diverse relationships. Thus, the analysis of female work begins to understand that the relationships in these spaces are also social constructions permeated with power and domination, and that this fact, entails the definition of so-called "feminine" and "masculine" spheres. (CAVALCANTE, 2012)

[7] Patriarchy is a system whose foundation is sociocultural, with structures and relationships that aim to favor men, especially white, cisgender and heterosexual men. In patriarchal society, there is a prevalence of power relations and domination of men over women and other subjects who do not fit the "normative" pattern of race (white), gender and sexual orientation (straight).

Drawing the parallel with this research, thinking about women's autonomy is to reflect how they express themselves, what are their challenges in the disrupture with unequal gender relations, not only in private spaces, but also in public spaces as well as in relationships in the labor market. (CAVALCANTE, 2012). Thus, for the purpose of discussion of this study, autonomy is understood as indicated by SOARES (2011, p. 281):

> We understand women's autonomy as the ability to make free and informed decisions about their own life, so that they can be and make according to their own aspirations and desires, in a given historical context. The advancement of autonomy is related to the advancement of women in public and private life, as a guarantee of the full exercise of rights. The lack of autonomy is the result of the poor distribution of power, income, the use of time, the lack of recognition of women's rights.

The possibility of financial autonomy of women in situations of domestic violence, is not only envisioned in the idea that only the opportunity of women to work for paid activities will overcome the situation of financial and/or economic subordination, it is understood that it is necessary to reflect on the entire cultural, symbolic and social context that women are inserted. It is also understood the thought that it is necessary to leave the deterministic conceptual structures and employ from the perspective of gender also in this social, historical and cultural construction, exhausting these power relations between men and women. (CAVALCANTE, 2012) Thus, it is essential to analyze the prevailing current changes and trends and how they reflect in the family institution in the contemporary context, marked by the individuation of social life.

In this sense, public policies must intervene in order to combat wage discrimination and occupational segregation that women go through, but actions beyond the monetary nature are also essential, with practices that can provide these women - the construction of new relationships with their partners, as well as in the domestic sphere, that is, affective relationships that are not permeated by the patriarchal order of gender, with women with access to employment, having the conditions to produce and commercialize with dignity, the possibility of personal development and also the right to free time. (CAVALCANTE, 2012)

According to SILVA (2021), when it comes to female autonomy, public policies have been working in an articulated way with various agencies, predicting the insertion of women in the labor market. It is understood that female economic autonomy is one of the ways of overcoming violence or, at least, minimizes its effects. However, most income generation policies are focused on entrepreneurship that reinforces the individualizing logic, and women are responsible for seeking their financial autonomy, through the development of skills focused on subalternized positions in the labor market, as revealed in the living conditions of the women in our study. Most of them are in precarious, low-income jobs that require low schooling, contributing to situations of vulnerability and violence, in addition to accumulating overload of domestic work and family support network. (SILVA, 2021)

The social agendas have included women in a more present way, with the survey of discussions and actions for the valorization and effectiveness of the defense of their rights, prerogatives, capacity, qualification and conditions to occupy the same spaces of men; whether for decision making, management, work or simply making your own choices. To this do so, the Brazilian Fundamental Law, in article 5, item I, treats that "men and women are equal in rights and obligations" (Brasil, 2021). This equality of rights provided in the main norm of the country regulates that women's opportunities must go through all fields: social, political, economic, environmental, labor and family.

Thus, the construction of a State capable of promoting equal rights in the most diverse spheres, including gender issues, is defended. A state that has a leading role, which favors the construction of democratic spaces and more egalitarian relations between men and women. To provide democratic spaces, the State must build strategic agendas that represent the deliberation of broad actors, as well as ensure that popular anides are configured as political legitimacies through medium and long-term public policies. (CAVALCANTE, 2012)

According to ALVES (2019), this is the only way women become visible and "empower" socially, because this expression that still generates resistance in its concept, is linked to the strengthening of a portion of society that lives daily the contradiction: quantitatively, women are more than 50% of the world's population and are invisible in their work, are subordinate, silent, unworthy of decision; that is, as a colonized reproduction, without any conditions of equality with men. In this way, empowering women is to bring to her opportunities for personal growth, emancipation, financial and professional social, with prioritization of also intellectual equality.

However, it is understood, therefore, that fostering the financial autonomy of women requires time for them to strengthen their process of disruption of the situation of violence, but also requires immediate actions, in a context

in which cultural constructions are present that hold them responsible for the care of the family and all domestic issues, where financial autonomy must go through other spaces other than that of generating employment and income, but also of children and housing. (CAVALCANTE, 2012, p.172)

Thus, actions can be initiated from the woman's need for income, but should gradually gain other dimensions in which the woman can discover in this process. It is believed that it should be during the process that the woman can see himself as a subject capable of constructing a new position in the relationship, in the domestic sphere and, consequently, the possibility of seeking, among other possibilities, her financial autonomy. (CAVALCANTE, 2012, p.172)

The conquest of autonomy, understood as the control over one's own life, the body, the right to an independent identity and self-respect, is preceded by two conditions: one of them is the consideration of the needs and interests of men and women by policies and programs to achieve gender equity; the other is to support strategies that aim at strengthening and women's empowerment. (GUEDES, 2011, p.1733)

The relevance of the theme has been massive and has provoked the manifestation, including, of the United Nations Women's Organization, which in 2010 published a document listing the basic principles for women's empowerment, whether professional or social: that corporate leaders be established that envision gender equality at all levels; that all men and women be treated fairly in their work, with respect for human rights; to ensure the existential minimum: safety, quality of life, health and well-being; education, qualification and professional development is essential; to promote the entrepreneurship of women in communities and activism; and to record, analyze and publish the data, the progress of companies working on the promotion of gender equality (ALVES, 2019).

V. RESULT AND DISCUSSIONS

Rita Segato points out that: "(...) the genus has a time as long as that of the species, a time much slower than that of the history of mentalities. [...] it seems natural. [...] That is why it is so difficult to modify gender oppression" (Segato, 2003, p. 153). Thus, in our view, in addition to the exclusion of oppression and violence against women, it is necessary to break what has been crystallized, so it is proposed as an alternative to combating MVC:

Alternative one: One of the proposed ways is by education, with libertarian pedagogies, whose practice is based on human rights, empathy, inclusion, diversity and difference. The law itself "Maria da Penha" points out for the relevance of education during the permanent process of prevention and eradication of gender violence (Article 8): educational campaigns; dissemination of educational programs aimed at respecting human dignity and combating prejudices to gender, beliefs, religion, sex, ethnicities; qualification of professionals working with the theme and inclusion in school curricula and political non-censorship of gender issues (Brasil, 2021).

Alternative two: Quoting segato again (2017), this states that the precarious in existence generates violence. With the rates of inequalities already described in this work, it can be seen that the public policies implemented to combat MVC have hardly eradicated it, or social inequalities. This is largely due to the absence of state political interest and the establishment of neoliberalism as a financial system inserted in structural racism. A continuous act, although Brazilian laws are innovative, their effectiveness is reduced by the absence of constant political actions and investments (in pandemic Covid-19, the lack of chance with the theme by the federal government culminated in the reduction of public investment – which should be included as public health – which was notorious, because the Ministry of Women spent only 53% of the budget of the portfolio, 2020), as disclosed by the Chamber News Agency (Agência, 2021).

Also, the three: Eliminating machismo, misogyny, patriarchalism, decolonization of legal education (again the solution is education) and its institutions, is also a solution for Vcm. Moreover, denaturalize the MVC and break with this cruelty, from the feminist movements that are also aimed at men, because what is sought is the freedom of women, conquest of diverse spaces: conquest of choice, decision, power, and financial autonomy and social emancipation.

Moreover, the social relations that are constituted in contemporary society are marked by historical constructions that determine different social roles to men and women. In this sense, such historical attributions place women in a situation of subalternity, who, in the face of unequal gender relations, are the contingent that suffers the most consequences in this sociability, that is, they become hostages to diverse forms of oppression/exploitation resulting from these relationships. (SILVA, 2021, p.34)

> In a statement, the forms of oppression, inequalities, discrimination, all this social structure built on the basis of the sexual division of labor allows patriarchy to establish itself as a system that orders society, which pre-embodies

> capitalism, but is transmuted and incorporated into the capitalist system. (SILVA, 2021, p.27)

As for women's labor rights, these have not yet been established, it is necessary to recognize the female contribution in everyday life to the production of added value, that is, for the production of social wealth. Care for household duties and children are roles played almost exclusively by the female sex. The word "care" requires special attention, as it has a much broader meaning when it comes to public policies focused on the issue of gender. Gender inequality presupposes a form of structural inequality that is crossed by social relations. The term "care" is imbricated in a social norm, which associates the feminine with domesticity and which is expressed in the sexual division of labor, thus, it is worth saying that its meaning "primarily attributes to women the responsibility to the family" (SORJ, 2010, p.57).

> In times of globalization of the economy and flexibilization of labor, there is a tendency of public policies appear in a diversified scenario, that is, for a good portion of the working class, especially women, there is a kind of polarization of workers in different groups, that is, for a part of the female class, specifically the white middle class can keep up with the flexibilization of formal work. [...]. However, for the other portion of women inserted in the productive sphere, work becomes a contribution in family income, which does not in itself guarantee the support of the family. Generally, the functions held by black and brown women are less recognized, that is, under less favorable structural conditions. The factors are many, among them: low schooling, early motherhood, high vulnerability rates, among others (LOMBARDI, 2010).

It should be worth noting that women's autonomy in the context of public policies concerns the economic situation of women, as a way of overcoming violence. In this context, governmental and non-governmental actions allied to international agencies, which seek to feed back financial capital and interfere in the social issue, require a specific look at the particularities of social formation in the context of each country. (COUTO, 2010)

Finally, four. Socio-financial autonomy is essential for the decision-making power of this woman, who can, from her self-sufficiency, promote the break with daily interaction with her aggressor, with precariousness, poverty, non-professional qualification, improvement of quality of life, health, well-being, environment of her and her family.

VI. FINAL CONSIDERATIONS

From the theoretical framework sought and the analyses performed, it is perceived how complex the theme of violence against women is. First, because it is not only about pure and simple violence, but discussions encourage tours of gender; prejudice; the institute of patriarchy extremely natural and rooted in social culture; and even in their institutions; in the lack of public investment and mode of misimplementation of public policy to do so (it should be constantly in the area of public health).

Thus, after the research carried out, it is intended to continue studying the theme, contributing and promoting reflections. In addition, it is understood that coping with violence against women should permeate all relevant aspects of their lives and the society in which they live, starting in teaching; decolonizing the school curriculum with libertarian pedagogical practice; encouraging social activism; entrepreneurship and training and professional qualification, so that this woman can empower her life, her choices, her decisions; which will provide not only her, but the community in which she lives, the improvement of the place, politics and the environment. That is, to give this woman the possibility of seeing in herself and in other women, their strength, their values, their emancipation, their financial autonomy, their capacity and their self-confidence.

ACKNOWLEDGEMENTS

Luciano da Silva Façanha and other authors would like to thank the Coordination for the Improvement of Higher Education Personnel - thanks to CAPES (Finace code 001).

REFERENCES

[1] AGÊNCIA CÂMARA DE NOTÍCIAS. Violência contra as mulheres nas ruas cai durante a pandemia, mas aumenta dentro de casa. (2021). Disponível em: https://www.camara.leg.br/noticias/797543-violencia-contra-as-mulheres-nas-ruas-cai-durante-a-pandemia-mas-aumenta-dentro-de-casa/. Acesso em 20 jan. 2022.

[2] ALVES J. S., MOREIRA L. E., Oliveira; R. G., NATIVIDADE C. Mulheres em tempos de pandemia: um ensaio teórico-político sobre a casa e a guerra. (2020). Psicologia & Sociedade, v. 32. Recuperado de https://www.scielo.br/j/psoc/a/93BpjQdGtPs9Lxs9SCSWhkr/?lang=pt.

[3] ALVES, E. L. Empoderamento feminino como instrumento de combate à violência política. Resenha Eleitoral em Nuvens (Florianópolis), v. 23, n. 1, p. 51/70, 2019. Disponível em:

https://revistaresenha.emnuvens.com.br/revista/article/view/14/10. Acesso 20 jan. 2022.

[4] BEAUVOIR, S. de. O segundo sexo. Rio de Janeiro: Nova Fronteira, 2009. 904 p.

[5] BENEVIDES, B; NOGUEIRA, S. (2020). BOLETIM Nº 02/2020: Assassinatos contra travestis e transexuais em 2020. Antra Associação Nacional de Travestis e Transexuais. (2020). Recuperado de https://antrabrasil.files.wordpress.com/2020/05/boletim-2-2020-assassinatos-antra.pdf.

[6] BRASIL. Presidência da República. Constituição da República Federativa do Brasil/1988. Disponível em: http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm. Acesso em: 20 Jan. 2022.

[7] BRASIL. Presidência da República. Lei n. 11.340/2006, de 07 de agosto de 2006. O Código Penal e a Lei de Execução. Brasília, 2006. Disponível em: http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/lei/l11340.htm .Acesso em: 20 Jan. 2022.

[8] BRASIL. Presidência da República. Lei n. 13.104, de 9 de março de 2015. Altera o art. 121 do Decreto-Lei nº 2.848, de 7 de dezembro de 1940 - Código Penal, para prever o feminicídio como circunstância qualificadora do crime de homicídio, e o art. 1º da Lei nº 8.072, de 25 de julho de 1990, para incluir o feminicídio no rol dos crimes hediondos. Disponível em: http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2015/Lei/L13104.htm. Acesso em: 10 jan. 2022.

[9] BRASIL. Presidência da República. Lei nº 13.718, de 24 de setembro de 2018. Altera o Decreto-Lei nº 2.848, de 7 de dezembro de 1940 (Código Penal), para tipificar os crimes de importunação sexual. Disponível em: http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2018/lei/L13718.htm .Acesso em: 10 jan. 2022.

[10] BRASIL. Tribunal de Justiça de São Paulo (7. Câmara). Apelação Crime nº 0000311- 97.2014.8.26.0099. Apelante: J.S. Apelada: M.P. Relator: Min. Alberto Anderson Filho, 15 de outubro de 2015.

[11] BRASIL. Tribunal de Justiça do Rio Grande do Sul (5. Turma). Apelação Crime nº 70080574668. Apelante: F.B.M. Apelada: M.P. Relator: Cristina Pereira Gonzales. Porto Alegre, 17 de julho de 2019.

[12] CASAGRANDE, L. S. Educando as novas gerações: representações de gênero nos livros didáticos de Matemática. 2005. Dissertação (Mestrado em Tecnologia) - Programa de Pós -Graduação Tecnológica, Centro Federal de Educação Tecnológica do Paraná, Curitiba.

[13] CAVALCANTE, S. M. P. Violência contra a mulher e autonomia financeira: uma avaliação do atendimento do Centro de Referência Francisca Clotilde de Fortaleza/Ceará. 2012. 192f. – Dissertação (Mestrado) – Universidade Federal do Ceará, Programa de Pós-graduação em Avaliação de Políticas Públicas, Fortaleza (CE), 2012. Disponivel em: http://www.repositorio.ufc.br/handle/riufc/5977. Acesso em 12 de abr. de 2022.

[14] CONSELHO FEDERAL DE PSICOLOGIA [CFP]. Referências técnicas para atuação de psicólogas (os) em programas de atenção à mulher em situação de violência. Brasília: CFP, 2013.

[15] COUTO, B. R. O direito social e a assistência social na sociedade brasileira: uma equação possível? 4 ed. São Paulo: Cortez, 2010.

[16] COUTO, M. T. & GOMES, R. Homens, saúde e políticas públicas: a equidade de gênero em questão. Ciência e Saúde coletiva. 17 (10), p. 2569/2578, (2012). Disponível em: https://doi.org/10.1590/S1413-81232012001000002 . Acesso em: 19 jan. 2022.

[17] DINIZ, D. É hora d STF responder o que significa uma epidemia para a vida das mulheres. [Entrevista concedida a Helena Bertho, em 22 de abril de 2020]. Azmina. (2020). Recuperado de https://azmina.com.br/reportagens/debora-diniz-e-hora-do-stfresponder-o-que-significa--uma -epidemia-para-a-vida-dasmulheres/.

[18] Fórum Brasileiro de Segurança Pública. 2ª edição (2019). Visível e invisível: a vitimização de mulheres no Brasil. Recuperado de https://forumseguranca.org.br/quem-somos/.

[19] FOUCAULT, M. Vigiar e punir. Leya, 2014.

[20] GUEDES, R. N.; FONSECA, R. M. G. S. da. A autonomia como necessidade estruturante para o enfrentamento da violência de gênero. Revista da Escola de Enfermagem da USP, v. 45, p. 1731-1735, 2011. Disponivel em: https://doi.org/10.1590/S0080-62342011000800016. Acesso em 12 de abr. de 2022.

[21] HANADA, H.; D'OLIVEIRA, A. F. P.; SCHRAIBER, L. B. Os psicólogos na rede de assistência a mulheres em situação de violência. Revista Estudos Feministas. 18(1), 33-59, 2010. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0104-026X2010000100003 . Acesso em 19 jan. 2022.

[22] HEILBORN, M. L. Entre as tramas da sexualidade brasileira. Estudos Feministas. Florianópolis: UERJ, 14(1): 336, janeiro-abril/2006.

[23] HELOANI, R. Assédio moral: a dignidade violada. Aletheia, 22, 101-108. Disponível em: http://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S1413-03942005000200010 . Acesso em 26 jan. 2022.

[24] LIMA, P. M.; DANTAS, S. C. M.; OLIVEIRA, A. C. A; FEITOSA, A. C. Precariedades no contexto da pandemia da COVID-19: uma análise dos dados sobre violência contra a mulher no Brasil. International Journal of Development Research, Vol. 11, Issue, 12, pp. 52575-52580, December, 2021. Disponível em: https://doi.org/10.37118/ijdr.23549.12.2021. Acesso em 02 jan. 2022.

[25] LOMBARDI, M. R. A persistência das desigualdades de gênero no mercado de trabalho. In: COSTA, Albertina. ÀVILA, M. B. de M. et. al. (Orgs). Divisão sexual do Trabalho, Estado e crise do Capitalismo. Recife: SOS CORPO- Instituto Feminista para a Democracia, 2010.

[26] MAEIR, J. P.; SEGOBIA, S. E. A institucionalização do machismo nas decisões judicias brasileiras: uma análise do caso Mariana Ferrer sob a ótica do princípio da imparcialidade. Entrementes: 17ª ed., 2020. Disponível: http://sites.fadismaweb.com.br/entrementes/anais/wp-content/uploads/2021/02/a-institucionalizacao-do-

machismo-nas-decisoes-judicias-bras.docx.pdf. Acesso em 20 jan. 2022.

[27] PASINATO, W.; SANTOS, C. M. Mapeamento das delegacias da mulher no Brasil. Núcleo de Estudos de Gênero Pagu, Universidade Estadual de Campinas PAGU/UNICAMP, 2008.

[28] PASINATO, W. Diretrizes para atendimento em casos de violência de gênero contra meninas e mulheres em tempos da pandemia da COVID-19. Brasília. (2020). Recuperado de http://www.onumulheres.org.br/wpcontent/uploads/2020/08/Diretrizes-para atendimento_ONUMULHERES.pdf.

[29] QUEM SOMOS... (2021). Fórum Brasileiro de Segurança Pública. Recuperado de https://forumseguranca.org.br/quem-somos/.

[30] QUIJANO, A. Colonialidade do poder, Eurocentrismo e América Latina. In: Lander, Edgardo (org.). A colonialidade do saber: eurocentrismo e ciências sociais. Perspectivas latino-americanas. Buenos Aires: CLACSO, Consejo Latinoamericano de Ciencias Sociales, 2005, p. 117/142.

[31] SAFFIOTI, H. I. B. Gênero, Patriarcado, Violência. São Paulo: Perseu Abramo, 2015.

[32] SCHRAIBER, L. B. & D'Oliveira; A. F. P. L; Falcão, N. T. C; Figueiredo, W. S. Violência dói e não é direito: a violência contra a mulher, a saúde e os direitos humanos. São Paulo: Ed. Unesp, 2005.

[33] SCOTT, J. Gênero: uma categoria útil de análise histórica. Educação e Realidade. Porto Alegre, v. 20, n. 2, p. 71-100, jul./dez., 1995.

[34] SEGATO, R. L. Las estructuras elementares de la violencia: ensyos sobre género entre la antropología, el psicoanálisis y los derechos humanos. Bernal: Universidad Nacional de Quilmes, 2003.

[35] SEGATO, R. L. Por qué la masculinidad se transforma en violencia. La Voz. Buenos Aires, 2017. Disponível em: https://www.lavoz.com.ar/ciudadanos/por-que-la-masculinidad-se-transforma-en-violencia. Acesso em: 12 jan. 2022.

[36] SILVA. A. M. Violência contra a mulher: uma análise sobre as estratégias de enfrentamento da Rede Sócio Assistencial no município de Ouro Preto. 2021. 71 f. Monografia (Graduação em Serviço Social) - Instituto de Ciências Sociais Aplicadas, Universidade Federal de Ouro Preto, Ouro Preto, 2021. Disponível em: http://www.monografias.ufop.br/handle/35400000/3004. Acesso em 12 de abr. de 2022.

[37] SORJ, B. Os Cuidados com a família e as desigualdades de gênero e de classe. In: COSTA, Albertina. ÀVILA, Maria Betania de Melo. et. al. (Orgs). Divisão sexual do Trabalho, Estado e crise do Capitalismo. Recife: SOS CORPO-Instituto Feminista para a Democracia, 2010.

[38] SOUZA, T. M. C.; SOUSA, Y. L. R. S. Políticas públicas e violência contra a mulher: a realidade do sudoeste goiano. Revista SPAGESP, 16(2), pp. 59-74. (2015). Disponível em: http://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S1677-29702015000200006 . Acesso em 19 jan. 2022.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.15

Effluent Treatment System for Low Loads – Biodigester: Case Study

Pedro Carlos Lemos da Costa[1], Fabiano Battemarco da Silva Martins[2], Marcelo de Jesus Rodrigues da Nóbrega[3], Luiz Affonso de Paula Junior[4]

[1]Department of Environmental and Sanitary Engineering, Gama e Souza University, Brazil
Email: pclemos.costa@gmail.com
[2]Department of Environmental and Sanitary Engineering, Gama e Souza University and Santa Úrsula University, Brazil
Email: fabianobattemarco@gmail.com
[3]Department of Environmental and Sanitary Engineering, Gama e Souza University and Santa Úrsula University, Brazil
Email: engmarcelocefet@terra.com.br
[4]Department of Education Sciences, Columbia University of Paraguay, Paraguay
Email: luizaffonso1002@gmail.com

Received: 15 Apr 2022,

Received in revised form: 08 May 2022,

Accepted: 15 May 2022,

Available online: 23 May 2022

***Keywords*— Compact System. Anaerobic treatment. Sanitation.**

***Abstract*—** *Water is an extremely important resource for the maintenance of life on earth and several human activities depend on it for its development, such as: agricultural production, industrial activities and energy generation. It is estimated that in a short time this resource, which has already been considered renewable, will be the object of conflict between nations. In order to be able to continue enjoying this asset, measures are needed to maintain the quality of water sources, such as the proper treatment of sanitary sewage for the discharge of water bodies. In this context, the present work aims to present a low load sanitary effluent treatment equipment that can be adopted in homes and industries, the Biodigester by the FIBROMAR company. This equipment has 03 chambers, where the first two work as an RAFA (Ascending Flow Anaerobic Reactor) and the last as an Anaerobic Filter. It was installed for evaluation in an industrial shed receiving the contribution of 10 people during business hours, where in 2015, after 06 months of use, the analyzes performed showed efficiency values in the removal of 87% DBO (61.00 mg/l) and final concentration of RNFT 25.00 mg/l efficiency of the equipment to meet CONAMA No. 430/11 (supplementary No. 357/05) and NT-202-R10 (INEA-RJ). Recently in 2021, the analyzes were repeated to evaluate the system's functioning, the results showed DBO removal efficiency 93% (8.00 mg/l) and Total Suspended Solids less than 10 mg/l, remaining within the parameters of legislation previously evaluated and in line with recent legislation (NOP 45 – CONEMA 90).*

I. INTRODUCTION

Water is an extremely important resource for the maintenance of life on the planet, from simple activities such as consumption to agricultural and industrial production and energy generation. It is considerate a renewable natural resource, however, it is estimated that in a few years it will be the object of conflict between nations (DA COSTA, 2018).

One of the great challenges that humanity will face in the coming years will be to reconcile the expansion of

society is using natural resources in a sustainable way (VIEIRA, 2003). Among these resources with enormous importance are water sources, where, according to Jordão & Pessoa (2017), most of the sewage is released into rivers, lakes, bays and oceans, thus altering their physicochemical capacities.

According to Metcalf & Eddy (2016), sewage treatment methods began with a focus on public health and the adverse conditions caused by the discharge of sewage into the environment.

As for effluents of sanitary origin, they need to be treated so as not to generate environmental pollution, avoiding risks to man and his environment (BENJAMIN, 2015).

As an option to minimize these impacts, low load biological treatment systems have been adopted in order to reduce the organic load of the effluent. The best known are septic tanks, anaerobic filters and biodigesters.

The present work aims to present, through a case study, a model of treatment of low loads carried out by a biodigester, which aims to serve small residences (urban and rural), small businesses, restaurants and industries (generation of sanitary sewage).

Thus, we seek to present the academic community with a low-cost option for places with low effluent generation and with high efficiency.

II. DEVELOPMENT

2.1 Literature Review

According to the diagnosis of water and sewage services of the Ministério das Cidades of Brazil based on 2019 year, it indicates that in 54.1% of the country are covered with sanitary sewage collection services, with 61.9% meeting in the urban area and considering the portion of treated sewage, 78.5% go to Effluent Treatment Stations (SNIS, 2020).

According to Chernicharo (2016), it is evident that in the country there is a low rate of coverage of sewage collection networks, however, this is itself does not constitute an aggravating factor for unfavorable sanitary conditions. In developed countries with a large population, they adopt individual systems of treatment and disposal in the soil, however, in Brazil, there is a wide experience in the use of these, but not the technical rigor in the design of the project and operational control, resulting in inefficient systems (CHERNICHARO, 2016).

Domestic sewage consists of 99.9% water, the remaining fraction includes organic and inorganic solids, suspended and dissolved, as well as microorganisms. There is a need to treat sewage for this fraction of 0.1% (VON SPERLING, 2014).

In domestic sewage, the biological and physical-chemical characteristics vary according to the socioeconomic and health classes of the population, the nature of the water used and industrial waste (NUNES, 2014).

Lehmann and Medeiros (2019), describe the parameters for urban waters with high, medium and low concentrations. Regarding DBO, the values presented for high, medium and low are with the concentration in mg/l between 300, 250 and 120, respectively.

When raw sewage accumulates making it septic, the decomposition of the organic matter contained therein leads to the production of unpleasant by-products, such as the generation of bad odors, in addition to the various microorganisms that develop in the human intestine (METCALF & EDDY, 2016).

One of the main causes of pollution to water bodies and organic matter, the microorganisms present in its metabolic processes, consume dissolved oxygen for its use and stabilization (VON SPERLING, 2014).

According to Jordão & Pessoa (2017), one of the most used methods to measure the amount of organic matter presents is through is the determination of the Biochemical Oxygen Demand (DBO). This determination measures the amount of oxygen required to biologically stabilize the organic matter in a given period of time (05 days).

Biological unit processes are used primarily for the removal of biodegradable, colloidal and dissolved organic substances dispersed in sewage by biological activity (METCALF and EDDY, 2016).

The treatment method using the biodigester has existed for more than two centuries, with good responses regarding treatment, waste use and energy use (FRIGO et al., 2015).

The biodigester is a closed chamber where the organic material is placed in an aqueous solution, which undergoes the anaerobic decomposition process, with the decomposition of organic matter accumulated in the upper part of the layer as a product (DEGANUTTI et al., 2002).

According to Chernicharo (2016), in the process of anaerobic digestion, it is considered as an ecosystem where several groups of bacterial colonies act in the process of converting organic matter into methane, carbon dioxide, water, hydrogen sulfide, ammonia and other bacterial cells.

Low load digesters are built in a single compartment and do not have mixing mechanisms, usually the process

of digestion, sludge densification and supernatant formation occurs (CHERNICHARO, 2016).

Considering the treatment of effluents by anaerobic digestion, residential systems called septic tanks follow the same principle as biodigesters. Historical research records that in 1860 Jean Louis Mouras invented the septic tank by making a compartment in masonry before entering the sinkhole. The effluents from a residence in Veoul in France were sent, where the house opened 12 years later did not have the number of solids that was imagined (JORDÃO & PESSOA, 2017).

According to Jordão & Pessoa (2017), the septic tank is a compartment intended to treat one or more homes with simplicity and reduced cost, seeking to treat the effluent in proportion to its simplicity and cost.

As treatment systems for high loads, anaerobic sludge blanket reactors (UASB, RAFA, RAMA, RALF among others) are adopted. at 10 hours, resulting in the efficiency of organic matter around 70% (CHERNICHARO, 2016).

According to the Brazilian Association of Technical Norms (ABNT, 1993), the usual detention times in septic tanks vary from 12 to 24 hours, where they are also oriented on the contribution adopted to each activity and sludge generation, as well as relating parameters related to temperature.

Also adopting the anaerobic digestion process, anaerobic filters have been widely used for complementary treatment to septic tanks according to concepts maintained in NBR 13.969/97 (CHERNICHARO, 2016).

Anaerobic filters, although they can be used as the main treatment unit, are more suitable as post-treatment units, giving the treatment high operational safety and quality in the final effluent (CHERNICHARO, 2016).

In NBR 13.967/97, the anaerobic filter is defined as a compartment where a biological reaction takes place, consisting of an empty lower layer and an upper layer filled with a filter bed where the fixation of facultative organisms that act in the degradation of organic matter acts. It also addresses the dimensioning of the unit, filling material and dimensions of the compartments (ABNT, 1997).

According to Metcalf and Eddy (2016), anaerobic filters can be classified as fixed bed reactors, where the bed can be filled with some type of matter, such as stone, ceramic or more commonly used plastic material, and its flow can be ascending or descending.

According to Chernicharo (2016), for the dimensioning of larger treatment units, applied to post-treatment of effluents from anaerobic reactors, hydraulic detention times ranging from 5 to 10 hours can be adopted. related to the type of filter media and bed height.

For the release of treated effluents, according to CONAMA 430 (Brasil, 2011), the parameters for the release of effluents of sanitary origin the parameter referring to the concentration of DBO in the maximum limit of up to 120 mg/l, and the limit may exceed in the case of effluent with a minimum efficiency of 60% of DBO or through a self-purification study that shows that the receiving body is capable of receiving the remaining concentration without compromising its quality.

The competent environmental agency may, at any time, add other conditions to the treatment and make them more restrictive, aiming at the conditions of the receiving body and even requiring new environmentally appropriate technologies (Brasil, 2011).

According to NT-202-r10 (FEEMA-RJ, 1986), it established standards for the release of liquid effluents for potentially polluting activities, as for the release criteria referring to DBO, the legislation established that specific guidelines should be followed.

For several years, the legislation that directed the release parameters regarding the removal of carbonaceous organic matter was DZ-0215.r4. According to DZ-0215.r4 (INEA-RJ, 2007) the DBO removal parameters varied according to the total daily organic load of the enterprise, ranging from 30% (organic load less than 5.00KgDBO/day) to 85% (organic load greater than 80.00KgDBO/day) of removal, recommending which type of technology could be adopted to achieve the desired efficiency.

Recently, the CONEMA resolution (State of Rio de Janeiro, 2021) approved legislation that establishes the criteria for sanitary sewage discharge standards in the state of Rio de Janeiro, being applied to all buildings (residential, commercial, ports, concessionaires and treatment). of sanitary sewers) NOP 45 – INEA-RJ, fully amending DZ-0215.r4 and NT-202-r10.

According to NOP 45 (INEA-RJ, 2021), new parameters for DBO removal, among other ranges, these two stand out where it establishes concentration limits of 120 mgO2/L and total suspended solids of 110 mg/l for higher organic loads at 80 Kg.DBO/day, the DBO concentration values at the outlet have a limit of 40mg.O2/L and total suspended solids of 40mg/l, where the former differs from DZ-0215.r4 where the limit is 180mg.O2 /L was replaced making it more restrictive and the upper bound was kept.

The equipment used in the case study was a biodigester made by the FIBROMAR Group. This equipment is

characterized by a single tank developed in FRP (Fiberglass Reinforced Polyester), where through the cylindrical section, the equipment is divided into 03 equal parts. Where in the first 02 chambers, an ascending flow septic tank is configured and 01 chamber is composed of an Ascending Flow Anaerobic Filter in a total volume equivalent to 1,000L. In Fig. 1, we can see the floor plan of the treatment system and its divisions.

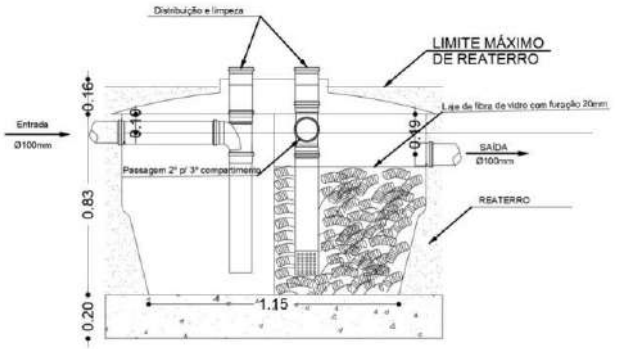


Fig. 1: Plant drawing of the equipment with the divisions of the lowlands. Source: Company's technical department of FIBROMAR.

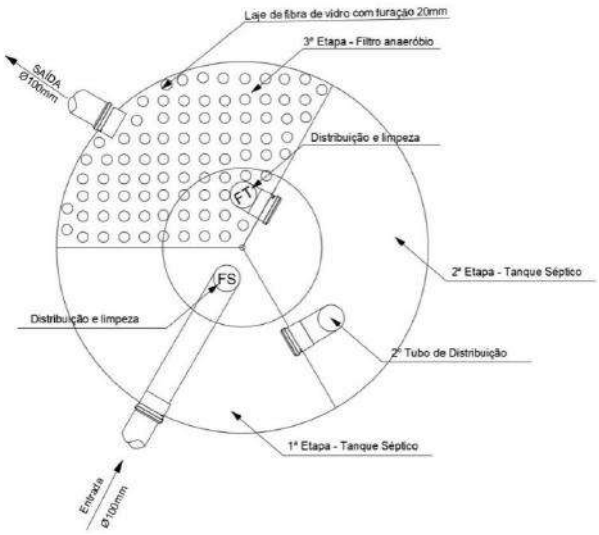


Fig. 2: Cutaway drawing of the transition from the 2nd (Upflow Septic Tank) to 3rd (Upflow Anaerobic Filter) Chamber. Source: Company's technical department of FIBROMAR

In Fig. 2, it can be seen in section how the passage from the 2nd chamber to the 3rd chamber is made, where the compartment corresponds to the anaerobic filter, the filtering medium adopted in the equipment is the plastic corrugated (conduit). According to Chernicharo (2016), plastic materials have an advantage over the gravel adopted in conventional filters due to their low density, providing bed mobility and reducing the risk of clogging, as well as their greater contact surface for bacterial colony formation (100 m²). /m³).

2.2 Methodology

For the development of the work, the biodigester was applied to treat the sanitary effluents of a part of the factory corresponding to a bathroom where 05 people used it during business hours (08:00h to 17:00h - Monday to Friday), at first, the results found were obtained after 08 months of implantation. In the second moment, this analysis was repeated to evaluate the system implemented after 06 years of installation.

It is important to emphasize that during this period the operational procedures for the correct functioning of the system occur regularly (removal of the annual portion of the excess sludge).

This equipment was installed in the industrial bathroom of the factory environment where daily around 10 employees use the treatment system from 07:00h to 17:00h. It is noteworthy that the installed system had a period of 6 months until the collection of the first sample to be analyzed for the maturation of the bacterial colony, where, according to Chernicharo (2016) the biological system takes from 03 to 06 months for acclimatization. of organic matter without performing the inoculation. In Fig. 3(a) and 3(b) we can observe the moment of collection.

It is important to emphasize that the collections were made in simple ways (one sample at the entrance and another at the exit) to evaluate the treatment capacity. As can also be seen in Fig. 3(a) and 3(b) by a collection point through a tap installed in the tank in the first and third chambers.

Fig. 3: (a) shows the time of collection of the raw influent; (b) the treated effluent. Source: Company's technical department of FIBROMAR.

In the first performance of the analyzes carried out in 2015, the parameters of D_5BO_{20} e RNFT were analyzed to evaluate the removal efficiency and as the equipment was installed in the municipality of Pinheiral-RJ, the results were compared with the values required in the DZ-215- r4, NT-202-R10 and CONAMA 430/11.

In this second analysis carried out in 2021, the results found were compared with the parameters established in NOP 45-INEA-RJ, which was prepared in February 2021 and entered into force in August 2021 (180 days after its elaboration).

III. RESULTS AND DISCUSSION

A simple collection was carried out in the equipment inlet pipe and at the outlet at the same time and taken to the accredited laboratory for analysis in November 2015. It can be verified in Table 01 in the following parameters D_5BO_{20} and RNFT:

Table 01: Input and output sample results (06 months after system installation).

Parameter	Input	Output	Efficiency	DZ-0215-r4	NT-0202-R10	CONAMA 430/11
BOD (mg/l)	469,2	61,00	86,99%	180	180	120
RNFT (mg/l)	-	25,00	-	180	-	-

Source: Technical Department of the company FIBROMAR – Result presented by Test Report No.: 21842.2015.A- V.0 – AMPRO Industrial Analysis – Date 10/02/2015.

It is observed that the parameter referring to DBO had a removal efficiency of 86.99%, a result above what is requested by the DZ-215-r4 (InEA-RJ effluent treatment guideline), a standard that requires the treatment minimum of 30% removal for organic load below 5.00 Kg.DBO/day and 65% for organic load between 5 and 25 Kg.DBO/day. The result also meets the requirements of CONAMA 430/11 (Federal directive) which requires 120 mg/l for sanitary effluents and requires at least 60% of DBO removal by means of a self-purification study of the receiving body.

As for the RNFT parameter, it appears that the value of 25.00 mg/l is lower than the values established in the DZ-215-r4.

In the second analysis carried out in June 2021, 06 years later, it evaluated the parameters of DBO, COD, SS, SST, mineral oils and vegetable oils. Table 02 shows the results found below:

Table 02: Input and output sample results (06 years after system installation).

Parameter	Input	Output	Efficiency	NOP 45 - INEA RJ	CONAMA 430/11
BOD (mg/l)	122,00	8,00	93,44%	120	120
COD (mg/l)	155,50	77,20	50,35%	-	120
Sedimentable Solids (mL/L)*	0,50	<0,10	80,00%	1	1
Total Suspended Solids(mg/l)*	11	<10	9,09%	110	Ausência
Mineral Oils (mg/l)*	<5,00	<5,00	0,00%	20	20
Vegetable Oils and Animal Fats (mg/l)*	<5,00	<5,00	0,00%	50	50

Source: Technical Department of the company FIBROMAR – Result presented by Test Report No.: 47792/2021- 0.A - Analytical EP - Date 06/25/2021.

It is observed that in relation to DBO, despite the value found is close to the concentration of light sanitary sewage, the results showed an efficiency of 93.44%, with the results within the parameters established by NOP 45 - INEA-RJ. It can be observed that for the other parameters of settling solids and total suspended solids the values also

comply with current legislation, however, their input values are very low. It is important to emphasize that in Fig. 3(a) it shows the collection of raw effluent was carried out by a faucet installed on the side of the equipment. Thus, the low values found at the entrance of the equipment are justified because as the flow is ascending, the material collected has already undergone a first process of degradation and sedimentation of the first chamber.

The values referring to mineral oils and vegetable oils and fats present a very low concentration due to the activity of not having generation of these compounds in the activity performed.

This efficiency in the treatment is justified by the process adopted in the treatment having the configuration of the ascending flow, promoting the contact of the organic load with the sludge blanket where the bacterial colony is installed in the first two compartments, different from the conventional septic tanks where the flow is horizontal. decanting and non-contact with the sludge blanket. In the 3rd chamber, where the compartment referring to the anaerobic filter is located, the adoption of low-density material with a high specific area, which is the anaerobic filter, allows for a better polishing in the system and as the material is mobile, clogging does not occur. of the bed. The improvement in efficiency presented from the first to the second analysis can be justified by the stabilization of organic matter due to the long period of installation of the system and the periodic maintenance that occurs regularly (removal of excess sludge).

In Fig. 04 below, it is possible to observe the visual aspect of the effluents collected at the entrance and exit of the equipment.

Fig. 4: Comparison of samples – On the left side the raw effluent and on the right side the treated effluent. Source: Prepared by the author (2021).

IV. CONCLUSION

The equipment provided by the company FIBROMAR meets guaranteed DBO and RNFT removal efficiency, surpassing conventional treatment processes. The adoption of upward flow has significantly influenced the increase in DBO removal from conventional systems. The conduit used as a filtered medium is an alternative that also influences the improvement of efficiency and prolonging the useful life of the equipment. Regarding the analysis parameters the equipment complied with both old and current legislation, in the federal and state.

With this, it can be said that for low organic loads the equipment safely meets the current environmental requirements and is ideal for places with low number of contributors such as residences and small standards.

In this work, only one aspect of the by-products of anaerobic digestion was analyzed, the treated effluent. As a suggestion for future works, it is of great value for those equipments at agricultural communities with the use of the generated sludge for fertilization. The generation of methane (CH4) and its forms of use within the property would also be evaluated, thus being an alternative for sustainable use and quality of life for local residents.

REFERENCES

[1] ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 13.969/97. Tanques Sépticos – Unidades de Tratamento Complementar e disposição final de efluentes líquidos – Projeto, construção e operação. Rio de Janeiro,1997.

[2] ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 7229/93 Projeto, construção e operação de sistemas de tanques sépticos: procedimento. Rio de Janeiro, 1993 – Versão corrigida 1997.

[3] BRASIL. Resolução CONAMA 357, de 17 de março de 2005. Conselho Nacional de Meio Ambiente. Disponível em: <http://www2.mma.gov.br/port/conama/legiabre.cfm?codlegi=459>. Acesso em: 26nov. 2021

[4] BRASIL. Resolução CONAMA 430 (complementar a 357/05), de 13 de Maio de 2011. Conselho Nacional de Meio Ambiente. Disponível em: <http://http://conama.mma.gov.br/>. Acesso em: 26nov. 2021

[5] CHERNICHARO, C.L. Reatores Anaeróbios. 2. ed. Belo Horizonte: Departamento de Engenharia Sanitária e Ambiental, Universidade Federal de Minas Gerais, 2016, 379p.

[6] DA COSTA, Pedro Carlos Lemos, DO CARMO, Dirlane Fátima. Avaliação do tratamento de águas pluviais por manta sintética: Uso do Acrílon – Dissertação de Mestrado. 2018.

[7] DE AZEVEDO FRIGO, Késia Damaris, FEIDEN, Armin, GALANT, Natasha Barchinsk, SANTOS, Reginaldo Ferreira, MARI, Angelo Gabriel, FRIGO Elisandro Pires. Biodigestores: seus modelos e aplicações. Acta Iguazu, v. 4, n. 1, p. 57-65, 2015.

[8] DEGANUTTI, Roberto, PALHACI, Maria do Carmo Jampaulo Plácido & ROSSI, Marco Biodigestores rurais: modelo indiano, chinês e batelada. Procedingsofthe 4th Encontro de Energia no Meio Rural, 2002.

[9] FERNANDES, Ana Carolina et al. A viabilidade do tratamento de águas negras através do tanque de evapotranspiração no meio rural. 2015.

[10] JORDÃO, Eduardo Pacheco; PESSÔA, Constantino Arruda. Tratamento de Esgotos Domésticos 8ª edição, Rio de Janeiro. Associação Brasileira de Engenharia Sanitária – ABES, 2017.

[11] LEHMANN, Aurelio Hernández; MEDEIROS, Djalma Mariz. Estação de Tratamento de Esgoto: conceitos teóricos e dimensionamentos. 1ª Edição–Natal/RN: INCIBRA, 2019.

[12] METCALF, Leonard; EDDY, Harrison P.; TCHOBANOGLOUS, Georg; tradução: HESPANHOL, Ivanildo; MIERZWA, José Carlos; Tratamento de efluentes e recuperação de recurso. 5. ed. – Porto Alegre: AMGH, 2016.

[13] NUNES, José Alves. Tratamento biológico de águas residuárias. 4ª edição, 2014.

[14] SANTOS, André Bezzera (org.). Caracterização, Tratamento e Gerenciamento de Subprodutos de Correntes de Esgotos Segregadas e Não Segregadas em Empreendimentos Habitacionais. Fortaleza: Imprece, 2019.

[15] SNIS – Sistema Nacional de Informações sobre Saneamento. Diagnóstico dos serviços de água e esgotos – 2019. Brasília: SNSA/MCIDADES. 2020

[16] VIEIRA, V. P. P. B. Desafios da gestão integrada de recursos hídricos no semi-árido. Revista Brasileira de Recursos Hídricos, v. 8, n. 2, p. 7-17, 2003.

[17] VON SPERLING, Marcos. Introdução à qualidade das águas e ao tratamento de esgotos. Editora UFMG, 2014.

[18] BENJAMIN, A. M. Bacia de evapotranspiração: Tratamento de efluentes domésticos e de produção de alimentos. 2013. 50 p. Dissertação (Mestrado) – Universidade Federal de Lavras, MG, 2013.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.16

Relationship between soil management and rainfall erosion: A case study in the Guajará-Mirim river watershed, Vigia - Pará

Jaime Carvalho Goes[1], Eder Silva de Oliveira[2]

[1]Department of Environmental and Sanitary Engineering, State University of Pará, Brazil
Email: jaime.goes@aluno.uepa.br
[2] Department of Environmental and Sanitary Engineering, State University of Pará, Brazil
Email: ederso@uepa.br

Received: 16 Apr 2022,

Received in revised form: 13 May 2022,

Accepted: 18 May 2022,

Available online: 23 May 2022

***Keywords*— Ground cover, Pluvial erosion, QGIS, Remote sensing, USLE.**

***Abstract*—** *This study aims to evaluate the relationship between soil management and its loss by rainfall erosion in the watershed of the Guajará-Mirim river. The methodology used was essentially carried out by remote sensing, literature review and the application of the Universal Soil Loss Equation (USLE), with the geoprocessing of matrix and vector files in the QGIS software. The results show that, in relation to soil management in the study region, considering that it is a plain and that there were no measures to control soil erosion, its loss by rainwater transport is aggravated the greater the exposure of the soil, that is, the removal of vegetation and the revolving soil horizons. This assertion is evidenced by the greater soil loss in the areas mapped for sand extraction and deforestation by calculating the Universal Soil Loss Equation.*

I. INTRODUCTION

According to the provisions of item II, article 3 of the National Environmental Policy [1], the degradation of environmental quality consists of adverse changes in the characteristics of the environment. Such unfavorable alteration may have a natural or anthropic origin. In cases where the origin is natural, it can be said that unavoidable disasters or losses have occurred. Otherwise, when degradation is caused by human intervention, the loss of environmental quality would be avoidable and the human being assumes the role of responsible for altering the quality of the environment, which may or may not exceed its capacity for natural self-recovery [2].

The process of soil erosion consists of the disaggregation, transport and deposition of parts of the soil, whether small grains or larger amounts, and may be caused by the action of natural agents, mainly water and wind, or by human pressure. Water erosion caused by rainfall is one of the main causes of soil fertility loss, being observed mainly in areas with high rainfall, exposed soil and uneven topography. Wind erosion is related to arid and semi-arid climate zones that present exposed soil, both in plains and in irregular reliefs [3].

From a physical point of view, what causes soil loss due to rainfall erosion is the impact of the raindrop against the soil (splash) and the surface runoff of water (soil drag). The susceptibility to erosion of an area depends on certain physical characteristics, which include the nature of the soil (texture, structure and porosity), the rainfall rate of the region, relief and soil cover [3].

It has been developed about water erosion in hydrographic basins in order to estimate the soil loss caused by the action of rain over time. This measurement can help in decision-making in soil management plans, and one of the main ways of calculating to estimate soil loss

from rainfall erosion is the Universal Soil Loss Equation [4], [5].

Deforestation and fires with a view to agricultural and logging use are among the human causes that aggravate soil erosion by the action of rain, reducing the amount of organic matter in the surface layers of the soil, as well as losses in the aggregation between particles and a drop in fertility [6].

The intensive use of agricultural equipment and grazing are also potential factors for increasing soil erosion, as they leave the soil compacted and with little vegetation cover. Mineral exploration in an environmentally unregulated manner is also a factor to be considered, since soil disturbance and exposure to physical weather favor the leaching process, and the risk of leakage in ore tailings dams must also be considered [2].

Geographic Information Systems (GIS) currently represent a set of computational tools of great use for professionals in the environmental area [7]. They specialize in acquiring, storing, retrieving, transforming and issuing geospatial information. Your data depict real objects in terms of cartographic position, non-apparent attributes, and topological relationships. A GIS can be used in environmental studies, in the prediction of certain phenomena and in supporting planning decisions, considering the concept that the stored data represent a model of the real world [8].

Among the most used geoprocessing software today, QGIS stands out in this work for its relevance in the academic and professional environment, being characterized as free, open source (programmers can contribute to its improvement with new tools) and have regular updates [9].

Therefore, as in the Guajará-Mirim river microbasin area, there are several land uses with different potential for rainfall erosion and, in view of the importance of preserving soil quality, an attempt was made to classify and quantify the land cover areas and their respective losses from rainfall erosion through the application of the USLE in the QGIS software.

This study evaluated the relationship between soil management and its loss by rain, in the watershed located on the banks of the Guajará-Mirim river, Vigia - PA, through the application of the Universal Soil Loss Equation (USLE) in the geoprocessing software. QGIS .

II. THEORETICAL REFERENCE

2.1 Photointerpretation

The use of satellite images, in the scope of geotechnologies, is invariably related to the process of photointerpretation of the identifiable categories in the area of interest. Satellite and drone images allow a detailed analysis of the ground surface and are treated in Geographic Information Systems (GIS). The affirmation of this type of analysis depends on the spatial resolution of the satellite images, as well as the technician's ability to visually recognize the land uses of the specific region [10].

The classes of soil cover or use and occupation may vary according to the scope of the study and the nomenclature adopted, and they generally involve: native vegetation; secondary vegetation; agriculture; clean pasture; dirty pasture; logging; burned; hydrography; rock formation; wooded areas; anthropized, civil construction and industrial areas [7].

2.2 Universal Soil Loss Equation (EUPS)

The Universal Soil Loss Equation - EUPS was developed by assistant scientists at the US Department of Agriculture [4], [5]. Its purpose is to predict the long-term average rate of soil erosion using six physical variables (1). It should be noted that its application is intended to calculate the loss of soil from laminar erosion or surface furrows, its formulation does not predict river bed erosion, as well as other more severe forms of erosion, such as ravines and gullies [11].

$$A = R\,K\,LS\,C\,P \quad (1)$$

Where: A is the estimated soil loss in ton per hectare per year (t ha^{-1} $year^{-1}$);

R is the rainfall erosivity factor, the potential for rainfall to cause erosion (MJ mm ha^{-1} h^{-1} $year^{-1}$);

K is the soil erodibility factor, the ability of the soil to resist the erosive process (t h MJ^{-1} mm^{-1});

LS is the topographic terrain factor, taking into account the ramp length (L) and the terrain slope factor (S), dimensionless;

C is the land use and management factor, proportional to the type of cover that is on the ground (dimensionless);

P is the conservation practices factor, it identifies erosion control measures applied in the region of interest (dimensionless).

III. METHODOLOGY

3.1 Study area

The study area is the Guajará-Mirim river watershed, located in the central region of the municipality of Vigia,

in the state of Pará. According to Faustino [12], hydrographic sub-basins are drainage areas of the tributaries of the main watercourse, ranging from 100 km² to 700 km². To a lesser extent, a microbasin has a drainage area to the main river of the sub-basin and an area of less than 100 km² [12]. Therefore, several watersheds form a sub-basin. The study area fits as a watershed because it has an area estimated by remote sensing of 96,541 km²

The estimated population in 2021 in the municipality of Vigia (PA) is 54,650 inhabitants, with a territorial area of 401,589 km² and a population density of 88.83 inhab/km². In livestock, the local economy stands out for the tambaqui aquaculture, for the creation of cattle and chicken herds and for the cultivation of honey, in addition to breeding buffaloes, goats, horses, sheep and pigs [13].

Vigia integrates the mesoregion of Northeast Pará and the microregion of Salgado, forming part of the Amazon biome [13]. According to Kottek et al. [14] the municipality is included in the Köppen climate classification, presenting a tropical monsoon climate (Am), with a brief dry season and an average annual rainfall that can vary from 1750 to 3000 millimeters.

The cartographic scale of Figure 1 refers to the main map of the study area, the secondary map of the location of the municipality is illustrative.

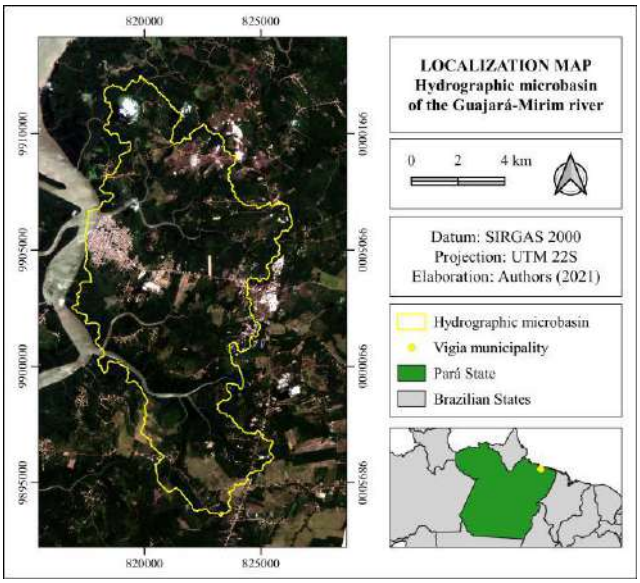


Fig. 1. Location map of the Guajará-Mirim river watershed in Vigia (PA).

3.2 Software, satellite image and vector base

The elaboration of thematic maps was performed in the geoprocessing software QGIS 3.16.8 Hannover. For the location map of the watershed, a scene from the CBERS 04A satellite was used, with a capture date on 08/20/2020, quadrant 211/114 (Path/Row). For the selection of the best image in the Image Generation Division [15] the one with better visibility, less presence of clouds and the most recent imaging date, with temporal resolution from 01/01/2020 to 07/31/ 2021. The cartographic bases of the municipalities and states used were the IBGE [13]

3.3 Composition of CBERS 04A satellite spectral bands

The image composition in natural colors of the CBERS 04A satellite was made in the QGIS 3.16.8 Hannover software, through the composition of bands 3 (red), 2 (green) and 1 (blue) of 8 meters of resolution, with band 0 (panchromatic) of 2 meters of resolution, improving the spatial resolution of the image from 8 to 2 meters in the area of interest [16].

3.4 Correction of the Digital Elevation Model

One of the necessary input data for the elaboration of USLE thematic maps is an altitude raster. It took 4 quadrants to fully cover the area of interest, obtained from the Topodata project website, which provides 30-meter spatial resolution SRTM (Shuttle Radar Topography Mission) radar images: 00S495, 01S495, 00S48 and 01S48 [17]

An altitude raster usually presents imperfections in its primary state, as there is no perfect digital elevation model, given the complexity of the earth's surface and the level of geometric fidelity that geoprocessing software provides, but there are technically acceptable models. To alleviate the imperfections, three processes were necessary: the removal of negative altitude values [18]; filling in the pixels without data (tiny blank spaces) [19]; and the leveling of spurious depressions (pixels with incongruent values in relation to their immediate altimetric neighborhood [20].

To correct the negative altitude values, the Raster Calculator function of the SAGA (System for Automated Geoscientific Analyses) in QGIS was used, with the input of the formula: “ifelse (a<0, 0, a)”, which considers negative values as zero altitude and maintains the other values [18],[21].

To fill in the tiny blank spaces, we used the Fill no data function, with the default setting. In this way, the software fills the blank values with values that are in accordance with the most likely statistic of the pixel neighborhood [19]

To correct the spurious depressions, SAGA's Fill sinks (Wang & Liu) tool was used, which flattens the altitude of pixels with outliers. After these technical procedures, there is a Hydrologically Consistent Digital Elevation Model (HCDEM), with altimetric values closer to reality [20]

3.5 Rain Erosivity Factor (R)

The method of calculating the factor R proposed by Lombardi Neto and Moldenhauer [22] was implemented, which arrived at Equation 2, derived from the regression between the average monthly erosion index and the rainfall coefficient.

$$EI_{mensal} = 68{,}730\left(\frac{p^2}{P}\right)^{0{,}841} \quad (2)$$

Where: EI is the monthly average of the erosion index (MJ.mm/ha.h.year);

p indicates the average monthly rainfall (mm);

P indicates the average annual precipitation (mm).

To obtain the annual rainfall erosivity factor, it is necessary to calculate the average of the EI values for the 12 months of the year (3). The historical series used was from the years 1990 to 2020. The average of R was calculated for each sample year and the average of 31 years (4), which is the final value considered for the map algebra (R factor of USLE). The data used were downloaded from the Hidroweb platform of the National Water Agency [23], selecting the rainfall station in Vigia (PA). The calculation of the mentioned formulas was done in the Excel 2019 program [22].

$$R_{anual} = \frac{\sum_{i=1}^{12} EI(i)_{mensal}}{12} \quad (3)$$

$$R_{final} = \frac{\sum_{i=1}^{31} R(i)_{anual}}{31} \quad (4)$$

3.6 Soil Erodibility Factor (K)

The soil erodibility factor K depends on the geological knowledge of the soil in question. According to the Soil Map of Brazil [24], the Guajará-Mirim river watershed in Vigia (PA) is predominantly located in the patch of dystrophic yellow latosol of medium texture, with pedological formations of dystrophic concretionary petric plintosol and neosol orthic quartzarenic.

According to the Geodiversity Cartographic Survey of the State of Pará [25], the watershed of the Guajará-Mirim River is part of the lithological formation of Post-Barreiras Sediments. It has a characteristic presence of consolidated and semi-consolidated sands, yellowish cream and white, with fine to medium granulometry, containing a fraction of clay and millimetric quartz clasts. In a field survey in the area, the authors of the present study found the presence of quartzarenic neosols in the sand mineral extraction areas.

3.7 Topographic Factor (LS)

The method applied in the QGIS 3.16.8 software to calculate the LS topographic factor was carried out using the field-based SAGA (System for Automated Geoscientific Analyses) Factor LS tool. A Digital Elevation Model (DEM) is required as input, and catchment areas are derived according to Freeman's computational model, being used instead of the slope factor originating from the EUPS [26], [21].

As a DEM with a spatial resolution of 30 meters was inserted [17], the resulting raster has this same characteristic. The selected LS topographic factor equation that allowed automatic calculation in QGIS was developed and described by Desmet and Govers [27].

3.8 Soil Cover Factor (C)

The soil cover classes were identified in the Guajará-Mirim river microbasin through photointerpretation and manual vectorization in the QGIS 3.16.8 software and comparison with the classes from the shapefile provided by ESRI, Use and Occupation of Soil of Globo Terrestre for the year of 2020, with a spatial resolution of 10 meters [28]. The soil cover classes adopted and identified were: native vegetation, secondary vegetation, clean pasture, dirty pasture, hydrography, dam, anthropized area, deforestation and mineral extraction. An attempt was made to use nomenclatures similar to those of the TerraClass Project by Embrapa [29].

The native vegetation is characterized by the presence of dense forest and closed canopy, presenting predominantly dark green coloration, with no identifiable water courses below this vegetation by the orthogonal view. The secondary vegetation is characterized by shrubs, few tall trees and a canopy of lower height than the native vegetation, with a predominant medium green color [28],[29].

Clean pasture can be seen in areas with a low presence of shrubby vegetation, associated with the creation of herds, homogeneous grasses with little or no higher vegetation; may have wild cereals, without human planting. Grass is characterized by areas that may have previously been used for grazing and are undergoing an ecological succession process, or areas that have been degraded for some time and have begun to recover naturally; are fields with little or no tree cover, but which already have some surface cover greater than that of clean pasture, such as sparse shrubs and tall grass [28],[29].

The hydrography is characterized by the presence of the Guajará-Mirim river and its tributaries, meanders that can reach up to 10 meters in width, in addition to some ponds with still water, being small lakes of dark water that

normally serve for recreation or animal watering. The category of anthropized area comprises the nuclei of residences and buildings, mainly in the central part of the municipality of Vigia. As it is a municipality with a large presence of rural areas, some houses are in very close contact with native and secondary vegetation. In the photointerpretation, only those areas with significant soil impermeabilization were considered as anthropized areas, mainly in the central area of the municipality [28],[29].

Areas of deforestation were identified by the presence of clearings in the midst of native or secondary vegetation, in locations where no connection between the clearings and the presence of anthropized areas was identified, implying that this is possibly an area that suffered clear-cutting of wood. The areas of mineral extraction of sand are easily identified by satellite image due to their white-yellowish tone, different from the other land cover classes [28],[29].

After vectorizing the entire area of interest, the Rasterize operation in QGIS was necessary to convert the files in shapefile (vector) to raster (matrix) format, so that it can be used in map algebra. Inverse operation was performed on the final raster of soil loss due to rainfall erosion (Vectorize), the values of each pixel of 30 meters were extracted in the form of vector points, for the calculation of soil loss by cover class.

IV. RESULTS AND DISCUSSION

4.1 Rain Erosivity Factor (R)

According to the defined methodology, the result of the Rfinal factor, which is used in the algebra of the equation A = R K LS C P, was approximately 682 MJ.mm/ha.h.year [22]. This value numerically represents the average rainfall erosivity factor, considering the sampling interval of 31 years adopted and the rainfall data from the Vigia meteorological station [23].

Table 1. R_{final} value.

R_{final}	Unit
682	MJ.mm/ha.h.year

According to Silva et al. [30], this is an R factor considered of weak erosivity, according to the classification Table 2. This shows that the region, characterized as a plain, with little altimetric variation and being located in the equatorial zone of the globe (IBGE, 2021b), presented a weak potential for rainfall erosivity throughout the historical series of analysis.

Table 2. R values according to the levels of rainfall erosivity, in MJ mm ha^{-1} h^{-1}.

R Factor	Erosivity
< 2452	Weak
2452 – 4905	Medium
4905 – 7357	Medium to Strong
7357 – 9810	Strong
> 9810	Very Strong

Source: Silva et al. (2003).

4.2 Soil Erodibility Factor (K)

Silva and Alvares [31], carried out a review of K values for soil classes in the state of São Paulo, finding mean values for soil classes similar to those found in the Guajará-Mirim river watershed. The soil cover classes were classified as dystrophic yellow latosol: native vegetation, secondary vegetation, dirty pasture, clean pasture, agriculture and deforestation. For the areas photointerpreted as sand extraction, quartzarenic neosols were considered. The classes of anthropic area, hydrography and weir did not receive soil erodibility values, since they do not fit the K-factor erosion measurement criterion (Table 3).

It is noteworthy to evaluate the K factor that the quartzarenic neosols present in the basin area have a sandy texture along the profile, with a very reduced A horizon, it is in these soils that the activities of sand extraction are carried out. The dystrophic yellow latosols present conditions of good water retention, good permeability and sandy-clay texture, where all agricultural practices in the area are developed.

Table 3. Values for the Erodibility Factor K, in $t.ha^{-1}.MJ^{-1}.mm^{-1}$.

Soil Class	K Factor
Dystrophic yellow latosol	0.0043
Quartzarenic neosol	0.0127

Source: Silva e Alvares [31].

According to the classification proposed by Silva et al. [30], the soil classes identified in the Guajará-Mirim river watershed have low soil erodibility values. The higher the value for K, the lower the natural resistance of the soil structure to rainfall erosion (Table 4).

Table 4. Soil Erodibility Potential, in t ha MJ^{-1} mm^{-1}.

K Factor	Erodibility
< 1.471	Low
1.471 – 2.943	Medium
> 2.943	High

Source: Silva et al. [30].

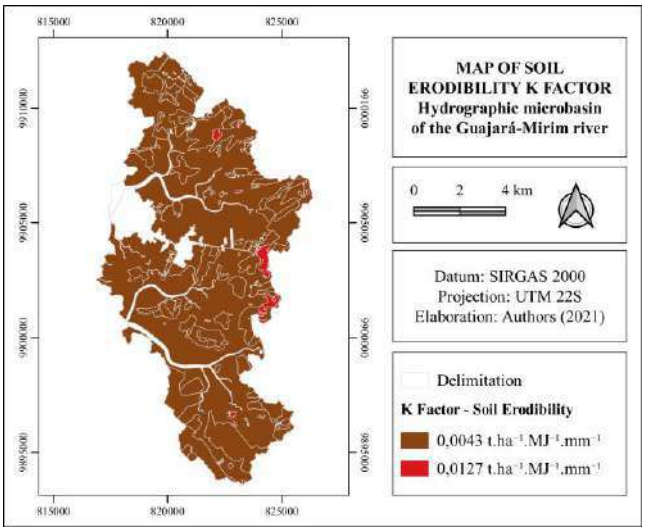


Fig. 2. Soil Erodibility K Factor Map.

4.3 Topographic Factor (LS)

According to the resulting calculations, the LS topographic factor presented values ranging between 0.03 and 17.41 in the Guajará-Mirim river watershed, with most of the area not exceeding 2.50. Values above 2.50 are linked to river slope areas. The higher the LS topographic factor, the greater the susceptibility of the region to the occurrence of erosion, as the slope of the terrain favors the dragging of soil by the rains [11].

Table 5. Slope Classes.

Slope (%)	Relief
0 – 3	Plan
3 – 8	Soft-wavy
8 – 20	Wavy
20 – 45	Strong-wavy
45 – 75	Mountainous
> 75	Strong-mountain

Source: Embrapa [32].

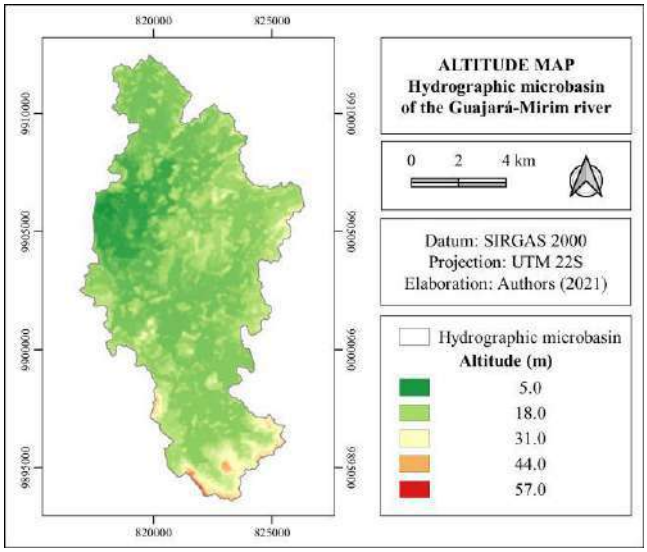


Fig. 3. Altitude Map.

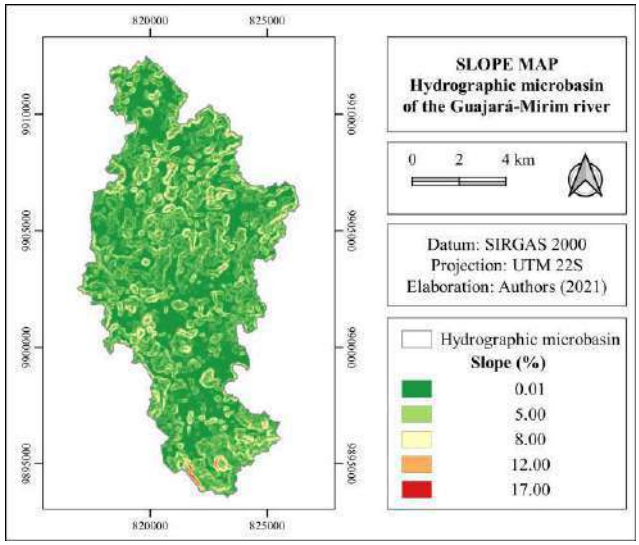


Fig. 4. Slope Map.

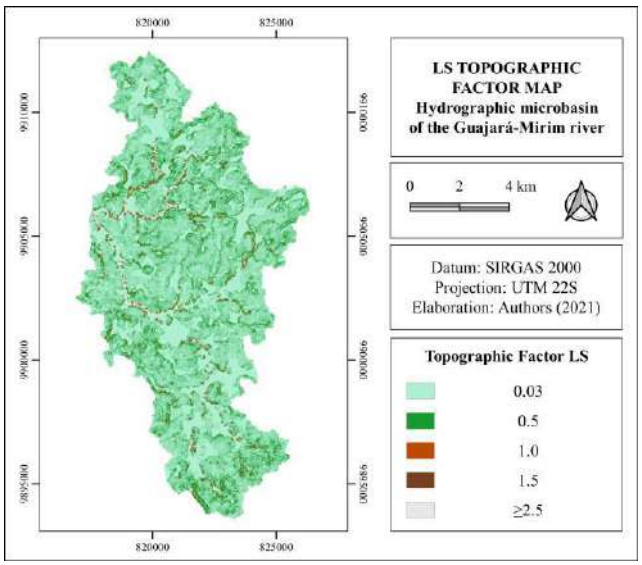


Fig. 5. LS Topographic Factor Map.

4.4 Soil Cover Factor (C)

For factor C, different values were used for each land cover class, based on studies by different authors, requiring the correlation of the nomenclature used by these authors with the one adopted in this work [33],[34],[35],[22].

Table 6. Values for Soil Cover Factor C.

Soil Cover	C	Reference
Anthropized area	0.000	Oszoy *et al*. (2012)
Hydrography/Weir	0.000	Oszoy *et al*. (2012)
Native vegetation	0.001	Oszoy *et al*. (2012)
Secondary vegetation	0.010	Oliveira *et al*. (2014)
Grass	0.038	Oszoy *et al*. 2012
Pasture	0.090	Oszoy *et al*. (2012)
Agriculture	0.290	Beskow *et al*. (2009)
Deforestation	0.404	Bertoni, Lombardi Netto (2012)
Sand extraction	1.000	Oszoy *et al*. (2012)

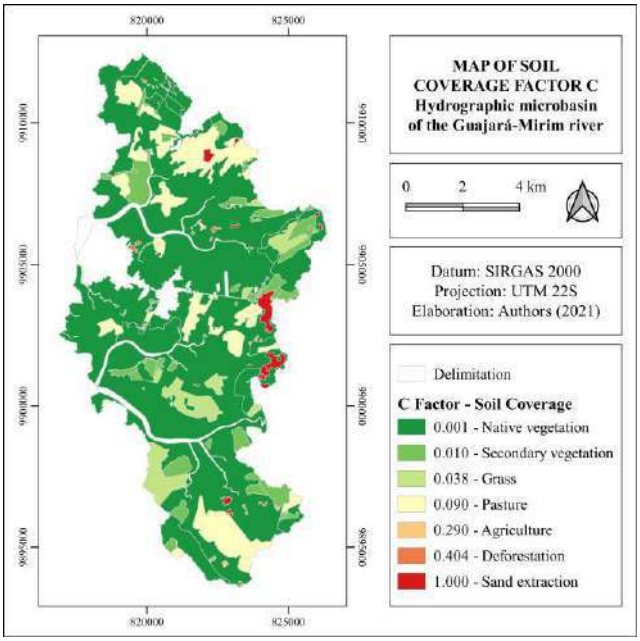


Fig. 6. Land Cover C Factor Map.

The areas of the blank map represent the classes of anthropized area, hydrography and dams, for which the literature determines that the value 0.000 (zero) for the C factor of land use should be used. Therefore, they will not be considered as having the potential for rainfall erosion in the USLE [33].

Much of the area of the Guajará-Mirim river watershed is covered by native and secondary vegetation, evidencing the rural characteristic of the municipality. In contrast, there are considerable areas of pasture that are used in local agriculture [13]

With less expressiveness in territorial extension, few areas of agriculture were verified in the microbasin. Having the greatest negative environmental impact, the areas of mineral extraction of sand and deforestation of vegetation showed the highest values for the C factor of soil cover, since they leave the soil more exposed by removing its surface protection, increasing the erosive potential [22],[33].

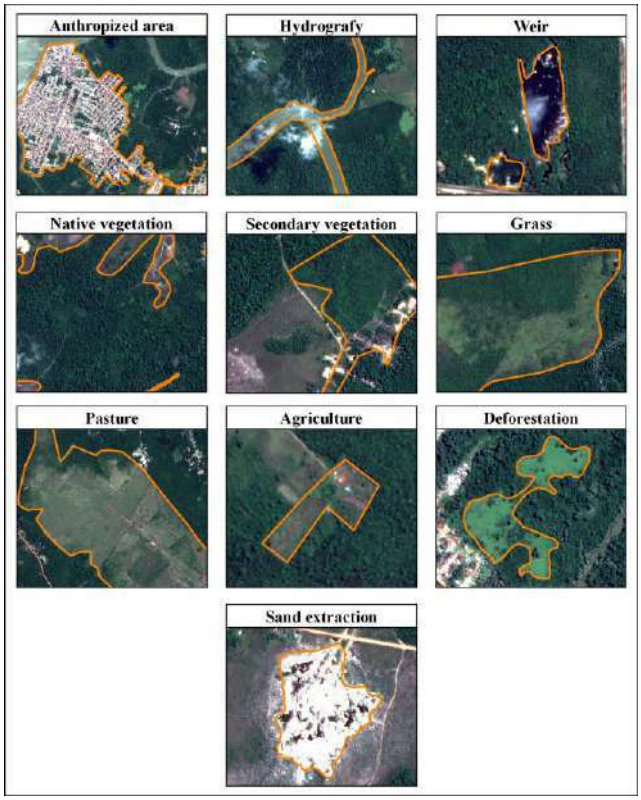


Fig. 7. land cover classes identified in the study area.

4.5 Factor of Conservation Practices (P)

In the Guajará-Mirim river watershed, it was not possible to verify the implementation of conservation practices against soil erosion through satellite images, field surveys and literature review [16],[13].

Table 7. P values for different conservation practices.

Conservation practices	P value
Planting down the hill	1.0
Contour planting	0.5
Alternation of weeding + Contour planting	0.4
Permanent vegetation string	0.2

Source: Pruski [36]

It is inferred that because the study area does not have many hectares of agricultural use currently in activity, is located in a low-altitude region and due to the lack of more active technical monitoring in the area of soil conservation, local rural landowners have not implemented expressively such soil erosion control practices described in the literature, such as contour planting and permanent vegetation cordon [36]. Therefore, a value of 1.0 must be adopted for the P factor of the Universal Soil Persian Equation [4].

4.5 Soil Loss (A)

The Rainfall Erosion Soil Loss Map is the result of multiplying the factors of the Universal Soil Loss Equation, in the form of georeferenced raster files and pre-established numerical values. Thus, each pixel with a spatial resolution of 30 meters has a soil loss value that depends on the characteristics of the area. The multiplication in the Raster Calculator of the RKLS.CP factors generated the map in Figure 8, with the factors R = 682 and P = 1. The physical variables K, LS and C entered as previously processed matrix files [35].

Oliveira et al. [34] developed a classification of intervals to measure the degree of soil loss, in tons per hectare per year, serving as a reference to know how vulnerable the watershed in question is to erosion.

Table 8. Soil loss classification intervals in tons per hectare per year.

Soil loss (t ha^{-1} year^{-1})	Vulnerability
0 – 2.5	Slight
2.5 – 5	Slight to Moderate
5 – 10	Moderate
10 – 15	Moderate to High
15 – 25	High
25 – 100	Very High
> 100	Extremely High

Source: Oliveira et al. [34].

Figure 8 shows a rainfall erosion that varies from mild, in most of the watershed, to moderate, specifically in the sand extraction areas. Table 9 indicates an average soil loss of 1.8381 t.ha^{-1}.year^{-1} for the study area, being classified as slight [34].

However, the estimated total soil loss for the entire microbasin area over one year was 249.59 tons of soil. This amount reveals the importance of implementing conservationist practices against erosion, since agribusiness, agriculture, livestock and forest management depend on the quality of the soil. In short, soil degradation harms society in general, as it provides much of what is essential for human and animal life [11].

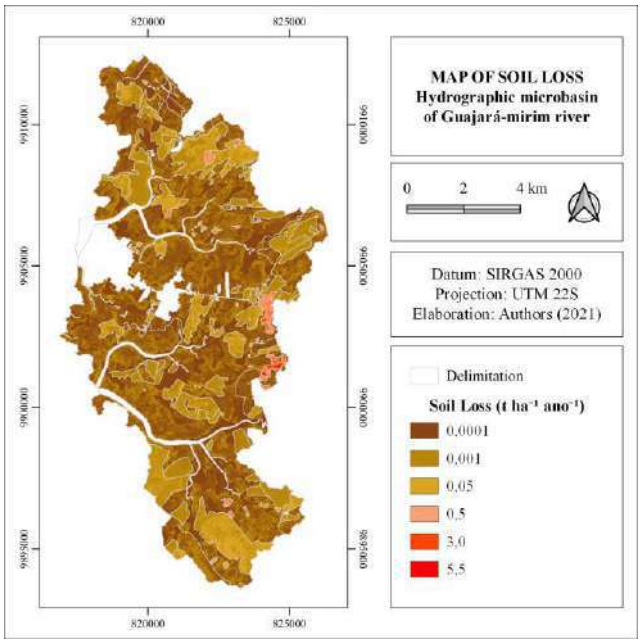


Fig. 8. Soil Loss Map.

It is inferred that investments in soil preservation can bring greater returns in a financial and environmental sense, as there are expenses to replace the loss of nutrients that the soil suffers naturally and by anthropic action over time, especially with regard to potential use. agricultural and forestry [37].

It is costly to the environment that rural landowners constantly seek to convert new areas of vegetation for livestock or for logging and mining, when they found degraded the areas they had previously explored [11].

Table 9. Percentage value of soil loss by cover class.

Class	Area (%)	Estimated loss (%)
1. Anthropized area	4.70	-
2. Hydrography	3.14	-
3. Weir	0.13	-
4. Agriculture	0.16	0.95
5. Deforestation	0.21	1.39
6. Secondary vegetation	7.11	1.52
7. Native vegetation	67.43	1.80
8. Grass	4.43	3.01
9. Pasture	11.41	20.37
10. Sand extraction	1.28	70.97

Table 9 reveals that, despite being the smallest in extent among all land cover classes, the sand mineral extraction category represented the highest percentage amount of erosion for the study area. With the second highest erosive potential, the activity of clean pasture is evident, being the second area in extension of land use in the study area [22].

Table 10. Soil loss by cover class.

Class	Area (ha)	Average Loss (t ha^{-1} $year^{-1}$)	Estimated Loss (t ano^{-1})
1	452.95	-	-
2	302.17	-	-
3	12.49	-	-
4	15.32	0.1547	2.37
5	19.80	0.1749	3.46
6	684.91	0.0055	3.79
7	6496.61	0.0007	4.48
8	427.06	0.0176	7.51
9	1099.48	0.0462	50.83
10	123.15	1.4385	177.14
	Total	**Total**	**Total**
	9633.93	1.8381	249.59

The native vegetation, even with the largest territorial extension in the Guajará-Mirim river watershed, showed a very low soil loss, numerically confirming the importance of vegetation in the control and prevention of soil loss by pluvial erosion [22]

V. FINAL CONSIDERATIONS

The results show the potential of remote sensing and geotechnologies for soil quality assessment and monitoring. QGIS software is an excellent tool for handling raster and vector data. In it, there was the possibility of classifying the land cover for the study area based on the satellite image CBERS 04A of INPE, in addition to all the geoprocessing procedures described in the methodological part.

The conservation of vegetation and the adoption of erosion control measures are essential to reduce the natural wear and tear that the soil suffers over time. In contrast, the removal of natural vegetation to create pasture areas and the extraction of wood without adequate forest management are causes of soil degradation, as is the mineral extraction of sand. Such practices must be carried out in a sustainable way, combining economic, social and environmental factors.

It is worth mentioning that, whenever possible, there is a greater investment in technical monitoring and scientific research, there is the possibility of carrying out tests to determine specific values of the physical factors of the EUPS, generating more accurate estimates of soil loss. The monitoring of land cover change at regular time intervals by remote sensing is interesting for inspection by environmental agencies, as well as it can meet the interest of research institutions and professionals related to the environmental area.

Finally, the Soil Loss Map is the maximum product that could be elaborated by combining the Universal Soil Loss Equation and the potential of the QGIS geoprocessing software. It is interesting to underline the importance of applying physical equations that can be specialized in order to help professionals who work with the environment to make accurate decisions in their projects.

REFERENCES

[1] BRASIL. Lei nº 6.938, de 31 de agosto de 1981. (1981). Institui a Política Nacional do Meio Ambiente. Diário Oficial da União. Brasília - DF, 1981.

[2] Lepsch, I.F. (2010). Formação e Conservação dos Solos. Oficina de Textos, 2ª ed., São Paulo – SP.

[3] Pes, L.Z.; giacomini, D.A. (2017). Conservação do solo. Colégio Politécnico da Universidade Federal de Santa Maria.

[4] Wischmeier, W. H.; smith, D. D. Predicting rainfall erosion losses: a guide to conservation planning. (1978). U.S. Department of Agriculture, Agriculture Handbook Nº 537.

[5] Renard, K. G.; Foster, G. A.; Weesies, D. K; Mccool, D. K; Yoder, D. C. (1997). Predicting Soil Erosion by Water: A Guide to Conservation Planning With the Revised Universal Soil Loss Equation (RUSLE). U. S. Department of Agriculture, Agriculture Handbook, n. 703.

[6] Bertoni, J.; Lombardi Neto, F. (2012). Conservação do solo. 8ª ed. São Paulo: Ícone.

[7] Pirovani, D. B.; Silva, A. G.; Santos, A. R.; Cecílio, R. A.; Martins, S. V.; Gleriani, J. M. (2012). Uso de geotecnologias para estudo da fragmentação florestal com base em princípios de ecologia da paisagem. Geotecnologias aplicadas aos recursos florestais, c. 1. Centro de Ciências Agrárias da Universidade Federal do Espírito Santo. Alegre – ES.

[8] Burrough, P.A. (1986). Principles of geographical information systems for land resouces assessment. Oxford, Clarendon Press.

[9] QGIS. Sistema de Informação Geográfica Livre e Aberto. 2021. Available at: <https://qgis.org/pt_BR/site/>.

[10] Zanetti, S. S.; Agrizzi, D. V.; Scárdua, M. D.; Fukunaga, D.; Oliveira, K. D. (2012). Estimativas do escoamento

superficial em uma sub-bacia hidrográfica no município de Rio Novo do Sul, ES. Geotecnologias Aplicadas aos Recursos Florestais. Alegre – ES.

[11] Guerra, A. J. T.; Silva, A. S. Da; Botelho, R. G. M. (2020). Erosão e Conservação dos Solos. Bertrand Brasil, Rio de Janeiro, 11ª ed.

[12] Faustino, J. (1996). Planificación y gestión de manejo de cuencas. Turrialba: CATIE, 1996.

[13] IBGE. (2021b). Instituto Brasileiro de Geografia e Estatística: Portal Cidades. Vigia - Pará. Available at: <https://cidades.ibge.gov.br/brasil/pa/vigia/panorama>.

[14] Kottek M., Grieser J., Beck C., Rudolf B., Rubel F. (2006). World Map of the Köppen-Geiger climate classification updated. Meteorologische Zeitschrift, v.15, n. 3, p.259-263. DOI:10.1127/0941-2948/2013/0507

[15] INPE. (2021a).Instituto Nacional de Pesquisas Espaciais. Divisão de Geração de Imagens. Available at: <http://www2.dgi.inpe.br/catalogo/explore>.

[16] INPE. (2021b). Instituto Nacional de Pesquisas Espaciais. Câmeras Imageadoras CBERS 04A. Available at: <http://www.cbers.inpe.br/sobre/cameras/cbers04a.php>.

[17] INPE. (2021c). Instituto Nacional de Pesquisas Espaciais. Projeto Topodata: Banco de Dados Geomorfométricos do Brasil. Available at: <http://www.dsr.inpe.br/topodata/acesso.php>.

[18] Santos, A. R. (2020a). Pré-processamento - Etapa 03: Correção de valores negativos do MDE SRTM de 30m no QGIS. Available at: <https://youtu.be/h75zqJMMs9A>.

[19] Santos, A. R. (2020b). Pré-processamento - Etapa 04: Preencher pixels sem dados do MDE SRTM de 30m no QGIS. Available at: <https://youtu.be/w5oD56xmWh8>.

[20] Santos, A. R. (2020c). Pré-processamento - Etapa 05: Remoção de depressões espúrias do MDE SRTM de 30m no QGIS. Available at: <https://youtu.be/1J2TR50oTZU>.

[21] SAGA. GIS Module Library Documentation: Module LS Factor, Field Based. 2021. Available at: <www.saga-gis.org/saga_tool_doc/2.2.7/ta_hydrology_25.html>.

[22] Lombardi Neto, F.; Moldenhauer, W. C. (1992). Erosividade da chuva: sua distribuição e relação com as perdas de solo em Campinas (SP). Bragantia, v. 51, n. 2.

[23] ANA. (2021). Agência Nacional de Águas. *Sistema Nacional de Informações sobre Recursos Hídricos (SNIRH).* Available at: <https://www.snirh.gov.br/hidroweb/serieshistoricas>. Acesso em: 14 jul.

[24] IBGE. (2006). Instituto Brasileiro de Geografia e Estatística: Mapa de Solos do Brasil.

[25] CPRM. (2010). Serviço Geológico Do Brasil. Mapa Geodiversidade do Estado do Pará. https://rigeo.cprm.gov.br/handle/doc/14705.

[26] Freeman, G. T. (1991). Calculating catchment area with divergent flow based on a regular grid. Computers and Geosciences, 17:413-22.

[27] Desmet, P. J. J.; Govers, G. (1996). A GIS Procedure for Automatically Calculating the USLE LS Factor on Topographically Complex Landscape Units. Journal of Soil and Water Conservation, 51 (5), 427-433.

[28] ESRI. (2020). Esri 10-Meter Land Cover: A 10-meter resolution map of Earth's land surface from. Available at: <https://livingatlas.arcgis.com/landcover/>.

[29] TERRASCLASS. (2021). GeoPortal TerraClass - Amazônia Legal. Available at: <https://www.terraclass.gov.br/geoportal-aml/>.

[30] Silva, A. M.; Schulz, H. E.; Camargo, P.B. (2003). Erosão e hidrossedimentologia em bacias hidrográficas. São Carlos: RiMa.

[31] Silva, A. M.; Alvares, C. A. (2005). Levantamento de informações e estruturação de um banco de dados sobre a erodibilidade de classes de solos no Estado de São Paulo. Geociências, Rio Claro, v. 24, n. 1.

[32] EMBRAPA. (1979). Empresa Brasileira de Pesquisa Agropecuária. Súmula da 10 - Reunião Técnica de Levantamento de Solos. Serviço Nacional de Levantamento e Conservação de Solos. Rio de Janeiro.

[33] Oszoy, G.; Aksoy, E.; Dirim, M. S.; Tumsavas, Z. (2012). Determination of soil erosion risk in the Mustafakemalpasa River Basin, Turkey, using the Revised Universal Soil Loss Equation, Geographic Information System, and Remote Sensing. Environmental Management. 50(4):679- 694.

[34] Oliveira, V. A.; Mello, C. R.; Durães, M. F.; Silva, A. M. (2014). Vulnerabilidade dos solos à erosão hídrica na bacia hidrográfica do Rio Verde, sul de Minas Gerais. Ciência e Agrotecnologia, Universidade Federal de Lavras, v. 38, n. 3, p. 262-269.

[35] Beskow, S.; Mello, C.R.; Norton, L. D. (2009). Soil erosion prediction in the Grande River Basin, Brazil using distributed modeling. Catena. 79(1):49-59.

[36] Pruski, F. F. (2009). Conservação de solo e água: Práticas mecânicas para o controle da erosão hídrica. Viçosa: Ed. Viçosa.

[37] Paiva, J. B. D.; Paiva, E. M C. D. (2003. Hidrologia Aplicada à Gestão de Pequenas Bacias Hidrográficas. FINEP, ABRH, Porto Alegre.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.17

Strategies for the assessment of tuberculosis contacts: An integrative literature review

Ianny Ferreira Raiol Sousa[1], Ana Karolina Oliveira dos Santos Aguiar[2], Marina Pereira Queiroz dos Santos[3], Jady Barreirinhas Barros[4], Ana Alice Matias Ambé[5], Carolyna Magno Corvello[6], Ruth de Souza Martins[7], Gabriel Fazzi Costa[8], Claudia Ozela El-Husny[9], Juliana Conceição Dias Garcez[10], Karla Valéria Batista Lima[11].

[1,8] Nurse, Postgraduate Program in Parasitic Biology in the Amazon Master's UEPA/IEC, Belém, Pará, Brazil.
[3] Nurse, Postgraduate Program in Epidemiology and Health Surveillance IEC, Belém, Pará, Brazil.
[2,4,5,6,7] Nursing Students at the Centro Universitário Metropolitano da Amazônia (UNIFAMAZ), Belém, Pará, Brazil.
[9] Professor of the Nursing Course at the Centro Universitário Metropolitano da Amazônia (UNIFAMAZ), Belém, Pará, Brazil.
[10] Professor of the Nursing Course at the Centro Universitário Metropolitano da Amazônia (UNIFAMAZ), Postgraduate Program in Parasitic Biology in the Amazon Doctorate UEPA/IEC, Belém, Pará, Brazil.
[11] Bacteriology and Mycology Section, Evandro Chagas Institute (IEC), Ananindeua, Pará, Brazil.

Received: 19 Apr 2022,
Received in revised form: 11 May 2022,
Accepted: 17 May 2022,
Available online: 24 May 2022

***Keywords*— Communicable Disease Control, Tuberculoses, Health Care, Outcome and Process Assessment.**

Abstract— *Objective: to describe, based on a literature review, the strategies used to assess the contacts of tuberculosis patients. Methodology: This is an exploratory and qualitative study, based on an Integrative Literature Review (RIL), composed of 6 stages. Applying the appropriate filters, resulted in 540 articles, in which 14 were selected using the exclusion criteria properly, in which materials that portrayed and explored the evaluation of tuberculosis contacts, latent tuberculosis, as well as the challenges in implementation were prioritized. of actions for this disease. Results: categorized into the following topics: Knowledge of contacts about what the disease is, care and transmission; The importance of contact tracing and Role of health professionals on tuberculosis transmission. Conclusion: the importance of evaluating tuberculosis contacts with the objective of controlling the disease was highlighted. In this way, it is important to emphasize that the health professional has a huge responsibility towards this public, and to the community in general, and it is necessary to always be seeking new knowledge in order to improve their health practices and ensure that their professional attitudes towards contacts make it possible to optimize identification and investigation of TB contacts.*

I. INTRODUCTION

Infectious-contagious disease is an infectious disease mainly caused by the tuberculosis virus, which mainly affects the lungs, but can reach the organs of the organs and even the pandemic (COVID-19), among the main causes of death, the single infectious agent throughout the world. world, in addition to being the leading cause of death among people living with HIV ((TEIXEIRA, SAMICO, MARTINS, 2020; SILVA, MELO, MIGLIORI, 2020; WHO, 2021).

A quarter of the world's population is infected with M. tuberculosis, and in 2020, about 9.9 million people became ill with TB in the world, and in Brazil, in 2020, 66,819 new TB cases were reported, which corresponded to one case incidence rate of 31.6 cases/100 thousand inhabitants (Brazil, 2019; WHO, 2021; Silva, Melo, Migliori, 2020). The northern region of the country, in 2020, had the highest TB incidence coefficient, with 43.0/100,000 inhabitants, remaining above the national average. , et al, 2021; BRASIL, 2021).

Ananindeua-PA, municipality of Ananindeua-PA, it was observed that one of the problems for the surveillance and care of TB, consequently, is related to the shame and fear of revealing the family, which contributes to the worsening of the health status. of the individual, as well as for transmission of the pathogen to their family members. In addition, studies indicate that in home visits presented by nurses, other problems are directed to the conditions of the population, in which they live in unsanitary conditions, where, in most windows of entire houses, there is only one to ventilate the entire house (BRITO, this form 2020).

Ministry of Health (MS) recommends 100% of contacts who identified the treatment of Latent Tuberculosis Infection LTBI with the intention of reducing the risk of illness. The proportion of 20.9% in the northern region of the country (Brazil, 2019; Teixeira, Sa, Martins, et al, 60.9% in the northern region of the country) 2020; Brazil, 2021).

Among the actions proposed by the National Tuberculosis Control Program (PCNT) is the evaluation of patient contacts, as well as among the strategies of the Plan for the End of Tuberculosis is to intensify the evaluation of contacts. It is known that contacts are all people who live in the same environment as the index TB case, however the degree of exposure will depend on the disease, environment and exposure time (SOARES, COELHO, MONTEIRO, 2016).

According to Teixeira, Samico, Martins, et al, 2020, there are two types of contact with tuberculosis patients: home contact, used to define the contacts of TB patients who live with the index case in the same household; and the close contact, used to define the close contacts of the index case, including relatives who do not live in the same house, colleagues from work, leisure activities and other types of contacts. Therefore, the evaluation of these contacts becomes an indispensable strategy in TB programs, since the investigation of TB in contacts of bacilliferous patients is one of the simplest and most mandatory TB control actions to control the emergence of new cases, mainly in these more susceptible patients.

It is pointed out that living with a bacillary TB patient, the susceptibility of the exposed person and the intensity of contact are factors that contribute to TB illness. According to the Ministry of Health (2019) 3.5% to 5.5% of family members or close contacts of a person with TB had previously undiagnosed disease. It is understood that people in the same household share the same socioeconomic conditions and, often, the same life habits, in which they contribute to illness from the disease, thus, the evaluation of contacts is essential for early diagnosis, as well as to reduce disease transmission.

In this context, the adequate assessment of the contacts of the person with TB represents an effective and low-cost way to detect the disease early, contributing to the interruption of the transmission chain and the propagation of microbial resistance. It is noteworthy that this assessment is a challenge for health services, due to the resistance of family members to attend the service and the lack of appreciation given to this procedure by professionals (LIMA, SCHWARTZ, CARDOZO GONZÁLES, et al, 2013).

According to Lima, Schwartz, Cardozo Gonzáles, et al (2013) evidence and strategies in the practice of evaluating contacts of people with TB, through the execution of evaluation protocols, monitoring of patients and their contacts must be carried out through the primary care, in view of the decentralization that the PNCT provides for this condition. In view of the above, the following guiding question was defined: What strategies are used to assess the contacts of tuberculosis patients based on scientific evidence in the period from 2011 to 2021?; The objective of the research is to describe, from a literature review, which strategies are used to assess the contacts of tuberculosis patients.

II. METHODOLOGY

This is an exploratory and qualitative study, based on an Integrative Literature Review (RIL), composed of 6 steps: 1) Establishment of a hypothesis or research question: What strategies are used for the evaluation of the contacts of the carrier of tuberculosis based on scientific evidence from 2011 to 2021; 2) Sampling or literature search; 3) Categorization of studies; 4) Evaluation of the studies included in the review; 5) Interpretation of results; 6) Synthesis of knowledge or presentation of the review (MARCONI, LAKATOS, 2017).

According to Silva and Fossá (2015) bibliographic research is one of the best ways to start a study, as it seeks similarities and differences between the articles found in the reference bases, thus contributing to a deeper understanding of the topic already investigated. The objective of this review method is to point out knowledge gaps that need to be filled and the need to carry out new studies.

To carry out the research, the following databases were used¸ Virtual Health Library (VHL), Latin American and Caribbean Literature on Health Sciences (LILACS), Medical Literature Analysis and Retrieval System (MEDLINE) and Database of Bibliographic Specialized in the area of Nursing (BDENF). The descriptors based on the Population, Intervention, Context and Time (PICot) methodology were: Tuberculosis; Prevention and Control; Latent Tuberculosis. The descriptors were searched by crossing them with the Boolean operator connector AND in the descriptors field in the Virtual Health Library to build the search strings.

Inclusion criteria are complete online texts in Portuguese, English and Spanish; articles published from 2011 to 2021, whose publications were in the databases; used the descriptors proposed for the scientific search. And as exclusion criteria, articles that were repeated in the databases and outside the period of literature review were adopted.

After the electronic search, we used the PRISMA flowchart, which serves as a supporting document explaining and elaborating how it was produced following the style used in other guidelines. (Figure 1). And the pre-selection was carried out, with a thorough reading of the titles and abstracts of the articles, with the intention that they comply with the established inclusion criteria. Thus, at first, 540 articles were pre-selected. These articles were analyzed using an instrument adapted from URSI (2005).

The instrument was presented, in which it is composed of several axes of methodological evaluation, however, it was adapted for this research, with two axes and their respective subdivisions, the first: Axis 1 Profile of productions, Axis 2 Results in evidence.

For content data analysis proposed by Bardin, which encompasses 3 phases: 1) pre-analysis, which is the organization of the preconceived idea and establishes direction for the interpretation of collected information; 2) Exploration of the material, where it categorizes information from texts, interviews, allocating, for example, in paragraphs according to related topics and 3) Treatment of results, inference and interpretation, consisting of interpreting and mastering all the content collected (BARDIN , 2016).

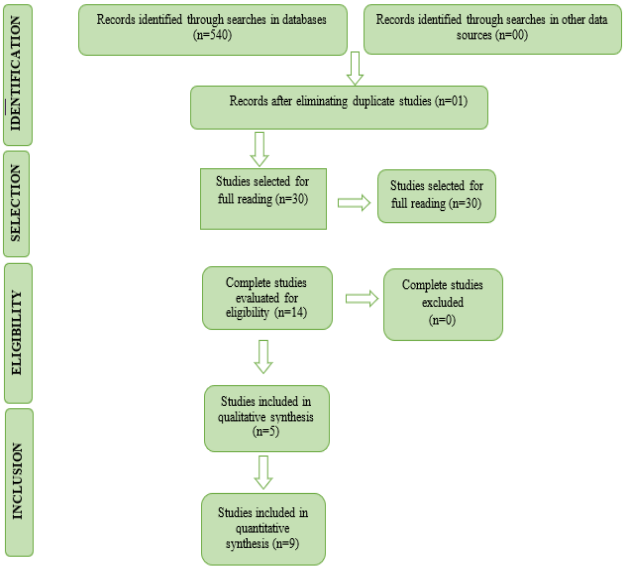


Fig.1: Flowchart on the study selection procedure, identification and eligibility for analysis. Belém-PA, Brazil, 2021.

III. RESULTS AND DISCUSSIONS

As shown in Table 1, 14 articles were selected, predominantly in English (92.85%), with quantitative, qualitative, observational, systematic, analytical, cohort and descriptive methods; published in the period from 2020 to 2014, no articles from the year 2021 were found with the descriptors used; in national and international journals and mostly indexed in Medline.

Table 1. Identification of articles selected for analysis, by title, year, place of study and main results. Belém (PA), Brazil, 2021.

Title	Year/Author	Year/Author	Main results
Tuberculosis: knowledge and adherence to prophylactic measures in contact individuals in the city of Recife, Pernambuco, Brazil	TEIXEIRA AQ et al (2020)	Quantitative, descriptive/LILACS	In this study, it was found that tuberculosis contacts have little or no knowledge about the disease, low adherence to primary health care and the active search for contacts is still inefficient. It was also analyzed that some of the TB contacts are unaware of the form of transmission of tuberculosis and

			the need to be evaluated and to carry out the requested tests.
MDR/XDR-TB management of patients and contacts: Challenges facing the new decade. The 2020 clinical up date by the Global Tuberculosis Network	MIGLIORIA et al (2020)	Non-systematic literature/MEDLINE	This study talks about the importance of eliminating the challenges in the fight against tuberculosis, especially in cases of multidrug-resistant tuberculosis. The review also comprehensively describes the latest information on contact tracing and management of LTBI in MDR-TB contacts, while providing guidance on post-treatment functional assessment and rehabilitation of TB sequelae, infections and other public health priorities.
Is the EU model for contact investigation applicable to high TB burden settings?	ZELLWEGER JP (2020).	Quantitative/MEDLINE	This study shows that it is possible and important to carry out contact investigation of patients with a transmissible form of tuberculosis. Early diagnosis allows for a shorter treatment, preventing the transmission of the disease. Implementation of preventive therapy for people at higher risk of developing TB in the future, that is, reducing the pool of future TB cases.
Knowledge, attitudes and practices on tuberculosis transmission and prevention among auxiliary healthcare professionals in three Brazilian high-burden cities: a cross-sectional survey	TRAJMAN et al, (2019).	Cross-sectional, quantitative/MEDLINE	A study showed that knowledge among auxiliary health professionals about the transmission and prevention of tuberculosis presents relevant gaps. These knowledge gaps were notably related to the management of LTBI, including how to recognize it and prevent progression to active tuberculosis through treatment.
Acceptance of Chemo-prophylaxis for Latent Tuberculosis Infection among High School/College Student Contacts of Tuberculosis Patients in Shanghai, China	LI Yang et al, (2018).	Cross-sectional study/MEDLINE	The present study aims to evaluate the contacts of students with tuberculosis and the level of knowledge about TB and their availability to participate in LTBI chemoprophylaxis.

Close contact interferon-gamma response to the new PstS1(285–374): CPF10: a preliminary 1-year follow-up study	ARAÚJO LS et al, (2017).	Analytical Study/MEDLINE	This study aimed to perform a one-year follow-up on recruits in the city of Rio de Janeiro, and as a result, they obtained low IFN-g reactivity to all antigen stimuli during the entire follow-up period, except for one participant.
Knowledge about tuberculosis transmission and prevention and perceptions of health service utilization among index cases and contacts in Brazil: Understanding losses in the latent tuberculosis cascade of care	SALAMEL FM et al, (2017).	Observational cross-sectional study/MEDLINE	The present study excelled in unraveling what is called the cascade of contacts and what are the steps for losses to occur, as well as evaluating the degree of knowledge of these contacts about care and transmission.
Improving tuberculosis contact tracing: the role of evaluations in the home and workplace	DUARTE R; NETO M; BARROS H, (2012).	Analytical comparative study/MEDLINE	The present study highlights the importance of tracing TB contacts, and people who have recently acquired the disease, in order to eliminate the disease. They perform a comparison of screening data that reveal that there is a greater decrease in severe cases if there is early screening.
Tuberculosis clinical units improve contacttracing	BRUGUERAS et al, (2016).	Observational Study/MEDLINE	This study evaluates the impact of the clinical picture of tuberculosis in units that trace TB contacts. Where it was observed that the creation of clinical units managed to track a greater number of contacts and significantly increased the number of adherence to treatment. Therefore, they concluded that there was an organizational advance in this screening, and adherence to early treatment of TB contacts.
Tuberculosis Contact Investigations United States, 2003-2012.	KAI H YOUNG, et al (2016)	Observational cross-sectional study/MEDLINE	This study evaluates improving contact investigation activities to ensure completion of treatment for contacts recently infected with *M. tuberculosis*, which is essential to achieve the goal of eliminating TB.

Risk Assessment of Tuberculosis in Contacts by IFN-Î³ Release Assays. A Tuberculosis Network European Trials Group Study.	JEAN-PIERRE ZELLWEGER et al (2015)	Descriptive cross-sectional study/MEDLINE	The present study analyzes the results of the IGRA and the effect of preventive chemotherapy on tuberculosis progression rates in recent contacts.
Age-specific risks of tuberculosis infection from househ old and Community exposures and opportunities for interventions in a high-burden setting	JONATHAN L. ZELNER et al. (2014)	Analytical study/MEDLINE	This study presents a new approach to estimating age-specific infection risks (ROI) from household and community sources in Lima, Peru.
Yield of tuberculosis contact investigations in Amsterdam: opportunities for improvement.	ROSA SLOOT et al (2014)	Observational study/MEDLINE	The present study determines contact investigation coverage and throughput, assesses compliance with guidelines, and identifies opportunities for improvement.
Risk for tuberculosis in child contacts. Development and validation of a predictive score.	PEI-CHUN CHAN et al (2014)	Cohort Study/MEDLINE	This study aims to develop and validate a simple and easy-to-use predictive score for TB risk using data routinely available during contact investigation.

The literature review revealed that it is possible to formulate three categories from relevant points of view. Thus, the following categories were developed: Knowledge of contacts about what the disease is, care and transmission; The importance of contact tracing; Role of health professionals on tuberculosis transmission.

Category 1: Knowledge of TB contacts about the disease, care and transmission.

Tuberculosis, the second (after COVID-19) deadliest infectious killer, is caused by a bacterium called Mycobacterium tuberculosis and most often affects the lungs and can be transmitted through coughing, talking and sneezing by the infected person, or that is, those who have a bacillus in their saliva (PAHO, 2021).

The pulmonary form, in addition to being more frequent, is also the most relevant for public health, especially the positive one on smear microscopy, as it is primarily responsible for maintaining the disease transmission chain. It is emphasized that the extrapulmonary form, which affects other organs, occurs more frequently in people living with the Human Immunodeficiency Virus (HIV), especially among those with immune compromise (CARVALHO, PONCE, SILVA-SOBRINHO et al, 2018).

According to Brasil (2019) the main way to control tuberculosis is the diagnosis and immediate start of treatment, because when starting treatment, transmission tends to decrease gradually and, in general, after fifteen days of treatment, it is very reduced, allowing the chain of transmission of the disease to be broken. However, the MS recommends that control measures be implemented until the smear test is negative, such as covering the mouth with the arm or tissue when coughing and keeping the environment well ventilated, with plenty of natural light, as the bacillus is sensitive to light. sunlight and air circulation allows the dispersion of infectious particles. Therefore, ventilated environments and direct natural light have been shown to reduce the risk of transmission.

In general, the contacts of TB cases report that they know that the disease is serious, that it has a cure and treatment, however, they are unaware of the form of

transmission and the symptoms, which shows that knowledge about TB is insufficient, even if there is someone in the family with the disease. Thus, information about TB becomes indispensable for the recovery of knowledge about the health-disease process in order to reduce social issues and demystify the disease. It can even influence the most common consultations and attitudes of contacts of TB patients and the investigation of obstacles that distance them from prophylactics (TOURINHO, OLIVEIRA, SILVA AL, 2020).

The research by Tourinho, Oliveira, Silva et al (2020) also points out that TB contacts are unaware of the way TB is transmitted, and the need to disseminate and carry out the requested medicines because they are inserted in inequities, often, possibly empowering them. the possible problems, more conscious for the early detection of cases, as well as for the disease, in the process and reduction of the incidence of the disease by in the transmission of the transmission of the early disease.

Linked to the fact of having knowledge about the community, it can impact the results and support the control of the disease, considering that the actions and references to the grievance refer to the power held by society and early identification of the signs and symptoms of tuberculosis, as well as the power of attorney for health services to carry out disease prevention. Society becomes an ally in the awareness process and also needs to be aware of and access to public health services. Thus, health education and guidelines on tuberculosis prevention are essential to achieve disease control objectives and strategies (CARVALHO, PONCE, SILVA-SOBRINHO et al, 2018).

Category 2: The importance of contact tracing.

TB cases initially identified as new or recurrent, in a person of any age, in a specific household, are considered an index case. The importance of rapid diagnosis and early treatment of the index case is perceived, and this should be investigated to identify the people who will be considered contacts, that is, those who have contact with the case (SILVA, LIMA, SANTOS et al, 2018; SILVA et al, 2021).

In this way, information about contacts and the type of relationship established should be listed and, whenever possible, home visits should be carried out to better understand the circumstances and invite them to come to the Health Unit to be evaluated and, if If necessary, request tests such as chest radiography, smear and tuberculin skin test (PT) with PPD (Purified Protein Derivative) or Interferon-Gamma Release Assays (IGRA) (TEIXEIRA, et al, 2020).

It should be noted that for the control of tuberculosis, it is essential to interrupt the chain of transmission of the disease, since each person with undiagnosed pulmonary TB tends to infect 10 to 15 people/year, and of these, one to two become ill, maintaining transmission and disease at an endemic level (GUIMARÃES, 2017).

It is confirmed that the individual with Active Pulmonary Tuberculosis, when coughing, sneezing or talking, releases droplets (Pflüger droplets) that transport the bacilli to the environment, the smaller these droplets (Wells nuclei), the longer they remain in the air, and, therefore, the greater the possibility that they are aspirated, inhaled and infect other people (SILVA, et al, 2018).

Although TB is a curable disease, available free of charge in the Unified Health System (SUS), Brazil is among the 30 countries with the highest TB burden in the world, due to the unstructured health system, restricting access to health services. population, unplanned urbanization, unhealthy practices and environments. Since 2010, the PNCT has recommended that tuberculosis contacts be monitored. Controlling the contacts of TB cases is a strategy for preventing future illness (SILVA, et al, 2018; FIGUEIREDO JÚNIOR, SÁ, 2019).

Contacts who are no longer monitored and/or evaluated represent an important factor for the maintenance of TB, as they are more susceptible to developing the active disease in the future, perpetuating the disease transmission chain (FIGUEIREDO JÚNIOR, SÁ, 2019; MENDES, 2018) .

In this way, the contacts of the TB index case must be examined for the symptoms of the disease and/or the Tuberculin Test (PT) should be performed, this test evaluates the cellular immune response in vivo against the antigenic extract of Mycobacterium tuberculosis; and/or IGRA, an exam being implemented in the SUS, which also evaluates the cellular immune response, albeit in vitro. For those with TB symptoms, specific tests such as sputum smear, rapid molecular test (MRT) or culture should be performed; users who are asymptomatic should perform PT and chest X-ray. Those who are asymptomatic, PT or IGRA positive and without signs of active TB on chest radiograph, treatment for Latent Tuberculosis Infection (LTBI) is recommended (CASELA, 2020; SILVA, et al, 2018; BRAZIL, 2019).

Individuals who live with TB carriers have a high risk of infection and disease progression, especially when this interaction is intense and/or continuous (MENDES, 2018). According to the study by Figueiredo Júnior and Sá (2019), who evaluated 1000 medical records of TB contacts, the most frequent type of interaction between contacts and patients with active TB was continuous (n = 915), in addition to representing the largest positive PT frequency (52.80%), with the “Father/Mother” group presenting the highest frequency of positive PT with 64.90%, followed by the “Spouse (a)” group with a positive PT frequency of 57.40% .

Given the above, screening for Latent Tuberculosis Infection (LTBI) is recommended for all contacts of infected patients, regardless of age or comorbidity. LTBI is the period between the first contact with the bacillus and the development of active TB, that is, the individual is infected by the TB bacillus, but without manifestation of the active disease. The detection of LTBI for the World Health Organization (WHO) means a strategy for the control of TB, as the detection of latent infection allows the initiation of drug treatment, preventing progression to active disease (SILVA et al, 2021; FIGUEIREDO JÚNIOR, SA, 2019).

According to Dantas et al (2018), the vast majority of TB contacts identified with LTBI were never investigated, and there are losses that occur mainly in the first stages, which are: identification and investigation. It was noticed that there are many reports of active TB cases, but they could be avoided in Brazil if all contacts were investigated. It also states that the contacts would like to have been investigated and would undergo treatment for LTBI if prescribed, which represents, in this case, a missed opportunity.

It is understood the question of why, that there are few contacts investigated in Brazil, one of the main reasons is the lack of close relations between the health team and the patient, with this it is necessary to train health professionals about their attitudes. and health practices together with the TB patient (DANTAS et al, 2018).

Category 3: Role of health professionals on tuberculosis transmission.

TB has a prevention method, through the treatment of LTBI that is available in the SUS and which makes most deaths from the disease avoidable. According to Trajman et al (2019), a quarter of the world population has LTBI, which constitutes a reservoir for new TB cases and that contact tracing of index TB cases is an important task of Primary Health Care services (APS).

Less than 10% of people who need treatment for LTBI received the proper diagnosis, as obstacles to accessing health care, attitudes, practices on TB transmission/prevention, knowledge and beliefs are among the possible explanations for losses in the cascade. of contact care. This fact makes it difficult to adequately control the disease (TRAJMAN et al, 2019).

To date, there is no exam considered the gold standard for the diagnosis of LTBI, which is based not only on the result of a diagnostic test, but also on the exclusion of the active form of the disease, as well as, the PT has limitations such as the need of return of the patient to the health establishment to carry out the reading, low sensitivity, especially in immunocompromised individuals, low specificity, due to the possibility of a false positive result in populations that have broad vaccination coverage with BCG, as well as cross-reaction with atypical mycobacteria (SILVA et al, 2020; CASTILE, 2020).

Thus, the role of PHC is highlighted, considered the main gateway to health services in Brazil, and decentralizing the PNCT's health actions to it. The Family Health Strategy (ESF) covers two-thirds of the Brazilian population and is the largest public health system in the world. It is noteworthy that ESF coverage has significant results that are associated with successful treatment of active TB. It is emphasized that the ESF, the Community Health Agents (ACS), are auxiliary workers who live in the community and are trained for health tasks and responsible for home visits, being able to detect those individuals with respiratory symptoms, observe and directly administer the treatment of TB and convening the presence of TB contacts for evaluation in the FHS (GUIMARÃES, 2017).

The increase in FHS coverage and the development of actions for active search, control and treatment of TB, combined with improvements in the laboratory network and the implementation of rapid diagnostic methods, it is possible to visualize a favorable scenario for the improvement of the current epidemiological situation of the disease. (GUIMARÃES, 2017).

Health teams, with the support of auxiliary workers, have a very important role with the patient for the control of TB in Brazil, because by adopting the necessary measures, they create a bond and increase the probability of cure. It is stated that the nurse must be a professional qualified for TB control actions, in order to identify clinical, epidemiological and social information of the disease suspects and take steps to clarify the diagnosis (GUIMARÃES, 2017).

IV. CONCLUSION

The evaluation of tuberculosis contacts is an important strategy for the control of TB, because through it, it is possible to prevent new cases of active TB from happening, controlling and breaking the chain of transmission of the disease, being used for this purpose the investigation of symptomatic patients. respiratory diseases, the performance and evaluation of PT and/or IGRA and the treatment of LTBI, as the main form of prevention of active TB.

It is noteworthy that the contacts who have contact with the TB case are more susceptible to infection by the bacillus, so it is imperative to perform the LTBI screening and start preventive treatment, but there are still some barriers to the implementation of this strategy such as the difficulty in diagnosing LTBI, the awareness of the population to take the contacts in the health services for the evaluation of the contacts, as well as the feedback in the reading of the PT.

Thus, there is a need to carry out health education actions with professionals to answer questions, explain about the disease and the main forms of prevention, raise awareness of the importance of evaluating contacts and train for the application and reading of the tuberculin skin test and initiation of LTBI treatment. It is considered that the health professional has a huge responsibility to this public, and to the community in general, and it is necessary to always be seeking new knowledge in order to improve their health practices and ensure that their professional attitudes towards contacts make it possible to optimize identification. and investigation of TB contacts.

It is also imperative to empower the community with knowledge about TB and the forms and strategies of disease control so that they work together with health professionals in the actions of investigation of cases of the disease and in the evaluation of contacts, looking for the service and professionals of health for the specific exams.

REFERENCES

[1] Bardin, L. (2016). Análise de conteúdo. Traduzido por Luís Antero Reto, Augusto Pinheiro. São Paulo, 70ª ed.

[2] Brasil (2019). Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de Vigilância das Doenças Transmissíveis. Manual de Recomendações para o Controle da Tuberculose no Brasil. Brasília: Ministério da Saúde, 364 p.

[3] Brito, B.R.S., Pires, C.A.A. (2020). Vigilância e cuidado em tuberculose: uma experiência de aspectos da doença no território de uma Equipe de Saúde da Família em Ananindeua, Pará. Saúde em Redes, 6 (2), 243¬248.

[4] Casela, M. (2020). Comparation of the interferon gamma release assay and tuberculin skin test for diagnosis of latent tuberculosis in health professionals at a tertiary tuberculosis reference center, State of Bahia. Rev. Ciênc. Méd. Biol., 19(1): 49-53.

[5] Carvalho, C.F., Ponce, M.A.Z., Silva-Sobrinho, R.A., Mendez, R.D.R, Santos, M.A., Santos, E. M., Wysocki, A. D. (2018). Tuberculosis: knowledge among nursing undergraduate students. Rev Bras Enferm, 72(5), 1279-87

[6] Dantas, D.N.A., Enders, B.C., Oliveira, D.R.C., Vieira, C. E. N. K., Queiroz, A. A. R., Arcêncio, R. A. (2018). Fatores associados ao atraso na procura por atendimento pelo doente de tuberculose. Rev Bras Enferm, 71(Supl 1), 646-51

[7] Figueiredo Júnior, A. M., Sá, A. M. M. (2019). Prevalence of latent tuberculous infection in communicants of patients with pulmonary tuberculosis. REAS/EJCH, 30

[8] Guimarães, M. H. D (2017). Tuberculose: Uma Reflexão Sobre o Papel do Enfermeiro na Saúde Pública. Revista Científica Multidisciplinar Núcleo do Conhecimento, 15, 54-62

[9] Lima, L.M., Schwartz, E., Cardozo Gonzáles, R.I., Harter, J. Lima, J. F. (2013). O programa de controle da tuberculose em Pelotas/RS, Brasil: investigação de contatos intradomiciliares. Rev Gaúcha Enferm, 34(2), 102-110.

[10] Marconi, M.A., Lakatos, E.M. (2017). Fundamentos de metodologia cientifica. 8ª ed. São Paulo, Editora Atlas.

[11] Silva, A.H., Fossá, M.I.T. (2015) Análise de conteúdo: exemplo de aplicação da técnica para análise de dados qualitativos. Qualitas Revista Eletrônica, 17 (1), p.1-14.

[12] Mendes, M. J. F., Rodrigues, J. P., Cruz Neto, M. S., Camargo, J. H., Oliveira, E., Sá, A. M. M. (2018). Enferm. Foco, 9(1), 19-24.

[13] OPAS (2021). Mortes por tuberculose aumentam pela primeira vez em mais de uma década devido à pandemia de COVID-19. https://www.paho.org/pt/noticias/14-10-2021-mortes-por-tuberculose-aumentam-pela-primeira-vez-em-mais-uma-decada-devido

[14] Silva, D.R., Mello, F.C.Q., Migliori, G.B. (2020). Série Tuberculose 2020. J. bras. Pneumol. São Paulo, 46 (2)

[15] Silva, D. R., Rabahi, M. F., Sant'Anna, C. C., Silva-Junior, J. L. R., Capone, D., Bombarda, S., Miranda, S. S., Rocha, J.L., Dalcolmo, M. M. P., Rick, M. F., Santos, A. P., Dalcin, P. T. R., Galvão, T. S., Mello, F. C. Q. (2021). Consenso sobre o diagnóstico da tuberculose da Sociedade Brasileira de Pneumologia e Tisiologia. J Bras Pneumol, 47(2).

[16] Silva, M.E.N., Lima, D.S., Santos, J.E., Monteiro, A. C. F., Torquato, C. M. M., Freire, V. A., Ribeiro, D. B. C., Feitosa, A. C. S., Teixeira, A. B. (2018). Aspectos gerais da tuberculose: uma atualização sobre o agente etiológico e o tratamento. Revista Brasileira de Análises Clínicas (RBAC), 50 (3), 228-32.

[17] Soares, H.B.M., Coelho, I.M., Monteiro, S.H.C, Araújo, A. S. S., Rocha, F. C. V. (2016). Avaliação dos contatos de tuberculose na estratégia saúde da família pelos enfermeiros. Rev Enferm UFPI, 5 (1), 52-59.

[18] Távora, M.M., Rodrigues, I. L. A. R., Nogueira, L. M. V.; Silva, F. O. (2021). Percepções de enfermeiros e doentes sobre a adesão ao tratamento diretamente observado em tuberculose. Cogitare enferm. v. 26.

[19] Teixeira, A.Q., Samico, I. C., Martins, A. B., Galindo, J. M., Montenegro, R. A., Schindle, H. C. (2020). Tuberculose: conhecimento e adesão às medidas profiláticas em indivíduos contatos da cidade do Recife, Pernambuco, Brasil. Cad. saúde colet, 28 (1), 116-129.

[20] Tourinho, B.D., Oliveira, P.B., Silva, G.D.M., Rocha, M. S., Penna, E. Q. A. A., Pércio, J. Evaluación del Sistema de Vigilancia de la Tuberculosis Drogorresistente, Brasil, 2013-2017. Epidemiol. Serv. Saúde, 29 (1).

[21] Trajman, A., Wakoff-Pereira, M.F., Ramos-Silva, J., Cordeiro-Santos, M., Militão de Albuquerque, M.F., Hill, P.C., Menzies, D. (2019). Knowledge, attitudes and practices on tuberculosis transmission and prevention among auxiliary healthcare professionals in three Brazilian high-burden cities: A cross-sectional survey. BMC Health Services Research, 19 (1), p. 1–8WHO, World Health Organization (2021). Global tuberculosis report 2021. Geneva: WHO.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.18

Student Satisfaction: Analysis of the Equity students and student satisfaction at the Higher education- Implementation of Relevant Education

Maria Erilucia Cruz Macedo

Administrator, Specialist in Project Management, Controlling and Organizational Strategy, UNIVS - Vale do Salgado University Center

Received: 21 Apr 2022,

Received in revised form: 12 May 2022,

Accepted: 18 May 2022,

Available online: 24 May 2022

***Keywords*— Business Law, Student satisfaction, Equity students, Equal student treatment.**

***Abstract*—** *This study's objective was to investigate the connections between staff perceptions of equality and the levels of student contentment at private institutions in the Kurdistan area of Iraq. Specifically, the researchers were interested in the following: In order to collect data, a face-to-face survey was administered to 119 students from five private institutions located in the Kurdistan region of Iraq. According to the findings, there is a significant and favorable relationship between affirmative action and student satisfaction at private universities in the Kurdistan region of Iraq. On the other hand, there is no significant and favorable relationship between embracing diversity and student satisfaction at these universities.*

I. INTRODUCTION

For several decades, the level of satisfaction felt by students has been a recurrent concern in the academic world. The awareness of this feature has extended throughout the academic fields, with ideas coming from psychologists, organizations, corporate law, administration, and, more recently, managers. Managers and industrial globalization, in addition to involvement in businesses and their surroundings, have sparked a renewed interest in gaining a better knowledge of how students are pleased or inspired, as well as the multifaceted relationships that exist between satisfaction and equity students. This interest has been sparked by the fact that managers and globalization of industry are now more prevalent (Khan & Abdullah, 2019).

The mindset that an students brings to their work is frequently cited as the primary contributor to overall student satisfaction. Studies have shown that a significant influence in a wide variety of serious positive and poor employment outcomes is the level of pleasure a student has with their educational experience. The level of pleasure experienced by students has been shown to have an inverse relationship with unfavorable job outcomes like students turnover, but a positive association with work outcomes like increased productivity (Sohail & Dhuha, 2020).

Take into account the level of worker satisfaction and attitude toward the obligations and tasks that have been assigned to them, as well as the level of justice and fairness that exists between them (Darbandi, 2017). This will make it easier for corporate directors to successfully carry out the cooperative responsibilities and commitments that they are responsible for. A student's level of satisfaction can be defined as the sum of the good and negative feelings they have toward the many obligations and responsibilities they are responsible for. When an students begins working for an organization, they bring with them the requirements, desires, and knowledge that control the prospects and potential that the students has discharged. These can be thought of as the "requirements, desires, and knowledge that control the prospects and

potential that the students has discharged (Mahmood et al. 2022)." According to Hassan & Ahmed, (2020), the level of student satisfaction is a reflection of the degree to which expectations are matched with and match the actual rewards. The majority of the time in the modern world, higher-level students are unhappy with their work as a direct result of their negative attitude toward their jobs. This, in turn, has an effect on the entire performance of the company. Those who have a sense that their employer treats them fairly are more likely to be satisfied with their occupations, to experience less of a sense of urgency to find other work, and to be more dedicated to the work that they do (Sadq et al. 2020). Despite this, it's possible that the pupils' perception of themselves as unequal contributes to their discontent and bad attitude. This suggests that the performance of a worker could be evaluated based on the level of student satisfaction that he or she generates, which will serve as a signal on the worker's attitude toward justice and fairness. According to Othman et al. (2020), pleasurable experiences such as satisfaction will lead to higher performance. This is particularly true when performance is regarded as being more than merely duty performance. It is also important to highlight that a good salary, a pleasant working environment, and a level playing field for all students can all contribute to a positive work attitude, and their combination will influence students performance in the business. It is also important to highlight that a level playing field for all students can contribute to a level playing field for all students (Rashid, 2022).

II. LITERATURE REVIEW

Equity students

Equity students has recently garnered more attention from human resource professionals, particularly in terms of the justice of penalties. Equity students, or more properly, inequity students, is a key issue of business, labor, and government. The fairness of the disagreement between the students and the corporation is not typically viewed by the students as solely a commercial matter(Abdalla Hamza, et al. 2021), but a component of comparative justice is involved. Equity This may be applicable to any social scenario in which an exchange happens, such as between a married couple, basketball players, or a worker and a boss. When two individuals exchange something, one or both of them may consider that the exchange was inequitable. This is typically the case when a person swaps his or her services for payment (Sultan, 2021).

According to Ahmed & Mohammed, (2018), a worker will associate his or her proportion of the benefits he or she receives from working for a business or company to the inputs the students contributes to the company, as well as a similar proportion for others both internal and external to the company. According to Wu et al. (2022), a worker would want to preserve parity between the alleged inputs that he or she gives to a higher education and the alleged outputs that he receives from it, in contrast to the perceived inputs and results of others. According to the theory, an individual would feel demotivated if he views unjust treatment of others, both internal and external to the company that employs him (Aziz, 2016). Furthermore, Mardan & Ahmed, (2017) assert that a worker would experience an equitable condition if he sees the percentage of his inputs to his outputs to be equal to those internal and external to the company for which he works. If a comparable worker generates more output and this comparable worker puts in more effort, the worker will receive it. For example, if everything else is equal, a worker would earn a lesser compensation while another individual with more experience obtains a greater income. According to Bourdage et al. (2018), inputs comprise all of a member's contributions to the interpersonal transaction and are considered as "entitling him to benefits or expenses." Time, effort, loyalty, qualifications, flexibility, tolerance, devotion, enthusiasm, personal sacrifice, and other elements are common inputs. Outputs contain all of a member's interactions with the firm that employs him. The typical results include the presence of certain hygiene-related factors and motivators. Anguish in the form of fury or shame will be experienced by the worker if it is brought to his attention that his percentage is lower than that of the individual being compared. In the same vein, if the worker realizes that his percentage is higher than the percentage of the individual serving as a comparison, he will feel the ache of anguish in the form of guilt. There is a correlation between the worker's anxiety and their sense that they are being treated unfairly. As a consequence of this, the worker will feel more grief as the apparent imbalance increases, and he will make greater efforts to restore equity among students (Wang, 2018). These efforts can take the form of cognitive distortion, in which the worker intentionally misrepresents inputs and/or outcomes in his own mind, direct changes to inputs and/or outcomes, or resignation from the organization (Han, et al. 2018).

Antecedents of inequity students

According to Ross and Kapitan (2018), the focus of the theory is on the exchange association, which describes the situation in which individuals give something and anticipate receiving something in return. Inputs are generally understood to relate to the information that is given by the individual. What the individual ends up with after the transaction is completed is referred to as the result. This is the "other hand" of the trade. A third aspect,

known as the situation individual or cluster, is considered to be important in addition to the inputs and outputs of the system. This scenario group can include a coworker, a member of the family, a neighbor, or even a group of people from work. It's even possible that the person in question is themselves, but in a different occupation or social role.

If a person considers any of these to be information, then it is information, and the person who provided it anticipates a simple return in exchange for it. The issue emerges when just the representative views a certain piece of information rather than the firm as a whole. In this scenario, a sense of guilt is experienced; for instance, a corporation may base his promotion on rank rather than advancement; the student "feels" that there has been some kind of unethical behavior on the part of the school (Cheng, et al. 2018). The manner in which an individual understands the connection between the data sources they use and the results that they produce is the primary factor in determining whether or not they believe a social trade is discriminatory. When an individual not only sees other inputs offset with the outcomes that they themselves have produced, but also sees their own sources of knowledge offset with the outcomes that other individuals have produced, then that individual is in a condition of perceived worth (Elmada, et al.2018). The value hypothesis acknowledges that even if an individual's data sources and outcomes do not change, the individual will still feel that they have been treated fairly even if it is thought that the other party does not have data sources and outcomes that are equal to their own (Wang, et al., 2018). inequality in the outcomes for pupils According to the findings of Audenaert et al. (2018), poor etiquette will result in disappointment, fury, and blame. People will feel anger and dissatisfaction if they receive less than they anticipated in proportion to what they anticipated receiving, and they will feel sorrow if they obtain more than they are worth. Adams names this "blame" when there is enough compensation, but he labels it "outrage" when there is insufficient compensation (disadvantageous disparity). It is typical for this rage to be directed towards the individuals and groups who were responsible for creating the imbalance; nevertheless, it is possible for it to be directed at the individual themselves if no other group is focused on disciplining or resisting it. As a consequence of this, Bourdage et al. (2018) postulated that individuals are motivated to strive toward eliminating visual disparity because it makes them feel unwelcome and that the level of incentive to do so correlates directly with the degree of disparity that is perceived. As a consequence of this, Adams provided a presentation in which he discussed a few ideas that he termed "methods for disparity reduction." These are the many approaches: 1) An individual who modifies the contributions he makes: An individual may choose to expand or decrease the number of information sources he uses as a response to a perceived imbalance, depending on whether or not the individual views the discrepancy as helpful. The person may either build his own data sources, such as efficiency or even the type of work, or he can limit the amount of data. Components such as instruction and skill level are able to be adjusted more effectively, however traits such as gender, color, and ethnic foundation are not possible to be transformed. Adams has two suspicions that he wants to express: a) The limit for the observation 8 of disparity is larger when an individual is overpaid as opposed to when the individual is underpaid. (a) It is a given that a person wants to cut their costs while simultaneously raising the amount that they provide, and this motivation is expected. In the second scenario, an individual will take action to eliminate inequity, which will lead to the most severe consequences for the person whose rights are being violated. 2) The individual altering his results: An individual has the ability to change his results by either raising or lowering them, depending on whether or not the value is beneficial. Either expanding the number of outcomes or cutting down on the number of information sources is one way for individuals to bring about a reduction in inequality. 3) An individual who subjectively modifies the information sources and results he uses: it is rationally conceivable to transfer from one reference group or individual to the next while still being physically involved in a comparable vital trade connection (Iglesias, et al., 2018). Adjusting the correlation item is one method that can be used to reduce the amount of inequality that exists in the world. If a worker believes that he or she is being underpaid, a thought that may strike a chord is that the amount of money the worker in question is making is more than what his or her father made at this age or what his or her colleagues in various industries make. There is a possibility that some individuals will find employment elsewhere. 4) An individual leaving the field: In the context of a job scenario, an individual may cease their activities, receive an exchange, or suffer increased truancy. 5) Person who is following up on another: even when deceit is present, a person may still attempt to manipulate or psychologically twist other data sources and results, or to drive others off of the field of play. If one individual has a lower participation rate than others, the individual in question may endeavor to decrease the contributions made by the other individuals rather than expanding his or her knowledge sources. 6) The person may alter "the examination other" with whom the individual in question analyzes oneself in the event that the individual experiences disparity and the individual in question and

"correlation other" continue to be in a trade relationship with an outsider. Because of this, the severity of the imbalance would be reduced. For instance, if two experts are performing the same task but one of them is making a considerably larger wage, they can be pleased with the situation since the person who is earning the higher wage might have more education, capabilities, experience, and rank (higher data sources). To put it more simply, inspections are created based on the nature of the result input proportions of the comparer and the correlation individual. This correlation may satisfy and be declared not to be biased, depending on the circumstances. 7) Alternatives to conventional approaches to conflict resolution: Every tactic that has been used in the past is up for scrutiny by all participants. Adams proposed a handful of factors that, together, establish an individual's modes.

A) The significance of the person's impact on the results would be greatly heightened.

B) They establish limitations on the expansion of inputs that are difficult to replace and expensive to do so. C) He or she will disregard genuine and psychological shifts in information sources that are vital to his sense of self-image and self-assurance.

D) When it comes to modifying perceptions of other people's outcomes and sources of information, he or she will be more resistant to change than when it comes to shifting perceptions of his or her own results and contributions.

The generation of imbalance was employed as a precursor condition, and methods for minimizing disparity were used as a required variable in the study. Take, for instance, the phrase "a laborer was short on": (Wang, 2018). It was demonstrated that a comprehensive research of the value hypothesis had been conducted in order to offer a complete hypothetical and practical understanding of the hypothesis. In the pages that are to come, we are going to look at the compensation result variable and all of the many connections that are associated with it in great detail.

Equity students in higher education Affirmative action

When it comes to minorities in society, institutional racism is a strategy in which a person's skin tone, color, gender, religion, or national origin are taken into account in order to broaden the opportunities given to an underrepresented segment of society. This is done in order to broaden the opportunities given to an underrepresented segment of society. Affirmative action for minorities in society programs are carried out by organizations and government components in order to enhance the percentage of individuals from particular groups who are employed by organizations, institutions, and other parts of society. This technique places an emphasis on socioeconomic groups who have, historically speaking, been underrepresented in domains such as initiative, skilled vocations, and academics. In most cases, this tactic is seen as as a method of addressing recorded victimization particular meetings. Affirmative action has been used in an effort to achieve a number of societal goals, including reducing economic and employment disparities, increasing access to educational opportunities, fostering a more diverse population, and rectifying evident wrongs, damages, or disincentives from the past. A variety of interpretations of the notion of affirmative action for underrepresented groups may be found across the country. Only a few nations still adhere to the time-honored practice of reserving a particular percentage of available employment in the public sector, political offices, and academic posts for members of a specific community or ethnicity. In some other locations where shares are not utilised, individuals who are a part of the minority gathering are given inclination or exceptional thought in the shape of determination. Affirmative action for societal minorities is considered to be in violation of the law in certain nations, such as the United Kingdom, due to the fact that it does not treat people of all races in the same manner. The term "partially blind" refers to this method of dealing with conditions that require the same therapy (Han, et al. 2018).

In nations like this, the primary focus will often be on ensuring that all aspects of the situation are equalized, including, for instance, directed supporting attempts to attract candidates from ethnic minority groups to join the police force. This is what some people mean when they talk about "positive activity." In the United States of America, racial segregation is against the law—except when it is. Techniques known as "affirmative action for minorities in society," which include separating individuals who belong to persecuted groups, are widely used in the United States of America as well as in numerous other nations. Pundits, including a significant number of those who supported the action at Harvard, say that they ought to be prohibited (Sharma et al. 2022). The United States Supreme Court has issued inconsistent directions on the question of whether or not it is permissible to take affirmative action on behalf of societal minorities, which has led to an increase in the level of confusion. The expression, on its own, lacks clarity. In the year 1965, the President of the United States, Lyndon B. Johnson, made an official request to government businesses, requesting them to take "affirmation action for minorities in society" and to "contract without regard to race, religion, or national birthplace." Since that time, the term has grown to mean essentially the reverse, which is giving preference to persons according to factors such as their ethnicity, religion, social position, or gender.

Individuals from certain groups who have been separated in the past or who are now being separated receive special treatment or benefits from the state in a number of different nations (Sharma & Kumar, 2021). People of color who come from nations that were formerly oppressive can now find chances in countries that have developed economies (Ibrahim et al. 2020). There is a sizeable population of individuals in India who are considered "untouchables" because of their position at the bottom of the Hindu social order (Sabir et al. 2021). In a few countries, there is an affirmative action program for members of minority groups in society. This program is intended for those who come from groups that, on the whole, have it worse than their neighbors, regardless of whether or not their neighbors have typically been unkind to them. Positive segregation, for instance (Khan, 2021), is practiced in Malaysia for native Malays, who suffer greater levels of misfortune and perform less well in school than their white counterparts.

Men of the same blood from China (Mohammed et al. 2018) and India (Rahmani et al. 2019). There are subtle differences depending on where you are. In certain nations, the practice of providing preferential treatment to members of societal groups who are underrepresented is restricted to spheres in which the government has direct authority, such as open employment contracts or entry to open institutions (Nithyanantham et al. 2019). In certain jurisdictions, private businesses are also required to conduct racial profiling of their employees (Sharma et al. 2022), including students (Ahmed et al. 2021), temporary workers, and even owners (Sharma et al. 2020). Advocates of positive separation typically argue that such agreements are required in order to face previously documented instances of negative behavior (Saleh & Jamil, 2021). Some people attributed the following statement to former President Lyndon B. Johnson: "You don't take a man who has been hampered by chains for a long time, release him, bring him to the starting line of a race, saying you are permitted to compete with all of the others, and yet believe you have been completely reasonable (Sadq et al. 2020)." Another perspective is that the victimization of a small number of groups (Khan, 2021) is so pervasive that it can only be solved by the use of coercive measures, such as forced separation. Those who are against providing preferential treatment to members of underrepresented groups in society argue that "two wrongs don't make a right," that "treating different ethnic groups differently will only make racial conflict worse," and that "social orders should intend to be largely blind to racial and ethnic differences" (Saadi, 2021).

Since these arrangements were offered (Abdulsamad et al. 2022), a significant number of the gatherings that are supported by affirmation activity around minority in society have either become more informative or richer in content (Sharma et al. 2019). Regardless (HamaAliFaraj et al. 2017), it can be difficult to assess the amount of credit that can be claimed for affirmative action by members of underrepresented groups in society (Cao et al. 2022). The cost of living around the globe has skyrocketed in recent years, along with an evident increase in the number of its offspring who have pursued higher education (Qasim & Alyousuf, 2021). The cost of living for people of Malay descent is substantially higher in neighboring Malaysia, where they have inclinations, than it is in Singapore, which does not have a Malay population (Abdalla Hamza, et al. 2021). Despite the fact that the people who gain from affirmative action for minorities in society are typically not as happy as their neighbors, the gatherings that are ensured by affirmative action for minorities in society will in general make more people miserable (Hamad, et al. 2021). In the United States, there is a government procurement program (Harouache et al. 2021) that gives preference to businesses that are operated by persons who are "socially and financially disadvantaged (Qader et al. 2021)." People in this situation can have a household income that is far higher than the typical American family and yet be classified as "disabled" if (Mohammad, 2021) their skin is the appropriate shade. One of the people who took part in the "Dark Economic Empowerment (Mohammed et al. 2022)" program in South Africa is now the new leader of the country, and he is expected to get $500 million. Education is the topic (Sadq et al. 2020) at the center of some of the most contentious disputes about the merits of beneficial segregation in some nations (Khorsheed et al. 2020). There are certain states in the United States, like California, Michigan (Ibrahim, 2021), and Florida (Khan et al. 2020), that do not permit the debate of race in college confirmations that are sponsored by the state. On the other hand, there are less and fewer of those other people. Universities that consider it are typically reluctant to specify how much weight they give (Muhammed & Mustafa, 2021) it because of privacy concerns. Pundits assume that this is due to the fact that they accord it an unquestionably greater weight than what the majority of Americans would deem realistic (Awdel et al. 2020). One research found that black applicants at certain schools who scored 450 points (Omar et al. 2021) lower than Asian candidates on entrance examinations were equally likely to get admitted (Othman et al. 2018). The study was conducted at certain institutions (Sharma & Ismail, 2022). The individuals who have filed the action against Harvard have high hopes that it would compel the institution to divulge the specific criteria it uses to select students for admission (Rashid et al. 2019). Affirmation action

respecting minorities in society laws are arrangements that are established by the legislation to help even the odds for those who are demonstrably disadvantaged due to factors such as race, ethnicity (Cao et al. 2021), religion, sex (Alyousuf et al. 2020), or country of origin (Mohammed et al. 2018). Affirmation action respecting minorities in society laws are also referred to as affirmative action. These laws are typically connected to the development of conditions in the areas of labor, education, and commerce (Al-Yousuf & Din, 2020).

The purpose of providing preferential treatment to those from economically challenged backgrounds in the name of affirmative action (Birdawod et al. 2018) for underrepresented groups in society is to facilitate the achievement of a more equitable social composition. These individuals usually face obstacles for reasons that may be substantiated, such as lengthy periods of being persecuted or subjected. In any event, there are restrictions attached to the application of these laws (Saleh & Jamil, 2017). As the initial sense of alienation and discriminatory treatment that led to the creation of these laws has lessened over time, a growing number of people have called for the removal of affirmative action policies that involve minorities in society (Sharif, 2017). A great number of people have expressed their concern that it may be harmful to society as a whole to choose an individual mostly on the basis of their membership in a protected class rather than on the basis of their actual abilities. Individuals who belong to protected classes have certainly started to call for the elimination of affirmative action (rzgar Ahmed & Sharif, 2018) regarding minorities in society. They argue that this practice assumes a lack of competence on the part of minorities and treats them in a manner that deprives them of the attention of their companions (Khan & Zada, 2021). Another challenge is the building of a so-called "turn around separation (Sultan et al. 2020)," in which individuals who do not belong to a certain class are effectively ignored in favor of wide variety applicants who have a lower level of qualification (Abdalla Hamza, et al. 2021).

Equal student treatment

Equal student treatment refers to fair treatment in business, advancement, training, and other higher education activities regardless of a student's race, color (Hamza et al. 2021), religion, sex (which includes sex, inappropriate behavior, and pregnancy), age, national origin, backlash (Karem et al. 2021), physical or mental handicap, hereditary data, parental status, or sexual orientation. Equal student treatment also refers to the absence of discrimination against pregnant students. Specific legislation and guidelines defining the legal reason for EST programs in Federal offices have been established. This was done so that every single federal representative and candidate for work with the federal government is provided with this chance. Reaching financial stability via practice runs of employment is essential for both people and businesses (Aziz et al. 2021).By itself, EST laws achieve a wide array of policy objectives. In the first place, EST sets a pattern for proper conduct, which is essential given the great variety of lifestyles, abilities, and inclinations that people have. In addition (Qader et al. 2021), EST procedures assist workers feel as though they are being treated fairly and consistently (Mohammed, 2017), which can boost a person's feeling of responsibility, fulfillment, and devotion to their employer (Majeed et al. 2021). EST practices make employees feel as though they are being treated fairly and consistently (Mohammed et al. 2020). A person's psychological attitude, together with their perception of their own importance and riches, is the third cause. A person's feeling of general value and capacity to engage peacefully will rise if the person feels confident in all situations, even those in which the person is a minority. This includes situations in which the person is a minority (Sadq et al. 2020).

Equal student treatment, often known as EST, is a perk that every active applicant receives throughout the course of the employment process. It makes a reference to the assurance effort made by competitors to combat separation on the basis of qualifying characteristics such as race, religion, gender, or country origin (Sultan et al. 2020), among other characteristics. It is against the rules for managers to form opinions about employees or determine whether or not they are fit for their jobs based on any of these factors. These actions are required to be carried out by the federal government, as well as by state and local governments, labor organizations, and the vast majority of privately owned businesses (Khan, 2021). The EST also safeguards currently enrolled students from expulsion for reasons such as promotions, pay, perks, or discharge. The United States Equal Student Treatment Commission is responsible for ensuring uniformity and taking appropriate action in the event that any breaches are identified (Mustafa & Muhammed, 2020

). The vast majority of managers are required to give their assent in order to achieve parity with their job opportunity obligations. You cannot discriminate against students on the basis of their race, color, religion, gender, national origin, age, handicap, or ancestry because of these criteria. The general approach objective for the firm segregation regulations that we will look at may be summed up by the term (Kareem, 2020

) "measure up to scenario." To a large extent, the purpose of these rules is not to hold individuals accountable for their performance; rather, it is to ensure that all those who are now employed or who are seeking employment have an equal chance to participate in the labor market. At the end of the day, the purpose of these laws is to try to (Saadi, 2021)"level the playing field" so that certain groups of people who have been treated unfairly in the past are not subjected to hostile treatment based on specific characteristics that have nothing to do with being a qualified candidate or representative. In other words, these laws are an attempt to prevent people from being hostile toward others based on characteristics that have nothing to do with being qualified (Sabir et al. 2019).

Relationship between Equity students and Student satisfaction

There has been a significant amount of study done in the past on the connection between equality and student pleasure. Examples of value in research include pay value (Honarbakhsh et al. 2022), procedural and distributive equality students, employer stability and multifarious character, pay organization value, pay level value, promotion chances value, assessment criteria value, and so on (Ali & Yahiya, 2018). A select group of knowledgeable individuals has investigated the connection between equality and the level of pleasure experienced by students. (Awasthi et al. 2019) conducted research to study a causal theory that links the perceptions of job satisfaction, affiliation obligation, and enough work assemble to the opinions that US military members have towards the rationality of equal opportunity (Gowsic et al. 2019)-related employment opportunities. McIntyre and colleagues found that the views of work assemble EO rationality of the 5000 people who participated in the study had a positive association with their activity fulfillment, authoritative responsibility, and perceived work aggregate viability (v). (Fareed et al. 2021), who wrote a study on a topic quite similar, looked at the variables that impact hierarchical citizenship behaviors. According to the results of Rifai's research, there are significant positive relationships between procedural equality and distributive equity students as autonomous determinants and work satisfaction as a dependent variable. This conclusion was reached on the basis of the study's reasoning that these relationships exist. (Cao et al. 2022) investigated the impact of pay value differences between host nation specialists and exiles on student happiness and performance. They did this using the Equity students Theory (Mohammed & Ahmed, 2018). Following field overviews as well as top-to-bottom meetings consisting of Korean ostracizes and Mexican laborers, the analysts were able to identify value gaps. They also noted that visible salary differences had a considerable impact, both positively and negatively, on the level of satisfaction felt by students. (Qasim et al. 2020) investigated the effects that pupils with distributive and procedural equality have on the levels of stress, work fulfillment, and authority among remedial staff. It was discovered that students who studied procedural equity had a substantial influence on work contentment, whereas those who studied distributive equity did not. The article (Jamil & Mawlud, 2021) investigates the connection between pay decency, work fulfillment, hierarchical responsibility, and expectations regarding employee turnover among advancing administrative faculty. It was shown that crucial outcomes, such as work contentment, are significantly impacted by factors such as how acceptable remuneration is seen to be (Dixit & Sharif, 2020). Higher levels of student satisfaction were shown to be associated with showcasing directors who ensured that awards were given out in an equitable manner (Sharif & Azeez, 2021). This had a significant impact on hierarchical responsibility and, conversely, on the intention to leave the organization. A favorable association was found to exist between the two variables in the majority of the research projects that were carried out to study the connection between equality and student happiness. (Kangarluei et al. 2012), ensured that the worker would feel anger, contempt, or embarrassment if he sees that his percentage is not the same as the examination individual's proportion in the event that he does notice this. If, on the other hand, the representative realizes that his proportion is more than the proportion of the individual who is being examined, he will experience difficulties as a result of a sense of blame. The wider the discrepancy, the more misery the worker will face, and the more he will struggle to rebuild worth for himself and his position in the company (Gardi et al. 2021).

Adams' value theory states that representatives seek to value one another as well as a variety of professions. When the ratio of worker results to information sources is equivalent to the ratio of representative outcomes to data sources, value is recognized (Sorguli et al. 2021). (Ismeal et al. 2021) argue that value theory distinguishes that people are concerned not simply with the total number of remunerations they get for their efforts, but also with the relationship of this sum to what others gather. In other words, people are concerned not just with the total number of remunerations they get for their efforts (Mohammed, 2021). They base their judgments on the link between the information sources and outcomes obtained by others, as well as the data sources and discoveries obtained by themselves. According to the value theory, workers ensure that their compensation is appropriate by coordinating the results of their work with various information sources.

Examples of outcomes include things like salary, basic pay, motivating forces, perks, working conditions, and anything else that is gained in return for administrations. Education or expertise, time and effort invested, and other obligations accepted by representatives are examples of sources of knowledge that should be recognized (Jamal, 2021).(Mohammed, 2019) conducted a study with the purpose of determining whether or not opinions of unfavorable imbalance at work have an influence on individual social work practitioners' acceptance of decency, shamefulness, and situation as factors that contribute to disparity. In any case, the findings of the investigation indicate that employees change their behavior when they are confronted with imbalance, which might result in subpar performance. In general, if leaders simply conversed with their subordinates and clarified what was required at a given time to get a specific level of execution, or how a given sum of money was distributed, their representatives would be bound to comprehend, and this would not result in a reduction in their output nor would it mean that they would leave the organization (Ahmed & Hassan, 2019).

According to (Riyadh et al. 2020), if students believe that the organization should treat them appropriately and observe that they are treated decently, then the students will be focused on the organization and will feel obligated to respond by giving something of significant value as a result of this focus. In a similar vein, (Sohail & Dhuha, 2021) suggests that the reasonableness of individual results that representatives receive may have a greater impact on their performance and turnover expectations. Additionally, (Khan & AAS, 2019) opined that trouble in an apparent disparity can prompt an alternative passionate response that propels individuals to untrustworthily support or harm others, demonstrating that negativity is a powerful motivator. On the other side, positive discrepancy has the potential to create coercion, which motivates the individual to assist the referent other in an untruthful manner. In any event, this demonstrates that an enthusiastic disposition among the specialists working for a firm may be generated by either excessive or inadequate compensation (Jamil et al. 2018). As a direct consequence of this, value places an emphasis on the necessity for a worker to be treated fairly and to be appraised in accordance with the pledges and efforts made by the representative in the direction of accomplishing hierarchical goals (Rezaei et al. 2019). This suggests that such perceived value may generally improve worker execution, hence contributing to the development of a sense of belonging in higher education. As a consequence of this (Fallahi et al. 2019), in order to describe value in relation to representative execution, one may attest that what workers perceived as value that is appropriate in the higher education sector may improve representative execution, whereas what is perceived as uncalled for and out of line may disrupt worker execution (Dixit & Sharif, 2019).

Embracing diversity

Equity students and diverse variation are linked in terms of organizations and their workforces to valuing and reaping the benefits of a diverse workforce that makes the most of individuals' abilities regardless of their experiences. This is the case because a diverse workforce makes the most of equity students and diverse variation (Abdalla Hamza, et al. 2021). When balance and decent variety are combined, they drive an organization to conform to anti-separation legislation while also emphasizing the advantages of assorted variety. These advantages include, for example, drawing on a larger pool of talent, decisively motivating all representatives, and meeting the needs of a more extensive and similarly diverse client base. Balance and decent variety also drive an organization to conform to anti-discrimination legislation (Hamad et al. 2021). Associations in South Africa function within a society that is multicultural and multiethnic, and the individuals that make up these associations engage with one another using differentiating traits including work techniques, mental models, and even identity kinds. The management of this particular condition could be challenging (Hamad et al. 2021). Organizations need to make an effort to understand various diversity while nevertheless following to situation enactment procedures in order to produce substantial results for the organization in which all employees are able to contribute and realize their full potential (Fatah et al. 2021). This advances a stream of original thoughts and ideas from societies, which can enable organizations to better understand the socioeconomics of the commercial center they serve and be better prepared to thrive in that commercial center than an organization with an increasingly limited scope of representative socioeconomics. Specifically, this can enable organizations to better understand the dynamics of the labor market in the commercial center they serve. Regardless, having a more diverse staff can boost representative happiness, productivity, and maintenance (Aziz et al. 2021).

A recent study conducted by the Harvard Business School indicated that a multicultural workforce helps enhance creativity. Additionally, a study conducted by Forbes discovered that "decent variety is a critical driver of advancement and is a basic part of being successful on a global scale (Mohammed, 2019)." By being aware of the varied sets of experiences and points of view, organizations will be able to obtain a competitive edge in a variety of domains, including critical thinking, corporate

image, and advertising. People bring a plethora of knowledge to the table, which is essential to properly sorting variation within an organization; failing to do so might hinder intercultural interaction (Yaba et al. 2021). A company or organization that values and actively encourages diversity will have an easier time adjusting to new circumstances. Variety breathes fresh life into idle chatter (Darbandi, 2018), has the potential to facilitate the eradication of currently verifiable assumptions in conduct and work rehearsals, and has the potential to facilitate the development of new and improved working methods. An organization's reality can be improved if it has a workforce that is representative of a fair variety of its customers because that workforce will be in a better position to understand the requirements that those customers have (Khan & Zada, 2020

). This rise in the number of distinct variations is a significant obstacle. Representatives are tasked with figuring out how to collaborate with constituents that come from diverse backgrounds and hold a variety of religious beliefs, sexual orientations, and other perspectives (Sohail & Nabaz, 2019). A lack of admiration for those who work with us contributes to a breakdown in group cohesiveness and makes it difficult for us to successfully cooperate with one another. Our audience has made some significant advances in this regard, but there is still a long way to go before we accomplish things like establishing genuine uniformity (Khan et al. 2019).

Student satisfaction

The sentiments that the student representative has regarding their role as a representative are often considered to be the primary component of student satisfaction. According to (Hamad et al. 2021), student satisfaction is both an attitude variable that may be a tangible indication for how much individuals love their job, and a wonderful passionate condition that results from the appraisal of one's activities (Sultan, 2021). A number of scales, such as the Rensis Likert scale, the Job Descriptive Index (Alyousuf & Din, 2020), Kendall, and (Kareem et al. 2022), the Job in General Index, the Minnesota Satisfaction Questionnaire (MSQ), the Student satisfaction Survey (Mohammed et al. 2018), and the Faces Scale, have been developed in order to quantify student satisfaction. Research has been announcing, according to one point of view, that student happiness is a useful indication of a few fundamental negative and good work outcomes(Qoitassi & Sharif, 2015). The level of happiness experienced by students has an inverse correlation with bad employment outcomes such as employee turnover (Shareef et al. 2021). However, it has positive relationships with positive work outcomes, such as profitability (Sadq et al. 2028), which explored the impact of student satisfaction on work turnover under the balance job of sexual orientation (Sharma et al. 2022). This study looked at the impact of student satisfaction on the balance job of sexual orientation. They observed that activity satisfaction was a useful predictor of future pauses by utilizing the data from the first two waves of the Swiss Household Panel, which were conducted in 1999 and 2000. They also found that the gender of the student had a major role as a driving variable in the link between the levels of student satisfaction and the turnover goals. (qusay Ebraheem & Ali, 2021) conducted an investigation of the use of 9 human resource executives dispersed across a total of 46 hotels in the United States. Their research showed that attitudes such as the level of pleasure felt by students were substantially connected to the expectations placed on turnover rates. An research into the influence of student satisfaction and hierarchical duty on withdrawal behaviors among Dutch and Slovakian representatives was conducted by (Ali & Ebraheem, 2021), who reported in a comparative study that authoritative responsibility moderating impacts turnover (Awasthi & Sharma, 2020). When comparing the value of hierarchical duty to that of student satisfaction as a predictor of turnover, (Balaji et al. 2019) found that both activity fulfillment and authoritative responsibility are useful markers of turnover among medical attendants. This was discovered while the researchers were examining the overall usefulness of hierarchical duty versus student satisfaction in predicting turnover. (Sivaram et al. 2020) conducted research to determine whether or not factors such as work environment and student happiness are significant markers of the profitability of R&D representatives. It was discovered that the level of contentment felt by students is a significant factor in determining the profitability of R&D laborers. In addition, (Manikandan et al. 2020) evaluated the influence of student motivation and student satisfaction as methods for enhancing productivity and constructing more stable connections with consumers (Prakash et al. 2020).

III. RESEARCH METHOD

The Protocols, the Methods, and the Examples A survey was designed with the help of tried-and-true and dependable procedures from the past. The questionnaire comprised 55 questions divided into five sections. The purpose of the first 14 questions was to get personal information from those who participated in the survey. In the second part of the survey, participants were asked to rate how they felt about affirmative action using a scale that went from 1 (strongly disagree) through 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree) (strongly

agree). The last part of the survey asked participants to rate how they felt about equal treatment of students on a scale that went from 1 (strongly disagree) through 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree) (strongly agree). In the fourth segment, participants were asked to score how they felt about Embracing Diversity on a scale that went from 1 (strongly disagree) through 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree) (strongly agree). The last step of the process involved participants rating their degree of student satisfaction on a scale that ranged from 1 (strongly disagree) through 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree) (strongly agree). From the overall population, I was able to obtain 119 questionnaires that were filled out in their entirety.

Research hypotheses:

Research hypothesis 1: Affirmation action has a significant and beneficial association with student satisfaction in private universities in Iraq's Kurdistan region.

Research hypothesis 2: In the Kurdistan region of Iraq, there is a significant and positive association between equal student treatment and student satisfaction in private universities.

Research hypothesis 3: In the Kurdistan area of Iraq, there is a significant and beneficial association between accepting diversity and student satisfaction in private universities.

Findings

Participants' demographic analysis

Table.3-Demographic Analysis

No	Parameters	Items	Frequency	Percent
1	**Gender**	Male	77	64.7
		Female	42	35.3
2	**Age**	18-20	6	5.0
		21-25	22	18.5
		26-30	26	21.8
		31-35	34	28.6
		36-40	12	10.1
		41-45	8	6.7
		45+	11	9.2
3	**Marital Status**	Married	67	56.3
		Single	52	43.7
4	**Level of Education**	Bachelor	85	71.4
		Master's degree	23	19.3
		PhD	11	9.2

The demographic information for the 119 respondents that took part in the current survey is shown in table 3. However, the data revealed that 77 male respondents and 42 female respondents participated in the current study. Regarding respondents' ages, the results revealed that six respondents were between the ages of 18 and 20 years old, 22 respondents were between the ages of 21 and 25 years old, 26 respondents were between the ages of 26 and 30 years old, 34 respondents were between the ages of 31 and 35 years old, 12 respondents were between the ages of 36 and 40 years old, eight respondents were between the ages of 41 and 45 years old, and eleven respondents were between the ages of 41 and 45 years old.

Table.4-Reliability Statistics

No	Variable	Cronbach Alpha	Number of items
1	Affirmative action	.736	14
2	Equal student treatment	.773	13
3	Embracing diversity	.719	13
4	Student satisfaction	.769	15

In terms of reliability statistics, the Cronbach alpha for all variables was greater than.7, indicating that all variables and questions are reliable for analyzing the relationship between equity students and student satisfaction.

Table.5- Correlation Analysis

		ffirmative action	EST	Embracing diversity	Student satisfaction
Affirmative action	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	119			
Equal student treatment	Pearson Correlation	.176	1		
	Sig. (2-tailed)	.056			
	N	119	119		
Embracing diversity	Pearson Correlation	.385**	.686**	1	
	Sig. (2-tailed)	.000	.000		
	N	119	119	119	
Student satisfaction	Pearson Correlation	.872**	.384**	.383**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	119	119	119	119
**. Correlation is significant at the 0.01 level (2-tailed).					

Concerning a research of the relationship between three independent variables (affirmative action, Equal student treatment, and embracing diversity) and student satisfaction in private universities in Iraq's Kurdistan area. The findings revealed that the association between the first variable, affirmative action, and student satisfaction is. This shows that there is a positive and significant link between affirmative action and student satisfaction, as for the second variable, Equal student treatment, with student satisfaction is. 384** This shows that there is a positive and significant link between Equal student treatment and student satisfaction, and finally for the third variable, embracing diversity, and student satisfaction is. This shows that there is a favorable and significant relationship between accepting diversity and job happiness.

Table.6-Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.915[a]	.837	.833	.13480
a. Predictors: (Constant), embracing diversity, affirmative action, EST				

As we found that R Square value is .837 this means that 83% of factors are explained effectively.

Table.7-ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.755	3	3.585	197.297	.000[b]
	Residual	2.090	115	.018		
	Total	12.844	118			
a. Dependent Variable: satisfaction						
b. Predictors: (Constant), embracing diversity, affirmative action, EST						

The F value was discovered to be 197.297, which is greater than.001, indicating that there is a strong and significant association between (affirmative action, Equal student treatment, and embracing diversity) and student satisfaction in private universities in Iraq's Kurdistan area.

Table.8- Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.345	.205		-1.681	.000
	Affirmative action	.826	.038	.890	21.648	.000
	EST	.465	.064	.379	7.261	.000
	Embracing -.214 diversity		.054	-.220	-3.957	.095

a. Dependent Variable: Student satisfaction

In terms of multiple regression analysis, the B value for the first research hypothesis, which indicated that there is a substantial and positive association between affirmation action and work satisfaction in private universities in Iraq's Kurdistan area, is.826 which is greater than.001. This suggests that the first research hypothesis, that there is a significant and positive association between affirmation action and work satisfaction in private universities in Iraq's Kurdistan area, is supported. The B value is.465 for the second study hypothesis, which indicated that there is a significant and positive association between Equal student treatment and student satisfaction in private universities in Iraq's Kurdistan area, which is greater than.001. This suggests that the second research hypothesis, that there is a significant and positive association between equal student treatment and student satisfaction in private universities in Iraq's Kurdistan area, is supported. Finally, the B value for the third study hypothesis, stating that there is a substantial and positive association between embracing diversity and student satisfaction in private universities in Iraq's Kurdistan area, is -.214, which is less than.001. This suggests that the third research hypothesis, that there is a strong and positive association between embracing diversity and student satisfaction in private universities in Iraq's Kurdistan area, is rejected.

IV. CONCLUSIONS

The purpose of this study was to investigate the relationships between equity students and work satisfaction at private universities in Iraq's Kurdistan region. The study anticipated a positive and substantial link between three independent variables (affirmative action, equal student treatment opportunities, and embracing diversity) and student satisfaction in private universities in Iraq's Kurdistan area. The data revealed that the B value for the first research hypothesis, which indicated that there is a significant and positive association between affirmation action and work satisfaction in private universities in Iraq's Kurdistan area, is.826 which is greater than.001. This suggests that the first research hypothesis, that there is a significant and positive association between affirmation action and work satisfaction in private universities in Iraq's Kurdistan area, is supported. The B value is.465 for the second study hypothesis, which indicated that there is a significant and positive association between Equal student treatment and student satisfaction in private universities in Iraq's Kurdistan area, which is greater than.001. This suggests that the second research hypothesis, that there is a significant and positive association between equal student treatmentand student satisfaction in private universities in Iraq's Kurdistan area, is supported. Finally, the B value for the third research hypothesis, which stated that there is a significant and positive relationship between embracing diversity and student satisfaction in private universities in the Kurdistan region of Iraq, is -.214, which is less than.001, indicating that the third research hypothesis, which stated that there is a significant and positive relationship between embracing diversity and student satisfaction, is rejected.

REFERENCES

[1] Winstone, N. E., Ajjawi, R., Dirkx, K., & Boud, D. (2021). Measuring what matters: the positioning of students in feedback processes within national student satisfaction surveys. *Studies in Higher Education*, 1-13.

[2] Ho, I. M. K., Cheong, K. Y., & Weldon, A. (2021). Predicting student satisfaction of emergency remote learning in higher education during COVID-19 using machine learning techniques. *Plos one*, *16*(4), e0249423.

[3] Khan, S., & Abdullah, N. N. (2019). The impact of staff training and development on teachers' productivity. *Economics, Management and Sustainability*, *4*(1), 37-45.

[4] Khan, S., Sultan, A. A., & Alsamarai, S. (2019). Social media and its adverse effect on academic performance of students. *Bulletin of Social Informatics Theory and Application*, *3*(1), 38-44.

[5] Keržič, D., Alex, J. K., Pamela Balbontín Alvarado, R., Bezerra, D. D. S., Cheraghi, M., Dobrowolska, B., ... & Aristovnik, A. (2021). Academic student satisfaction and perceived performance in the e-learning environment during the COVID-19 pandemic: Evidence across ten countries. *Plos one*, *16*(10), e0258807.

[6] Giray, G. (2021). An assessment of student satisfaction with e-learning: An empirical study with computer and software engineering undergraduate students in Turkey under pandemic conditions. *Education and Information Technologies*, *26*(6), 6651-6673.

[7] Khan, S. I., & AAS, H. A. R. (2019). Academic Performance, Social Media Effects, and Leaning of College Students: Evidence of Positive Influence in Erbil City. *Journal of Research on the Lepidoptera*, *50*(4).

[8] Sohail, I. K., & Dhuha, S. I. (2021). Study of outcome of Job rotation on performance by understanding the effect of multitasking and employee specialization on Job Rotation of employees from Manufacturing Industries. *Journal of Natural Remedies*, *21*(10), 1.

[9] Zeng, X., & Wang, T. (2021). College student satisfaction with online learning during COVID-19: A review and implications. *International Journal of Multidisciplinary Perspectives in Higher Education*, *6*(1), 182-195.

[10] Khan, S. I. (2021). Online classes amid the Covid-19 Pandemic: Parents Perspective. *European Journal of Molecular & Clinical Medicine*, *8*(02), 2021.

[11] Quispe-Prieto, S., Cavalcanti-Bandos, M. F., Caipa-Ramos, M., Paucar-Caceres, A., & Rojas-Jiménez, H. H. (2021). A systemic framework to evaluate student satisfaction in Latin American universities under the Covid-19 pandemic. *Systems*, *9*(1), 15.

[12] Müller, A., Bellhäuser, H., Konert, J., & Röpke, R. (2022). Effects of group formation on student satisfaction and performance: A field experiment. *Small Group Research*, *53*(2), 244-273.

[13] Khan, S. I., & Zada, R. S. E. (2021). A Study about Financial Planning and Tax Saving Options for Primary and Secondary School Teachers of Nagpur Region. *Elementary Education Online*, *20*(1), 2497-2502.

[14] Prifti, R. (2022). Self–efficacy and student satisfaction in the context of blended learning courses. *Open Learning: The Journal of Open, Distance and e-Learning*, *37*(2), 111-125.

[15] Riley, E., Capps, N., Ward, N., McCormack, L., & Staley, J. (2021). Maintaining Academic Performance and Student Satisfaction during the Remote Transition of a Nursing Obstetrics Course to Online Instruction. *Online Learning*, *25*(1), 220-229.

[16] Khan, S. İ., Ismael, D. S., & Zada, A. R. (2020). Drivers of customer satisfaction for mobile service provider in Maharashtra (India). *The Journal of Research on the Lepidoptera*, *51*(1), 708-720.

[17] Sohail, I. K., & Nabaz, N. A. (2019). The influence of social media on student's academic performance: a case study of Lebanese French University. *Ринкова економіка: сучасна теорія і практика управління*, (18, вип. 1), 38-56.

[18] Donia, M. B., Mach, M., O'Neill, T. A., & Brutus, S. (2022). Student satisfaction with use of an online peer feedback system. *Assessment & Evaluation in Higher Education*, *47*(2), 269-283.

[19] Khan, S. I. (2021). Impact of spirituality at workplace on organizational commitment in private banks of Nagpur, India. *Путеводитель предпринимателя*, *14*(4), 184-189.

[20] Alkhateeb, M. A., & Abdalla, R. A. (2021). Factors influencing student satisfaction towards using learning management system moodle. *International Journal of Information and Communication Technology Education (IJICTE)*, *17*(1), 138-153.

[21] Khan, S. I. (2021). Communal support, work attitude, stress and job outcome across gender. *Management and Entrepreneurship: Trends of Development*, *3*(17), 18-26.

[22] Long, S., DUANG-EK-ANONG, S., & VONGURAI, R. (2021). Determinants of business education on student satisfaction in higher education: A case study in Cambodia. *The Journal of Asian Finance, Economics and Business*, *8*(3), 1405-1416.

[23] Sohail, I. K., & Dhuha, S. I. A Study of Emotional Competence of Education, Telecommunication and Hospital Sector Employees in India. Journal of Xi» an University of Architecture & Technology, 2020, Vol. *XII*, *Issue II*, 5223-5233.

[24] Riyadh, H. A., Alfaiza, S. A., Khan, S. I., & Sultan, A. A. (2020). The Ugly Behind the Beauty of Corporate social Responsibility: A General Conceptual Perspective. *Journal of Research on the Lepidoptera*, *51*(1), 750-758.

[25] Khan, S. I., & Zada, R. Factor Influencing Consumers on Beguiling Craze of Online Shopping: A Study of Attitude in Nagpur City of Maharashtra (India).

[26] Darbandi, H. (2017). THE STATE OF SUSTAINABLE TOURISM IN ERBIL. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *2*(3), 293-316.

[27] Darbandi, H. The ability of management in developing tourism destination performance in Iraqi Kurdistan.

[28] Sultan, A. A., Fbk, H. A., & Hosam Alden, R. (2020). Challenges and opportunities for adopting innovation in Iraqi SMEs. *International Journal of Psychosocial Rehabilitation*, *24*(6), 7449-7456.

[29] Yaba, T. K., Ahmed, A. K., & Hamad, K. Q. (2021). COVID-19'S Impact on Brand, Campaigning and Marketing Creativity: A Social Marketing Theoretical Approach. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *6*(4), 944-954.

[30] Singh, S., & Jasial, S. S. (2021). Moderating effect of perceived trust on service quality–student satisfaction relationship: evidence from Indian higher management

education institutions. *Journal of Marketing for Higher Education*, *31*(2), 280-304.

[31] Mahmood, S. S., Hamad, S. A., Hamad, K. J., & Ahmed, A. K. (2022). The Conformable Derivative Is Used to Solve a Fractional Differential Equation Analytically. *QALAAI ZANIST JOURNAL*, *7*(1), 1050-1063.

[32] Hassan, M. I., & Ahmed, A. K. (2020). A Proposal System Design of Evaluating Employees Performance in Qaladze Bank, Kurdistan Region of Iraq. *Journal of University of Raparin*, *7*(4), 470-486.

[33] Ahmed, A. K., & Hassan, M. I. (2019). THE ROLE OF INTERNAL ENVIRONMENT FACTORS IN IMPROVING EMPLOYEE PERFORMANCE. *Qalaai Zanist Journal*, *4*(4), 1071-1102.

[34] Sadq, Z., Othman, B., & Mohammed, H. (2020). Attitudes of managers in the Iraqi Kurdistan region private banks towards the impact of knowledge management on organizational effectiveness. *Management Science Letters*, *10*(8), 1835-1842.

[35] Khorsheed, R. K., Abdulla, D. F., Othman, B. A., Mohammed, H. O., & Sadq, Z. M. (2020). The Role of Services Marketing Mix 7P's on Achieving Competitive Advantages (The Case of Paitaxt Technical Institute in Kurdistan Region of Iraq). *TEST Engineering and Management*, *83*, 15947-15971.

[36] Sadq, Z. M., Khorsheed, R. K., Mohammed, H. O., & Othman, B. (2020). The Effect of Administrative Leadership on Achieving Business Success Strategies (The Case of Lebanese French University). *International Journal of Advanced Science and Technology*, *29*(2), 3095-3102.

[37] Giantari, I. G. A. K., YASA, N. N. K., SUKAWATI, T. G. R., & SETINI, M. (2021). Student satisfaction and perceived value on word of mouth (WOM) during the COVID-19 pandemic: An empirical study in Indonesia. *The Journal of Asian Finance, Economics and Business*, *8*(6), 1047-1056.

[38] Kim, S., & Kim, D. J. (2021). Structural relationship of key factors for student satisfaction and achievement in asynchronous online learning. *Sustainability*, *13*(12), 6734.

[39] Sadq, Z. M., Mohammed, H. O., Othman, B., & Saeed, V. S. (2020). Attitudes of Managers in the Knowledge Private University towards the impact of Human Capital in Achieving Competitive Advantages. *TEST Engineering and Management*, *82*, 393-401.

[40] Mohammed, H. O. (2019). The effect of motivation on employee productivity (A case study private bank in Kurdistan regional government). *Restaurant Business journal*, *11*(118), 119-136.

[41] Othman, B., Harun, A., Sadq, Z. M., Rashid, W. N., Abdullah, K. M., Mohammed, H. O., & Faeq, D. K. (2020). Effects of Service Marketing Mix on Umrah Customer Satisfaction: Empirical Study on Umrah Traveling Industry in Malaysia. *TEST Engineering and Management*, *83*, 22895-22909.

[42] Mohammed, H. O., Aziz, A. I., Sadq, Z. M., & Othman, B. A. (2020). The Impact of Transformation Leadership on Employee's Effectiveness (The Case of Ministry of Higher Education and Scientific Research, Kurdistan Regional Government, Iraq). *International Journal of Multicultural and Multireligious Understanding*, *7*(11), 201-217.

[43] Ammigan, R., Dennis, J. L., & Jones, E. (2021). The Differential Impact of Learning Experiences on International Student Satisfaction and Institutional Recommendation. *Journal of International Students*, *11*(2), 299-321.

[44] Hettiarachchi, S., Damayanthi, B. W. R., Heenkenda, S., Dissanayake, D. M. S. L. B., Ranagalage, M., & Ananda, L. (2021). Student Satisfaction with Online Learning during the COVID-19 Pandemic: A Study at State Universities in Sri Lanka. *Sustainability*, *13*(21), 11749.

[45] Mohammed, H. O. (2019). Relationship between participatory decision making and job satisfaction: a case study of private sector organizations in kurdistan-lfu. *Russian Journal of Agricultural and Socio-Economic Sciences*, *90*(6).

[46] Sadq, Z. M., Ahmad, B. S., Faeq, D. K., & Muhammed, H. O. (2020). The Effect of Strategic Planning on Entrepreneurship Strategy Requirements (The Case of Private Hospitals in Iraqi Erbil City). *International Journal of Multicultural and Multireligious Understanding*, *7*(10), 147-164.

[47] Mohammed, H. O., Sadq, Z. M., Abdullah, N. N., & Arab, H. R. (2022). Role of Strategic Flexibility in Enhancing Innovation Performance From a Futuristic Perspective. *QALAAI ZANIST JOURNAL*, *7*(1), 1064-1081.

[48] Aziz, A. I., Mohammed, S. S., Muhammed, H. O., Sadq, Z. M., & Othman, B. A. (2021). The Gender-Biased Wording of Recruitment Advertisements in Iraq. *UKH Journal of Social Sciences*, *5*(2), 25-33.

[49] Majeed, H. L., Mohammed, H. O., & Qadir, B. M. (2021). The Role of Natural Gas in the Economic Diversity of the Kurdistan Region. *QALAAI ZANIST JOURNAL*, *6*(3), 1065-1091.

[50] Qadir, B. M., Mohammed, H. O., & Majeed, H. L. (2021). Evaluating the Petroleum Contracts of Kurdistan Region in the Surveying and Applying the Deloitte Data (A Comparative Review). *International Journal of Multicultural and Multireligious Understanding*, *8*(7), 236-244.

[51] Mohammed, H. O. (2021). The Role of Intellectual Capital on Competitive Advantage. *International Journal of Multicultural and Multireligious Understanding*, *8*(7), 245-258.

[52] Rodríguez-García, M. C., Gutiérrez-Puertas, L., Granados-Gámez, G., Aguilera-Manrique, G., & Márquez-Hernández, V. V. (2021). The connection of the clinical learning environment and supervision of nursing students with student satisfaction and future intention to work in clinical placement hospitals. *Journal of Clinical Nursing*, *30*(7-8), 986-994.

[53] Mohammed, H. O. (2017). *The effect of employee burnout on employee job satisfaction the case of Kurdistan telecommunication sector: Asiacell and Korek telecom* (Master's thesis, Sosyal Bilimler Enstitüsü).

[54] Jamal, S. (2021). The impact of online learning on students: Evidence from Lebanese French University-Erbil. International Journal of Research in Business and Social Science (2147-4478), 10(3), 522-532.

[55] Rashid, S. J. M. (2022). The Relationship Between Social Entrepreneurship, Corporate Social Responsibility and Organizational Performance in Social Economy Companies at Kurdistan Region of Iraq. *QALAAI ZANIST JOURNAL*, *7*(1), 1019-1037.

[56] Mohammad, S. (2021). Impact of Brand Loyalty on Customer Satisfaction (An Empirical Analysis of Clothing Brands). *Jamal, S. & Sultan, K.(2021). Impact of Brand Loyalty on Customer Satisfaction (An Empirical Analysis of Clothing Brands). Turkish Journal of Computer and Mathematics Education*, *12*(10), 7085-7093.

[57] Fatah, N. A., Hamad, H. A., & Qader, K. S. (2021). The Role of Internal Audit on Financial Performance Under IIA Standards: A Survey Study of Selected Iraqi Banks. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *6*(2), 1028-1048.

[58] Ismeal, B., Mahmood Aziz, H., Sorguli, S., Qader, K., Sabir, B. Y., Abdalla Hamza, P., ... & Anwar, G. (2021). The Role of External Auditing in Reducing Creative Accounting Practices. *Sarhang and Qader, Khowanas and Sabir, Bawan Yassin and Abdalla Hamza, Pshdar and Gardi, Bayar and Anwar, Govand, The Role of External Auditing in Reducing Creative Accounting Practices (November 7, 2021)*.

[59] Qader, K. S., Ismeal, B. A., Aziz, H. M., Hamza, P. A., Sorguli, S., Sabir, B. Y., ... & Gardi, B. (2021). The Effect of Human Resources Management Skills on Accounting Information Quality in Kurdistan Public Sector. *Journal of Humanities and Education Development (JHED)*, *3*(3), 131-143.

[60] Aziz, H. M., Sorguli, S., Hamza, P. A., Sabir, B. Y., Qader, K. S., Ismeal, B. A., ... & Gardi, B. (2021). Factors affecting International Finance Corporation. *Journal of Humanities and Education Development (JHED)*, *3*(3), 148-157.

[61] Hamad, K. Q., Qader, K. S., & Sharif, R. J. M. (2021). Effectiveness And Adequacy Of Disclosure Provisions In Tehran Stock Exchange. *PalArch's Journal of Archaeology of Egypt/Egyptology*, *18*(08), 2379-2388.

[62] Sorguli, S., Hamza, P. A., Ismeal, B. A., Sabir, B. Y., Aziz, H. M., Qader, K. S., ... & Gardi, B. (2021). Adaption of E-Filling of Income Tax Returns in Kurdistan.

[63] Abdalla Hamza, P., Sabir, B. Y., Qader, K., Mahmood Aziz, H., Ismeal, B., Sorguli, S., ... & Anwar, G. (2021). Global financial markets: Factors influencing the global financial markets. *International Journal of Advanced Studies of Scientific Research*, *7*(6).

[64] Sibai, M. T., Bay Jr, B., & Dela Rosa, R. (2021). Service Quality and Student Satisfaction Using ServQual Model: A Study of a Private Medical College in Saudi Arabia. *International Education Studies*, *14*(6), 51-58.

[65] Sabir, B. Y., Qader, K. S., Hamza, P. A., Ali, B., Ismeal, S. S., Aziz, H. M., ... & Anwar, G. (2021). Analysis of Accounting-Based Measures of Expected Returns: A Study of Private SME In Kurdistan.

[66] Karem, L. E., Hamad, H. A., Bayz, H. A., Fatah, N. A., Ali, D. J., Ahmed, Z. N., ... & Qader, K. S. (2021). Corporate Governance And Its Effect On Firm Performance In An Emerging Economy. *International Journal of Environmental, Sustainability, and Social Science*, *2*(3), 281-291.

[67] Qader, K. S., Hamad, H. A., Gardi, B., Abdalla, P., Hamza, D., & Anwar, G. (2021). The role of sophisticated accounting system in organizational planning.

[68] Hamad, H. A., Qader, K. S., Gardi, B., Abdalla, P., Hamza, D., & Anwar, G. (2021). The essential variables to consider before investing in financial markets during Covid-19.

[69] Cervera-Gasch, A., González-Chordá, V. M., Ortiz-Mallasen, V., Andreu-Pejo, L., Mena-Tudela, D., & Valero-Chilleron, M. J. (2022). Student satisfaction level, clinical learning environment, and tutor participation in primary care clinical placements: An observational study. *Nurse Education Today*, *108*, 105156.

[70] Hamza, P. A., Hamad, H. A., Qader, K. S., Gardi, B., & Anwar, G. (2021). Management of outsourcing and its relationship with hotels' performance: An empirical analysis of selected hotels in Erbil. *International Journal of Advanced Engineering Research and Science*, *8*, 10.

[71] Gardi, B., Hamza, P. A., Qader, K. S., Anwar, H., Hamad, D., & Anwar, G. (2021). Factors affecting the quality of financial statements on investment decision making.

[72] Harouache, A., Chen, G. K., Sarpin, N. B., & Majeed, N. (2021). Importance of green supply chain management in Algerian construction industry towards sustainable development. *Journal of Contemporary Issues in Business and Government Vol*, *27*(1).

[73] Abdalla Hamza, P., Sabir, B. Y., Qader, K., Mahmood Aziz, H., Ismeal, B., Sorguli, S., ... & Anwar, G. (2021). Global financial markets: Factors influencing the global financial markets. *International Journal of Advanced Studies of Scientific Research*, *7*(6).

[74] Gantasala, V. P., Gantasala, S. B., Na, T., & Prasad, P. (2021). Quality of learning experience, student satisfaction and perceived overall experience in the COVID-19 context. *Journal of Applied Research in Higher Education*.

[75] Abdalla Hamza, P., Sabir, B. Y., Qader, K., Mahmood Aziz, H., Ismeal, B., Sorguli, S., ... & Anwar, G. (2021). Global financial markets: Factors influencing the global financial markets. *International Journal of Advanced Studies of Scientific Research*, *7*(6).

[76] Gantasala, V. P., Gantasala, S. B., Na, T., & Prasad, P. (2021). Quality of learning experience, student satisfaction and perceived overall experience in the COVID-19 context. *Journal of Applied Research in Higher Education*.

[77] Abdalla Hamza, P., Gardi, B., Hamad, H., & Anwar, G. (2021). Analysis the impact of Information technology on Efficient tax Management. *Bayar and Hamad, Hawkar and Anwar, Govand, Analysis the impact of Information technology on Efficient tax Management (December 6, 2021)*.

[78] Hamad, H. A., Hamza, P. A., Gardi, B., Saeed, K., Qader, D., & Anwar, G. (2021). The influence of accounting software in minimizing business costs.

[79] Kangarluei, S. J., Motavasel, M., & Sharifi, R. M. (2012). The Effect of Off--balance Sheet Financing on Profitability and Leverage Ratios. *Editorial Note Words from the Board of Editor 2 Profile of Authors Included in this Number 3 Information for Contributors 5*, *5*(1), 85.

[80] Sultan, K., Ahmed, R. R., Jafar, R., Murtaza, M. M., & Gardi, B. (2020). Corporate financial policy and its impact on sustainable capital structure: empirical evidence from textile firms of pakistan. *Humanities & Social Science Review*, 149-158.

[81] Hamad, K. Q., Qader, K. S., & Sharif, R. J. M. (2021). Effectiveness And Adequacy Of Disclosure Provisions In Tehran Stock Exchange. *PalArch's Journal of Archaeology of Egypt/Egyptology*, *18*(08), 2379-2388.

[82] Sharif, R. J. M., & Azeez, T. Y. (2021). A Comparison Of Ifrs And Us Gaap With Potential Effects On Investment Analysis. *PalArch's Journal of Archaeology of Egypt/Egyptology*, *18*(4), 6177-6187.

[83] Dixit, P., & Sharif, R. J. M. (2019). Analysis of CSR Impact on Private Sector Secondary School: A study in North and South Delhi (India). *Social Development and Security*, *9*(6).

[84] rzgar Ahmed, R., & Sharif, R. J. M. (2018). The Effect of Tuition Fees on University Applications and Attendance: Evidence from the Kurdistan Region private Universities. *Qalaai Zanist Scientific Journal*, *3*(4), 812-836.

[85] Sultan, K. (2021). A Piece of Education on Comparative Performance Study of Islamic Banking system and Commercial Banking system in Pakistan. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *12*(10), 7074-7084.

[86] Sahinidis, A. G., & Tsaknis, P. A. (2021). Exploring the relationship of the big five personality traits with student satisfaction with synchronous online academic learning: The case of Covid-19-induced changes. In *Strategic innovative marketing and tourism in the Covid-19 era* (pp. 87-94). Springer, Cham.

[87] Rofingatun, S., & Larasati, R. (2021). The effect of service quality and reputation on student satisfaction using service value as intervening variables. *The International Journal of Social Sciences World (TIJOSSW)*, *3*(01), 37-50.

[88] Sultan, K. (2021). Human Capital as Competitive Advantage: Empirical Evidence from Entities of Pakistan. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *12*(7), 2176-2184.

[89] Dixit, P., & Sharif, R. J. M. (2020). Standard Taxation Gaps & Reforms: A Critical Review of Revenue Policies of Kurdistan Region of Iraq. *SRIWIJAYA INTERNATIONAL JOURNAL OF DYNAMIC ECONOMICS AND BUSINESS*, *3*(4), 341-354.

[90] Sharif, R. J. M. (2017). Motivational Factors that Influence Foreign Direct Investment in Kurdistan Region. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *2*(4), 312-325.

[91] Qoitassi, K. M., & Sharif, R. J. M. (2015). The Usability of classroom Technologies in English Language Teaching and Learning (ELT & ELL). *ANGLISTICUM. Journal of the Association-Institute for English Language and American Studies*, *3*(7), 46-59.

[92] Fallahi, A., Jamil, D. I., Karimi, E. B., Baghi, V., & Gheshlagh, R. G. (2019). Prevalence of obstructive sleep apnea in patients with type 2 diabetes: A systematic review and meta-analysis. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, *13*(4), 2463-2468.

[93] Rezaei, H., Jamil, D. I., Ebadi, A., & Gheshlagh, R. G. (2019). Psychometric properties of the persian version of the instrument for assessing cardiac patients' knowledge, attitude, and beliefs regarding heart attack. *International Cardiovascular Research Journal*, *13*(2), 62-68.

[94] Jamil, D. I., Saleh, D. M., & Rahim, A. G. (2018). Construction of New Standardized Attribute Control Chart based on defects per million opportunities. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *3*(3), 734-745.

[95] Saleh, D. M., & Jamil, D. I. (2017). Construction Three Charts Based on Inter Quartile Range and Comparison of Efficiency with Three Charts Based on Range. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *2*(3), 317-329.

[96] Jamil, D. I., & Mawlud, B. S. (2021). Gender in The Sustainable Development Goals in Kurdistan Region-Iraq. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *6*(4), 970-989.

[97] Saleh, D. M., & Jamil, D. I. (2021). Construction X-Bar Chart for Quality Control Using of Robust (MAD) Estimator in Under Consideration Is Outlier with An Application. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *6*(3), 575-588.

[98] Kadir, D. H., Saleh, D. M., & Jamil, D. I. Comparison between four Methods to Construction Number of Defectives Control Chart.

[99] Birdawod, H. Q., Jamil, D. I., & Saleh, D. M. (2018). Comparison of Efficiency and Sensitively between (Three Sigma, Six Sigma and Median Absolute Deviation) by using Xbar Control Chart. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *3*(2), 803-812.

[100] Nithyanantham, V., Paulmony, R., & Hasan, S. R. (2019). Self-perspective of 21st century educators: a challenge in the globalised educational world. *International Journal of Educational Research Review*, *4*(3), 325-333.

[101] Qasim, A. J., Din, R., & Alyousuf, F. Q. A. (2020). Review on techniques and file formats of image compression. *Bulletin of Electrical Engineering and Informatics*, *9*(2), 602-610.

[102] Alyousuf, F. Q. A., Din, R., & Qasim, A. J. (2020). Analysis review on spatial and transform domain technique in digital steganography. *Bulletin of Electrical Engineering and Informatics*, *9*(2), 573-581.

[103] Al-Yousuf, F. Q. A., & Din, R. (2020). Review on secured data capabilities of cryptography, steganography, and watermarking domain. *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)*, *17*(2), 1053-1059.

[104] Ahmed, F. Q. A., & Mohammed, A. S. (2018). Enhancing The Data Security In Cloud Computing By Using New Encryption Method. *Qalaai Zanist Scientific Journal*, *3*(1), 1011-1021.

[105] Mohammed, A. S., Ahmed, F. Q. A., & Ibrahim, B. F. (2018). Modification of load balancing method in networks with wimax technology. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *3*(2), 791-802.

[106] Alyousuf, F. Q. A., & Din, R. (2020). Analysis review on feature-based and word-rule based techniques in text steganography. *Bulletin of Electrical Engineering and Informatics*, *9*(2), 764-770.

[107] Mardan, F. N., & Ahmed, F. Q. (2017). A Paper Survey On The Impact Of (It) On The Quality Of Financial Data (Case Study Of Municipalities And Tourism Ministry In Kurdistan Region–Iraq). *Qalaai Zanist Scientific Journal*, *2*(2), 51-57.

[108] Kareem, S. W., Alyousuf, F. Q. A., Ahmad, K., Hawezi, R., & Awla, H. Q. (2022). Structure Learning of Bayesian Network: A Review. *QALAAI ZANIST JOURNAL*, *7*(1), 956-975.

[109] Wu, Z. Z., Xu, Y. P., Cheng, Z. L., Sun, H. W., Papari, B., Sajadi, S. S., & Qasim, F. (2022). Optimal placement and sizing of the virtual power plant constrained to flexible-renewable energy proving in the smart distribution network. *Sustainable Energy Technologies and Assessments*, *49*, 101688.

[110] Cao, Y., Dhahad, H. A., Mansir, I. B., ABo-Khalil, A. G., Alamri, S., Rajhi, A. A., ... & Qasim, F. (2021). Development of a combined system based on a PEMFC and hydrogen storage under different conditions equipped with an ejector cooling system. *International Journal of Hydrogen Energy*.

[111] Qasim, A. J., & Alyousuf, F. Q. A. (2021). History of Image Digital Formats Using in Information Technology. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *6*(2), 1098-1112.

[112] Mohammed, A. S., & Ahmed, F. Q. (2018). Study of video traffic In telecommunication systems for the purpose of service quality. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *3*(3), 665-673.

[113] M Aziz, M. (2016). Determine the pH. of Soil by Using Neural Network Based on Soil's Colour. *International Journal of Advanced Research in Computer science and Software Engineering*, *6*(11), 51-54.

[114] Ibrahim, B. F., Toycan, M., & Mawlood, H. A. (2020, January). A comprehensive survey on VANET broadcast protocols. In *2020 International Conference on Computation, Automation and Knowledge Management (ICCAKM)* (pp. 298-302). IEEE.

[115] Prakash, M. V., Porkodi, V., Rajanarayanan, S., Khan, M., Ibrahim, B. F., & Sivaram, M. (2020, September). Improved Conservation of Energy in Fog IOT Services Using Machine Learning Model. In *2020 International Conference on Computing and Information Technology (ICCIT-1441)* (pp. 1-4). IEEE.

[116] Manikandan, V., Gowsic, K., Prince, T., Umamaheswari, R., Ibrahim, B. F., & Sampathkumar, A. (2020, September). DRCNN-IDS Approach for Intelligent Intrusion Detection System. In *2020 International Conference on Computing and Information Technology (ICCIT-1441)* (pp. 1-4). IEEE.

[117] Cao, Y., Dhahad, H. A., Togun, H., El-Shafay, A. S., Alamri, S., Rajhi, A. A., ... & Ibrahim, B. F. (2022). Development and transient performance analysis of a decentralized grid-connected smart energy system based on hybrid solar-geothermal resources; Techno-economic evaluation. Sustainable Cities and Society, 76, 103425.

[118] Balaji, B. S., Rajkumar, R. S., & Ibrahim, B. F. (2019). Service profile based ontological system for selection and ranking of business process web services. *International Journal of Advanced Trends in Computer Science and Engineering*, *8*, 18-22.

[119] Mohammed, A. S., Ahmed, F. Q. A., & Ibrahim, B. F. (2018). Modification of load balancing method in networks with wimax technology. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *3*(2), 791-802.

[120] Mohammed, A. S., Ahmed, F. Q. A., & Ibrahim, B. F. (2018). Modification of load balancing method in networks with wimax technology. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *3*(2), 791-802.

[121] Cao, Y., Dhahad, H. A., Sharma, K., ABo-Khalil, A. G., El-Shafay, A. S., & Ibrahim, B. F. (2022). Comparative thermoeconomic and thermodynamic analyses and optimization of an innovative solar-driven trigeneration system with carbon dioxide and nitrous oxide working fluids. *Journal of Building Engineering*, *45*, 103486.

[122] Fareed, B., Toycan, M., & Mohammed, A. S. (2021). DTCR: delay time aware controlled rebroadcasting mechanism for intelligent transportation systems. *Soft Computing*, *25*(18), 12537-12549.

[123] Khan, M. N., Dhahad, H. A., Alamri, S., Anqi, A. E., Sharma, K., Mehrez, S., ... & Ibrahim, B. F. (2022). Air cooled lithium-ion battery with cylindrical cell in phase change material filled cavity of different shapes. *Journal of Energy Storage*, *50*, 104573.

[124] Sivaram, M., Rohini, R., Rajanarayanan, S., Maseleno, A., Mohammed, A. S., Fareed Ibrahim, B., & Goel, P. M. (2020). Efficient coverage greedy packet stateless routing in wireless sensor networks. *Measurement and Control*, *53*(7-8), 1116-1121.

[125] HamaAliFaraj, K., Ibrahim, B. F., & Salih, A. A. (2017). Distance Varieties Wireless Signals Relations Connected Peer to Peer Computers. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *2*(2), 189-203.

[126] Rashid, T. A., Hassan, M. K., Mohammadi, M., & Fraser, K. (2019). Improvement of variant adaptable LSTM trained with metaheuristic algorithms for healthcare analysis. In *advanced classification techniques for healthcare analysis* (pp. 111-131). IGI Global.

[127] Sharma, A., Awasthi, Y., & Kumar, S. (2020, October). The Role of Blockchain, AI and IoT for Smart Road Traffic Management System. In *2020 IEEE India Council International Subsections Conference (INDISCON)* (pp. 289-296). IEEE.

[128] Awasthi, Y., & Sharma, A. (2020). Contrasting of Various Algorithmic Techniques to Solve Knapsack 0-1 Problem. *JOIV: International Journal on Informatics Visualization*, *4*(1), 16-21.

[129] Gowsic, K., Manikandan, V., Sharma, A., Sivaram, M., & Porkodi, V. (2019). Design of a Hybrid Logic Based A daboost Decision Tree Model for Identifying Web Attacks. *International Journal of Advanced Trends in Computer Science and Engineering*, *8*(1.2), 52-58.

[130] Sharma, A., Hussain, O., & Sharma, A. (2019). A Smarter Way to Improvise Learning Outcome based on Computer Application. *International Journal of Innovative Research in Computer Science & Technology (IJIRCST)*, *7*.

[131] Sharma, A., & Ismail, Z. S. (2022). Weather Classification Model Performance: Using CNN, Keras-Tensor Flow. In *ITM Web of Conferences* (Vol. 42). EDP Sciences.

[132] Sharma, A., Miran, A., & Ahmed, Z. R. (2022). The 3D Facemask Recognition: Minimization for Spreading COVID-19 and Enhance Security. In *ICT Analysis and Applications* (pp. 619-637). Springer, Singapore.

[133] Sharma, A., & Kumar, S. (2021). Network Slicing and the Role of 5G in IoT Applications. In *Evolution of Software-Defined Networking Foundations for IoT and 5G Mobile Networks* (pp. 172-190). IGI Global.

[134] Awasthi, Y., Sharma, A., & Pandey, R. (2019, November). Image Watermarking Using APDCBT in Selected Pixel Blocks. In *2019 8th International Conference System Modeling and Advancement in Research Trends (SMART)* (pp. 250-255). IEEE.

[135] Othman, R. N., Alizadeh, F., & Sutherland, A. (2018, October). A novel approach for occluded ear recognition based on shape context. In *2018 International Conference on Advanced Science and Engineering (ICOASE)* (pp. 93-98). IEEE.

[136] Ahmed, N. F., Omar, S. A., Othman, R. N., & Kakarash, Z. A. (2021). SQL Processor based on Intelligence Technique: Fuzzy Petri Net Database Applications. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *12*(14), 1364-1371.

[137] Abdulsamad, T., Kakarash, Z. A., Othman, R., Omar, S., & Ahmed, N. (2022). Distributed Resource Allocation Model with Presence of Multiple Jammer for Underwater Wireless Sensor Networks. *Iraqi Journal For Computer Science and Mathematics*, *3*(1).

[138] Omar, S. A., Othman, R. N., Ahmed, N. F., Ezat, H. S., & Kakarash, Z. A. EFFECTIVE DATA PARALLEL OPTIMIZATION FOR QUANTIFYING THE MATHEMATICAL MODEL OF SUBSYSTEMS IN MULTIVARIABLE SYSTEMS.

[139] Ali, M. S., & Yahiya, T. A. (2018, October). Performance Analysis of Native Ipv4/Ipv6 Networks Compared to 6to4 Tunnelling Mechanism. In *2018 International Conference on Advanced Science and Engineering (ICOASE)* (pp. 250-255). IEEE.

[140] Honarbakhsh, A., Tahmoures, M., Afzali, S. F., Khajehzadeh, M., & Ali, M. S. (2022). Remote sensing and relief data to predict soil saturated hydraulic conductivity in a calcareous watershed, Iran. *CATENA*, *212*, 106046.

[141] Ali, M. S., & Ebraheem, N. Q. (2021). Ways to Increase the Efficiency of Steganographic Use of Fractal Image Compression Algorithm. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *6*(4), 1013-1030.

[142] qusay Ebraheem, N., & Ali, M. S. (2021). Features of Application of Data Compression Methods. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *6*(3), 969-983.

[143] Sharma, A., Miran, A., & Ahmed, Z. R. (2022). Correction to: The 3D Facemask Recognition: Minimization for Spreading COVID-19 and Enhance Security. In *ICT Analysis and Applications* (pp. C1-C1). Springer, Singapore.

[144] Sharma, A., Miran, A., & Ahmed, Z. R. (2022). The 3D Facemask Recognition: Minimization for Spreading COVID-19 and Enhance Security. In *ICT Analysis and Applications* (pp. 619-637). Springer, Singapore.

[145] Sadq, Z. M., Sabir, H. N., & Saeed, V. S. H. (2018). Analyzing the Amazon success strategies. *Journal of process management and new technologies*, *6*(4).

[146] Shareef, A. J., Saeed, B. R., & Sabir, H. N. (2021). Legal Regulation of The Civil Liability of The Air Carrier for Damages to The Goods. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *6*(2), 760-784.

[147] Sabir, H. N., Sadq, Z. M., & Saeed, V. S. H. Electronic Commerce: Administrative and Legal Framework.

[148] Awdel, Z. M., Odel, N. M., & Saadi, W. F. (2020). The rise of the globalization and its effect on the autonomy of state and political economy. *Journal of critical reviews*, *7*(6), 998-1000.

[149] Saadi, W. F. (2021). The New Generation of American Isolationists. *Annals of the Romanian Society for Cell Biology*, 19033-190

[150] Saadi, W. F. (2021). The islamic republic of Iran's hegemony in Iraq, the cause, effect, and consequences. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *6*(3), 1-23.

[151] Kareem, K. F. (2020). Methods and preventive measures for juveniles from committing a felony from an islamic perspective. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *5*(4), 428-448.

[152] Muhammed, H. K., & Mustafa, B. M. T. (2021). The Legal and Economic Aspects of a Free Zone Setting Up Possibility in Ibrahim Al-Khalil Area in The Kurdistan Region of Iraq. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *6*(2), 785-823.

[153] Mustafa, B. M. T., & Muhammed, H. K. (2020). Relations of Human Rights Documentations with Constitutional Regulation of Rights. *QALAAI ZANIST SCIENTIFIC JOURNAL*, *5*(3), 180-203.

[154] Rahmani, A., Hamanajm, S. A., Allahqoli, L., & Fallahi, A. (2019). Factors affecting dental cleaning behaviour among pregnant women with gingivitis. *International journal of dental hygiene*, *17*(3), 214-220.

[155] Ibrahim, S. (2021). Critically evaluating the special international relationship between the UN Security Council and the International Criminal Court (ICC). *QALAAI ZANIST SCIENTIFIC JOURNAL*, *6*(1), 902-919.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.19

A Complex and Intercultural thinking for Countryside Education

Um Pensar Complexo e Intercultural Para a Educação do Campo

Izabela do Nascimento Bernardo[1], João Batista Santiago Ramos[2]

[1]Bacharela em Direito (FIBRA) e Graduada em Licenciatura Plena em Letras (IFPA). Mestranda do Programa de Pós-Graduação em Estudos Antrópicos na Amazônia – PPGEAA/UFPA. Bolsista FAPESPA. Lattes: http://lattes.cnpq.br/6150420311029778
[2] Graduado em Filosofia pela Fundação Educacional de Brusque (1992). Especialista em História da Educação na Amazônia. Doutor em Filosofia pela Universidade do Porto/Portugal e Professor Universidade Federal do Pará e do Programa de Pós-graduação em Estudos Antrópicos da Amazônia – PPGEAA/UFPA
Lattes: http://lattes.cnpq.br/8078757512392983

Received: 18 Apr 2022,

Received in revised form: 12 May 2022,

Accepted: 19 May 2022,

Available online: 25 May 2022

***Keywords*— Rural Education, Complexity, Interculturality.**

***Palavras-chave*— Educação do Campo; Complexidade; Interculturalidade.**

***Abstract*—** *Some studies that are simplified in schools in the educational field are based on a pedagogical ideal associated with technical rationality, which also has a thought, for using a model/standard of education centered on the reproduction of knowledge and teachings as Universal truths, linked to cultural matrices "Eurocentric". Educational practices from this perspective are brought as marks of an authoritarian and colonizing pedagogy, insofar as they ignore and/or silence the knowledge and cultural experiences of these peoples. In this, the present study aims to contest the importance of complex and intercultural thinking in rural schools, through the debate on teaching practices and projects that are guided by the offer of a transformative education, which involves the context and the multidimensions of education. local community to the teaching-learning process of rural schools. From there, the methodology used involves a bibliographic review, developed from a reading, complementary interpretation and other publications on the subject.*

***Resumo*—** *Alguns dos projetos educativos que são desenvolvidos nas escolas do campo ainda se baseiam em um ideal pedagógico associado à racionalidade técnica, que tem por base também um pensamento simplificador, por utilizar um modelo/padrão de educação centrado na reprodução de conhecimentos e valores tidos como verdades universais, vinculados às matrizes culturais "eurocêntricas". As práticas educativas instituídas a partir dessa perspectiva, trazem as marcas de uma pedagogia autoritária e colonizadora, na medida que, ignoram e/ou silenciam os saberes e as experiências culturais desses povos. Nesse contexto, o presente estudo tem como objetivo discutir a importância de um pensar complexo e intercultural nas escolas do campo, por meio do debate sobre práticas e projetos de ensino que se pautem na oferta de uma educação transformadora, que envolva o contexto e as multidimensões da*

comunidade local ao processo de ensino-aprendizagem das escolas do campo. Ademais, a metodologia utilizada envolve uma revisão bibliográfica, desenvolvida a partir da leitura, interpretação de livros e demais publicações sobre o tema.

I. INTRODUÇÃO

A educação do campo é um dos temas que merece destaque, haja vista a luta pela equidade e pela garantia de uma educação de qualidade são fatores que possibilitam caminhos para a inserção no mundo globalizado. Caldart (2004) destaca que as escolas do campo têm suas identidades diretamente relacionadas aos sujeitos que dela usufruem, ou seja, pequenos agricultores, pescadores, povos indígenas, extrativistas, assentados e vários outros sujeitos que vivem nas comunidades do campo e que frequentam as escolas rurais como espaço de desenvolvimento intelectual. Sendo assim, devem ser respeitados os valores, as diversidades e a identidade desses sujeitos.

Nesse contexto, o presente estudo tem como objetivo discutir a importância de um pensar complexo e intercultural para as escolas do campo, por meio do debate sobre práticas e projetos de ensino que se pautem na oferta de uma educação transformadora, que envolva o contexto e as multidimensões da comunidade local ao processo de ensino-aprendizagem, tendo como ponto de partida a diversidade sociocultural dos campesinos, em razão da problemática do não desenvolvimento de uma educação que não subjugue a população da zona rural a um "projeto educacional" que desconsidera a sua cultura e está dissociado de suas vivências, e que promove a desvalorização do campo enquanto *locus* produtor de cultura e conhecimento.

Ademais, desenvolvida a partir da leitura, interpretação de livros e demais publicações sobre o tema, para estabelecer de maneira sistematizada os conceitos e opiniões defendidas, a metodologia utilizada neste estudo envolve uma revisão bibliográfica, pois ela "se desenvolve tentando explicar um problema, utilizando o conhecimento disponível a partir das teorias publicadas em livros ou obras congêneres" (KOCHE, 2011, p.123).

De acordo com ROCHA e MARTINS (2011) a Educação do Campo vai além dos muros da escola, alcançando os sujeitos no seu fazer cotidiano, por meio das suas representações sociais. Sendo assim podemos afirmar que a educação do campo é uma importante modalidade de educação escolar inclusiva que pode fazer do processo de escolarização um espaço de emancipação da população rural brasileira, respeitando a diversidade, os valores e a identidade desses povos.

Inicialmente, discorremos a respeito das colocações de Morin (2015a, 2015b) sobre o pensamento complexo, destacando sua importância para a construção de um conhecimento/saber não fragmentado e não redutor. Posteriormente, abordamos os princípios da redução e da disjunção relacionando-os ao contexto educacional campesino. Por fim, discutimos a importância das práticas educativas interculturais e do pensamento complexo para as escolas do campo.

II. O PENSAMENTO COMPLEXO.

De acordo com Morin (2015b), viemos de uma escola que adquire conhecimento sobre o mundo por meio, predominantemente, dos métodos empirista e lógico, sendo esse predomínio crescente, fazendo as "luzes da razão" retrocederem aos conhecimentos carregados de erros, ignorâncias e cegueiras. É importante destacar que, isso ocorre por conta da própria organização e dos modos simplificadores do conhecimento que não aprendem e nem reconhecem a "complexidade do real" (o pensamento complexo).

O problema da organização do conhecimento ou da sistematização das ideias (ideologias e teorias) se estabelece na seleção de conhecimentos considerados significativos e na exclusão ou rejeição de dos "não significativos". Sendo assim, há a separação, centralização e hierarquização de saberes e posteriormente, há a supremacia e a união dos dados selecionados. Esta ação está baseada em princípios de organização do pensamento denominados paradigmas, que são "princípios ocultos que governam nossa visão das coisas e do mundo sem que tenhamos consciência disso" (MORIN, 2015b, p.10).

A respeito do pensamento complexo, Morin (2015a, 2015b) enfatiza que ele agrega todos os possíveis modos simplificadores de pensar, mas não dá espaço às implicações redutoras, unidimensionais, mutiladoras. Dessa maneira, podemos considerar que o pensamento complexo aspira um saber não fragmentado e não redutor, tendo como característica a religação desses conhecimentos e saberes desconectados pelo paradigma simplificador, reconhecendo que qualquer conhecimento está inacabado, incompleto, e pode ser questionado, interrogado e reformulado.

Em contrapartida, o pensamento simplificador desintegra a complexidade do real e mutila mais do que exprime as realidades ou os fenômenos de que trata. Logo, é evidente que ele produz mais cegueira do que elucidação,

pois a "simplicidade vê o uno, ou o múltiplo, mas não consegue ver que o uno pode ser ao mesmo tempo múltiplo. Ou o princípio da simplicidade separa o que está ligado (disjunção), ou unifica o que é diverso (redução)" (MORIN, 2015b, p. 59).

Atualmente, há uma hegemonia dos princípios de disjunção e de redução, cujo conjunto constitui o paradigma de simplificação. Essa concepção teve origem no pensamento de Descartes, que:

> Separou de um lado o campo do sujeito, reservado à filosofia, à meditação interior, de outro lado o campo do objeto em sua extensão, campo do conhecimento científico, da mensuração e da precisão. (MORIN, 2015b, p.76).

Descartes separa, então, o sujeito pensante (*ego cogitans*) da coisa material/objeto de estudo (*res extensa*), dissociando a ciência da filosofia, estabelecendo como verdade aquilo que é "claro/evidente e distinto", ou seja, o próprio pensamento disjuntivo (MORIN, 2015b). Porém, a solução para esta disjunção foi a redução do complexo ao simples (redução do biológico ao físico e do humano ao biológico), que se configura como outra forma de simplificação.

Neste sentido, Morin (2015b) acrescenta ainda que o conhecimento científico clássico tem como ideologia descobrir, por meio da simplificação da complexidade, uma ordem perfeita para os objetos e sistemas. Este conhecimento é essencialmente operacionalizado na medida e no cálculo, desintegrando os seres, levando em consideração, como únicas realidades, as equações e fórmulas quantificadas.

Dessa forma, o paradigma da simplificação nos leva a patologia do saber ou patologia contemporânea do pensamento, ao qual Morin (2015b, p.12) denomina de "inteligência cega" que "destrói os conjuntos e as totalidades, isola todos os seus objetos do seu meio ambiente. Ela não pode conceber o elo inseparável entre o observador e a coisa observada". Assim, segundo o autor nos aproximamos de uma mutação inaudita no conhecimento, que cada vez menos é passível de reflexões e discussões pelos humanos, sendo constituído para "ser registrado em memórias informacionais manipuladas por forças anônimas, em primeiro lugar os Estados" (MORIN, 2015b, p.12).

> Infelizmente, pela visão mutiladora e unidimensional, paga-se caro nos fenômenos humanos: a mutilação corta a carne, verte o sangue, expande o sofrimento. A incapacidade de conceber a complexidade da realidade antropossocial, em sua microdimensão (o ser individual) e em sua macrodimensão (o conjunto da humanidade planetária), conduz a infinitas tragédias e nos conduz a tragédia suprema (MORIN, 2015b, p. 13).

Os problemas humanos são, então, entregues ao obscurantismo científico que produz especialistas mutiladores, que monopolizam as ideias, como possuidores do "conhecimento verdadeiro", tornando as pessoas reféns deste cientificismo limitado, reduzido e fragmentado.

Por conta disto, devemos utilizar as contribuições do Pensamento Complexo para a Educação do Campo, pois elas nos possibilitam ir além da visão reducionista, fragmentada e disjuntiva do modelo educacional vigente, ampliando as reflexões para um pensar mais crítico e criativo, que considera que essa instituição escolar como uma organização complexa, que necessita religar seus saberes e compreender e envolver seu contexto que é ao mesmo temo uno e múltiplo.

III. A REDUÇÃO E A DISJUNÇÃO NO AMBIENTE EDUCACIONAL DO CAMPO

Alguns dos projetos educativos que são desenvolvidos nas escolas do campo ainda se baseiam em um ideal pedagógico associado à racionalidade técnica, que tem por base também um pensamento simplificador, pois utilizam um modelo/padrão de educação centrado na reprodução de conhecimentos e valores tidos como verdades universais, vinculados às matrizes culturais "eurocêntricas".

Dessa forma, as práticas educativas instituídas a partir dessas perspectivas trazem as marcas de uma pedagogia autoritária e colonizadora, na medida que, ignoram e/ou silenciam os saberes e as experiências culturais desses povos, promovendo assim, a desvalorização do campo enquanto local de produção de cultura e de conhecimento.

De acordo com Morin (2015b, p.10), isso ocorre por conta dos erros, ignorâncias e cegueiras "do modo mutilador de organização do conhecimento, incapaz de reconhecer a complexidade do real".

Assim sendo, Candau (2016) aponta que:

> Parece que há uma única e verdadeira maneira de se

> pensar a escola, seus espaços e tempos, sua lógica de organização curricular, sua dinâmica e, até mesmo, sua decoração e linguagem visual. Tudo parece concorrer para afirmar a homogeneização e padronização. Acreditamos que somente avançaremos na construção de uma qualidade adequada aos tempos atuais se questionarmos essa lógica. Caso contrário, continuaremos enfatizando medidas paliativas e cosméticas (CANDAU, 2016, p.807)

Observamos então que a nossa tradição social de maneira geral se inspira em uma visão simplificadora, denominada também por Morin (2015b) de mutiladora, unidimensional (unifica o que é diverso – princípio da redução) de direitos, de cidadania, de igualdade e de educação, e isso ocorre quando ela ignora as diferenças de território, etnia, raça, gênero, classe.

É justamente isso que precisa ser superado, pois as escolas do campo têm autonomia, por exemplo, para elaborarem seus projetos de ensino específicos, e também para incluírem os saberes rurais e as tradições locais em todo o processo de ensino-aprendizagem em desenvolvimento em suas unidades, pois é importante a valorização do contexto cultural no qual estão inseridos seus estudantes.

É de suma importância que a escola do campo venha ser planejada, desenvolvida e avaliada com a participação dos sujeitos que a demandam, no caso, as populações camponesas e que o processo de ensino-aprendizagem nessas instituições seja articulado a realidade do aluno, ao meio cultural e social onde ele vive, a sua linguagem, aos seus meios de produção, enfim, ao conhecimento próprio adquirido das relações e da convivência em comunidade. Nesta perspectiva, Morin (2015b, p.7) afirma que não podemos "isolar um objeto de estudo do seu contexto, de seus antecedentes, de seu devenir".

Sobre os princípios da redução e da disjunção, é importante ressaltar que, os questionamentos levantados por Morin (2015a, 2015b), se encaixam perfeitamente no processo de escolarização de certas escolas. Onde o conhecimento se organiza, de antemão, compartimentado, dividido, com hiperespecializações e raríssima conexão com a realidade. Então, desconectados da vida camponesa, os saberes e conhecimentos transmitidos nessas escola não fazem sentido para aqueles a quem são oferecidos. O autor enfatiza também que, esse conhecimento constituído a partir de informações ou dos dados isolados se torna insuficiente.

Por isso, é preciso situar as informações e os dados em seu contexto para que adquiram sentido. Devemos buscar então, superar a fragmentação tradicional que dá centralidade à forma disciplinar e "mudar o modo de produção do conhecimento na escola do campo, tendo em vista a compreensão da totalidade e da complexidade dos processos encontrados na realidade" (MOLINA; SÁ, 2012, p.471).

No contexto da educação do campo, as reduções se configuram quando restringimos toda complexidade humana (particularidades, identidade, cultura, tradições...), simplificando tudo isso a um modelo cultural e educacional homogeneizador, que serve de padrão neste ambiente educacional, tratando tudo como algo mecânico.

Neste sentido, Morin (2015a) ressalta que:

> Ensinamos nossas crianças a conhecer os objetos separando-os, isolando-os, mas é necessário, também, recolocá-los em seu meio para conhecê-los, ensinar que um ser vivo só pode ser conhecido em sua relação com seu meio, de onde extrai energia e a organização (MORIN, 2015a, p.108).

Em contra partida, podemos visualizar as disjunções no isolamento radical dos campos do conhecimento, na uniformização de currículos, de conteúdos e até mesmo de didáticas educacionais, que se desconectam cada vez mais das particularidades desses sujeitos da comunidade campesina.

Desse modo, chegamos, segundo Morin (2015b), à inteligência cega, que aniquila os conjuntos e as totalidades, afasta todos os objetos do seu meio ambiente, tornando as realidades desintegradas. Sendo assim, um ensino contextualizado e que valorize os saberes e especificidades dos povos do campo se configura como um dos principais desafios enfrentados pelas instituições de ensino camponesas.

Neste sentido, Gadotti (2011) destaca que:

> Todo ser vivo aprende na interação com o seu contexto: aprendizagem é relação com o contexto. Quem dá significado ao que aprendemos é o contexto. Por isso, para o educador ensinar com

> qualidade, ele precisa dominar, além do texto, o "com-texto"; além de um conteúdo, o significado do conteúdo que é dado pelo contexto social, político, econômico, histórico (GADOTTI, 2011, p. 61).

Tais considerações enriquecem, também, os debates sobre a importância de uma educação intercultural nas escolas do campo. Doravante consideramos a possibilidade de articulação de um pensar complexo e intercultural para a educação do campo, em razão da existência de pontos em comum entre ambas as perspectivas os quais serão destacados no tópico a seguir.

IV. A IMPORTÂNCIA DE PRÁTICAS INTERCULTURAIS E DO PENSAMENTO COMPLEXO PARA AS ESCOLAS DO CAMPO

Homens e mulheres vivem em sociedade em meio a uma grande diversidade cultural, e entre essas culturas existem fronteiras que provocam certos distanciamentos, incompreensões, exclusões e até mesmo guerras. Dessa maneira, reconhecidamente essas barreiras precisam ser rompidas, em um exercício de respeito às diferenças e de percepção do outro como cidadão, com direito as suas singularidades.

Diante disso, o grande questionamento é: como quebrar e ultrapassar essas fronteiras que se estabeleceram ao longo da história, e têm por base visões ideológicas, subjetivas, culturais, políticas e econômicas? Inicialmente, podemos dizer que não se trata de uma tarefa fácil, muito menos rápida, pois se trata de um processo que passará pela educação, pela cultura, por mudanças individuais e coletivas que possibilitem desmistificar preconceitos, padrões, falsas premissas, subjetividades, intolerâncias e atitudes estigmatizadoras.

Apesar de a escola ter exercido, durante um longo período, um papel de grande influência no processo de homogeneização cultural, "tendo por função difundir e consolidar uma cultura comum de base ocidental e eurocêntrica, silenciando e/ou inviabilizando vozes, saberes, cores, crenças e sensibilidades" (CANDAU, 2010, p. 154), é válido ressaltar, que ela mesmo assim, se configura como uma das principais ferramentas para a superação dessas práticas.

E escola deve, então, assumir o desafio de romper com essas barreiras e construir pontes que levem a uma relação harmoniosa entre pessoas, religiões, formas de ver e de viver as diferenças. Para tanto, ela precisa desconstruir essas práticas homogeneizadoras que não reconhecem as diferenças enquanto contribuições para a construção dos conhecimentos e que utiliza projetos, currículos e práticas que privilegiam e hierarquizam pessoas, gostos, raças, culturas, etc.

Nessa perspectiva, Candau (2011) reforça que:

> A dimensão cultural é intrínseca aos processos pedagógicos, está no chão da escola" e potencializa processos de aprendizagem mais significativos e produtivos, na medida em que reconhece e valoriza a cada um dos sujeitos neles implicados, combate todas as formas de silenciamento, invisibilização e/ou inferiorização de determinados sujeitos socioculturais, favorecendo a construção de identidades culturais abertas e de sujeitos de direito, assim como a valorização do outro, do diferente, e o diálogo intercultural (CANDAU, 2011, p.253)

Para Ramos (2012, p. 273) devemos pensar a educação a partir da filosofia ético-libertadora, pois ela "busca estabelecer uma relação entre os sujeitos que não se configure uma relação de domínio ou uma relação de poder dessas que margeiam sempre o abismo de retorno à barbárie e à violência". O autor enfatiza ainda que devemos firmar o outro como alteridade, ao qual se deve todo respeito e a quem se reconhece ser completamente distinto.

Dessarte, é preciso construir novas formas de observar, interpretar e agir diante da diversidade humana e cultural. Estudos de muitos autores da contemporaneidade têm contribuído para um repensar das práticas pedagógicas a partir da perspectiva intercultural, pois ela contribui na fundamentação de organizações escolares abertas ao pensamento complexo, que considera as questões interculturais, abrindo espaço para os diferentes sujeitos e culturas, no lugar de se fechar para epistemologias e paradigmas simplificadores.

De acordo com Fleuri (2005) a intercultura indica um complexo campo de debate entre as variadas concepções e propostas que enfrentam a questão da relação entre processos identitários socioculturais diferentes, focalizando especificamente a possibilidade de respeitar as diferenças e de integrá-las em uma unidade que não as anule. O autor

destaca que, em todos os movimentos e práticas sociais e educacionais, que propõem uma convivência democrática entre diferentes grupos sociais e culturas, o trabalho intercultural tem como objetivo principal de "contribuir para superar tanto a atitude de medo quanto a de indiferente tolerância frente ao «outro», construindo uma disponibilidade para a leitura positiva da pluralidade social e cultural" (FLEURI, 2005, p. 93).

Segundo Fleuri (2003) a educação intercultural leva em consideração as relações entre seres humanos culturalmente diferentes uns dos outros e não busca somente apreender o caráter de várias culturais, mas, sobretudo, busca:

> Compreender os sentidos que suas ações assumem no contexto de seus respectivos padrões culturais e na disponibilidade de se deixar interpelar pelos sentidos de tais ações e pelos significados constituídos por tais contextos [...]. Nesta óptica, o reconhecimento das complexas e conflitantes relações interculturais pode ser fundamental para reverter os processos de exclusão estabelecidos pela adoção de mecanismos culturais hegemônicos que perpassam a escola e transformam em estrangeiros muitos sujeitos sociais (FLEURI, 2003, p.31).

Em complemento, Candau (2014) também conceitua o que seria de educação intercultural e destaca que ela parte da diferença como riqueza e:

> Promove processos sistemáticos de diálogo entre diversos sujeitos – individuais e coletivos –, saberes e práticas na perspectiva da afirmação da justiça – social, econômica, cognitiva e cultural assim como da construção de relações igualitárias entre grupos socioculturais e da democratização da sociedade, através de políticas que articulam direitos da igualdade e da diferença (CANDAU, 2014, p.1).

Podemos considerar que a educação intercultural se estabelece, na realidade, como um novo ponto de vista baseado no respeito às diferenças, que se concretiza, até mesmo, no reconhecimento da paridade de direitos. É válido ressaltar, que essa problemática vem trazendo diversos questionamentos para o campo da educação no Brasil, que vem respondendo com estudos e propostas que visam à incorporação da perspectiva intercultural no cotidiano escolar.

A exemplo disso, tivemos nas últimas décadas o desenvolvimento de alguns programas, leis e diretrizes voltados à promoção da educação intercultural, tais como: as Diretrizes Curriculares Nacionais para Educação Indígenas de 1999; Diretrizes Operacionais para a Educação Básica nas Escolas do Campo de 2002; Diretrizes Curriculares Nacionais para a Educação das Relações Étnico-raciais e para o Ensino de História e Cultura Afro-brasileira e Africana de 2003; e as Diretrizes Curriculares Nacionais para a Educação Escolar Quilombola de 2012, entre outros.

A partir disso, podemos perceber que houve avanços significativos no Brasil na afirmação dos direitos dos grupos sociais "minoritários" com a promulgação dessas leis e diretrizes e outros atos normativos, que vão tanto na direção do combate aos preconceitos étnico-raciais, religiosos, dentre outros, quanto na valorização e afirmação dos direitos e das práticas culturais das populações historicamente excluídas, a exemplo dos povos do campo.

Por isso, é importante à promoção de práticas educativas que reconheçam as diversidades culturais e os diferentes saberes como forma de garantir a formação de cidadãos capazes de interagir e de negociar objetivos comuns que garantam, a todos, respeito aos direitos legais e valorização de identidade, na busca da consolidação de uma escola e de uma sociedade democrática e justa.

Portanto, é imprescindível que a educação do campo seja pensada a partir de ponto de vista intercultural e de um pensar complexo, envolvendo o contexto e as multidimensões da comunidade local às práticas educacionais, possibilitando a elaboração de planejamentos, projetos e atividades que considerem a diversidade sociocultural dos campesinos, além de influenciar na formação de cidadãos críticos capazes de atuar de maneira efetiva e significativa na sociedade onde vivem.

É válido ressaltar que, a partir do pensamento complexo e das práticas educacionais interculturais, as escolas do campo podem adquirir respeito, equidade e engajamento social em relação aos outros projetos educacionais no panorama educativo brasileiro. A modalidade educacional tradicional, difundida em escala industrial e impositiva, apresenta abordagens pedagógicas

fora da realidade sensível dos alunos do campo. Ademais, até o próprio material didático carece de ser repensado a partir da cultura local, claro, com um pertinente diálogo com as demais manifestações culturais.

É evidente que sensibilidade para as questões relacionadas às diferenças culturais vem aumentando na sociedade e nos mais diversos contextos educativos. Mas, são muitos os desafios para se desenvolver uma educação intercultural nas nossas escolas do campo, especialmente se assumimos a perspectiva da interculturalidade crítica ao qual Candau (2016) atribui as seguintes características:

> Promove a deliberada inter-relação entre diferentes sujeitos e grupos socioculturais de determinada sociedade; nesse sentido, essa posição se situa em confronto com todas as visões diferencialistas, assim como com as perspectivas assimilacionistas; por outro lado, rompe com uma visão essencialista das culturas e das identidades culturais; concebe as culturas em contínuo processo de construção, desestabilização e reconstrução; está constituída pela afirmação de que nas sociedades em que vivemos os processos de hibridização cultural são intensos e mobilizadores da construção de identidades abertas, o que supõe que as culturas não são puras, nem estáticas; e tem presente os mecanismos de poder que permeiam as relações culturais, assumindo que estas não são relações idílicas, estão construídas na história e, portanto, estão atravessadas por conflitos de poder e marcadas pelo preconceito e discriminação de determinados grupos socioculturais (CANDAU, 2016, p.808).

Diante disso, a partir dessa perspectiva da interculturalidade crítica, precisamos superar uma maneira estereotipada e superficial de tratar esse tema nas escolas do campo, que é muitas vezes reduzido à incorporação de expressões culturais em momentos específicos, em geral, em comemorações de datas previstas no calendário escolar.

E de acordo Gadotti (2012) é preciso ter coragem para transformar essa realidade educacional, pois devemos parar de aceitar modelos educacionais prontos e acabados, que não estejam de acordo com a realidade dos alunos e não respeitem suas diferenças, ou seja, que se baseiam no paradigma da simplificação de Morin (2015a, 2015b). Gadotti (2012) destaca também o papel fundamental dos professores nestas mudanças, conscientizando os educandos a serem críticos e participativos, e que estes atuem como agentes passivos/ativos, receptores e produtores de conhecimento juntamente com os docentes.

Sendo assim, educação do campo como prática do diálogo intercultural e sob influência do pensar complexo, mobiliza-nos para a construção coletiva de um projeto de educação que não fica restrito ao espaço escolar e que tem por base outros paradigmas escolares, outras formas de organizar os conteúdos, metodologias, currículos, os espaços e tempos, o trabalho docente, as relações com as famílias e comunidades, de conceber a gestão de modo participativo, enfatizando as práticas coletivas, a partir de um conceito amplo e plural de sala de aula, etc.

Em resumo, a Educação do Campo deve dialogar com a teoria pedagógica desde a realidade particular dos camponeses se preocupando com a educação do conjunto da população do campo e, mais amplamente, com a formação humana. Sobretudo, trata-se de construir uma educação do povo do campo e não apenas com ele ou para ele (PICCIN; BETTO 2017).

V. À GUISA DE CONCLUSÃO

Apesar dos retrocessos dos últimos tempos, principalmente no campo ideológico, que afetaram drasticamente as políticas públicas direcionadas para a área da educação no Brasil, é preciso insistir em práticas escolares que se firmem na interculturalidade, que tragam para as escolas do campo o contexto e as multidimensões de suas comunidades, dando sentido às práticas educativas, possibilitando a elaboração de projetos e planejamentos que considerem a diversidade sociocultural dos campesinos, e que corroboram para a formação de cidadãos críticos capazes de atuar de maneira efetiva e significativa na sociedade onde vivem.

É necessário, então, realizar experiências pedagógicas a partir dos mais diversos paradigmas educacionais, bem como construir novas propostas educativas, que sejam mais coletivas e plurais, pois a educação do campo, sustentada em uma base intercultural, é uma das ferramentas fundamentais para a construção de

uma sociedade democrática, justa e inclusiva, que articule políticas de igualdade com políticas de identidade abrindo espaço ao paradigma da complexidade que também incorpora a positiva preocupação com a diversidade cultural.

Portanto, consideramos importante que a escola se reinvente a partir de práticas interculturais e com base nas contribuições do pensamento complexo, com promoção de diálogos entre culturas e saberes convergentes, para que ela possa responder de forma efetiva os diversos desafios impostos pela sociedade que vivemos. Logo, devemos deixar para trás o projeto hegemônico de educação ditado pelas elites nacionais e internacionais, que utiliza práticas precárias, fragmentadas e incompletas, que incentivam a padronização, a unificação de currículos e de perspectivas que reduzem o direito à educação a resultados uniformes.

Por fim, destacamos as principais convergências que nos possibilitaram a articulação de um pensar complexo e intercultural para a educação do campo, dentre as quais são: a crítica ao paradigma científico ocidental "universal e superior"; a proposição da valorização, religação e legitimação de saberes subalternizados; o entendimento da multidimensionalidade e complexidade dos indivíduos e suas relações e de seus grupos socioculturais; a preocupação com a superação das injustiças nas relações socioculturais e; a valorização do outro e a necessidade de compreendê-lo (em todas as suas multidimensões, culturas e identidades) com sensibilidade humana.

AGRADECIMENTOS

O presente trabalho foi realizado com apoio da Fundação Amazônia de Amparo a Estudos e Pesquisas - FAPESPA por meio do Programa de Pós-graduação em Estudos Antrópicos da Amazônia – PPGEAA/UFPA.

REFERÊNCIAS

[1] CALDART, R. S. **Pedagogia do Movimento Sem Terra.** São Paulo: Expressão Popular, 2004.

[2] CANDAU, V. M. F. RUSSO, K. Interculturalidade e Educação na América Latina: uma construção plural, original e complexa. **Revista Diálogo Educacional**. São Paulo, v. 10, n. 29, p. 151-169, jul. 2010. Disponível em: https://periodicos.pucpr.br/dialogoeducacional/article/view/3076. Acesso em: 05 fev. 2022.

[3] CANDAU, V. M. F. **Concepção de educação intercultural.** Rio de Janeiro: Editora PUC-Rio, 2014.

[4] CANDAU, V. M. F. Cotidiano escolar e práticas interculturais. **Cadernos de Pesquisa**, São Paulo, v. 46, n. 161, p. 802–820, 2016. Disponível em: http://publicacoes.fcc.org.br/index.php/cp/article/view/3455. Acesso em: 02 fev. 2022.

[5] CANDAU, V. M. Diferenças culturais, cotidiano escolar e práticas pedagógicas. **Currículo sem Fronteiras.** Rio de Janeiro, v. 11, n. 2, p. 240-255, Jul/Dez, 2011. Disponível em: https://saopauloopencentre.com.br/wp-content/uploads/2019/05/candau.pdf. Acesso em: 03 set. 2021.

[6] FLEURI, Reinaldo Matias. Intercultura e educação. **Revista Brasileira de Educação.** São Paulo: n. 23, p.16-35 Maio/Jun/Ago, 2003. Disponível em: https://www.scielo.br/j/rbedu/a/SvJ7yB6GvRhMgcZQW7WDHsx/?lang=pt&format=pdf. Acesso em: 02 set. 2021.

[7] FLEURI, Reinaldo Matias. Intercultura e educação. **Educação, Sociedade & Culturas.** Curitiba: n. 23, p. 91-124, 2005. Disponível em: https://www.fpce.up.pt/ciie/revistaesc/ESC23/23-Reinaldo.pdf. Acesso em: 02 set. 2021.

[8] GADOTTI, Moacir. **Boniteza de um sonho:** ensinar e aprender com sentido. São Paulo: Editora e Livraria Instituto Paulo Freire, 2011.

[9] GADOTTI, Moacir. **Educação e Poder:** introdução à pedagogia do conflito. São Paulo: Editora Cortez, 2012.

[10] KOCHE, José Carlos**. Fundamentos de metodologia científica:** teoria da ciência e iniciação à pesquisa. Rio de Janeiro: Vozes, 2011.

[11] MOLINA, Mônica Castagna; SÁ, Lais Mourão. Licenciatura em Educação do Campo. In: CALDART, R. et al. (Org.). **Dicionário da Educação do Campo.** São Paulo: Escola Politécnica de Saúde Joaquim Venâncio, Expressão Popular, 2012.

[12] MORIN, Edgar. **Ensinar a viver:** manifesto para mudar a educação. Porto Alegre: Sulina, 2015a.

[13] MORIN, Edgar. **Introdução ao pensamento complexo.** Porto Alegre: Sulina, 2015b.

[14] PICCIN, Marcos Botton; BETTO, Janaina. **Educação no campo, práticas pedagógicas e questão agrária.** Rio de Janeiro: Bonecker, 2017.

[15] RAMOS, João Batista Santiago. **Por uma Utopia do Humano**. Olhares a partir da libertação de Enrique Dussel. Porto: Edições Afrontamento, 2012.

[16] ROCHA, Maria Isabel Antunes; MARTINS, Aracy Alves. **Educação no campo:** desafios para formação de professores. Belo Horizonte: Autêntica Editora, 2011.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.20

Accelerated Sulphate Attack Study on Cement – Metakaolin – Flyash Concretes

Abhay Tiwari[1], Awadhesh Kumar[2]

[1]Research Scholar, Department of Civil Engineering, Delhi Technological University, Delhi, India
[2]Professor, Department of Civil Engineering, Delhi Technological University, Delhi, India
[1]abhayt111@gmail.com, [2]awadheshg@gmail.com

Received: 12 April 2022,

Received in revised form: 12 May 2022,

Accepted: 18 May 2022,

Available online: 23 May 2022

***Keywords*— accelerated sulphate attack, durability, flyash, metakaolin, wetting and drying cycles**

***Abstract*—** *Durability is that property of concrete which plays the prime role in governing the lifespan and serviceability of a structure with regard to its intended usage. Environmental conditions of the surroundings are the main criteria which decide the longevity and performance of concrete. For understanding the durability of concrete structures, analysis of the impact of chemical attacks may be crucial. As sulphate attacks are predominant chemical attacks on concrete structures, their study can interpret it when they are subjected to deterioration followed by damage. In this study, the effectiveness of ternary blends of OPC with metokaolin (MK) and flyash (FA) in sulphate resistance of concrete exposed to accelerated effect (i.e. by wetting and drying cycles) in 10% solution of sodium sulphate has been investigated. To assess the level of sulfate attack, the changes in strengths of concrete specimens and their weight change were measured after certain numbers of deterioration cycles. Cubes, prisms and cylinders of concrete were tested for compressive, flexural and splitting tensile strengths respectively whereas the weight changes (in percent) were measured for all the specimens. Combination of OPC with MK and FA has proved its effectiveness in improving the resistance against sulphate attack.*

I. INTRODUCTION

Concrete usage is steadily growing.It has proved to be the most favoured building material for construction of simple roads to iconic structures. Concrete is said to be durable if it works well in the environmental conditions to which it is exposed, as well as in the conditions that it is expected to be exposed to during its service life. [1]. Durability is that property of concrete which plays prime role in deciding the lifespan and serviceability of a structure with regard to its intended usage .The resistance of a structure against weathering, chemical assault and abrasion as well as its ability to withstand other service conditions characterize it.

[2]. Environmental conditions of the surroundings are the main criteria which decide the longevity and performance of concrete .To understand durability of concrete structures, analysis of the impact of chemical attacks may be crucial. As sulphate attacks are predominant chemical attacks on concrete structures, their study can interpret it when they are subjected to deterioration followed by damage [3]. Concrete deterioration induced by sulphate attack can manifest itself as expansion, cracking, and loss of strength. The outer layer of the concrete is damaged first and gradually the damage reaches the inner layers causing complete damage**.** [4]-[7].

In the past few years, metakaolin the calcined form of kaolinite clay has gained substantial interest due to its filling effect and pozzolanicity to combine with lime to form cementitious compounds. [8]-[12] Effect of these characterstics of MK on different properties of cementitious composites like porosity, compressive and flexural strengths, permeability, creep and cracking due to

shrinkage has been widely reported in the literature. [13]-[16]. Huge quantities of Flyash, a proven pozzolanic material, are readily and inexpensively available from thermal power plants all over the globe.

Some researchers have reported that certain combinations of Ordinary Portland Cement (OPC), MK and FA can provide concretes of high early strengths[17]-[18]. But, durability study on OPC, MK and FA concrete is necessary before recommending its use in actual structures. Sulphate attack is considered to be the most prominent effect, which reduces functional life span of concrete structures and this effect can be accelerated when the specimens are put through alternating cycles of wetting and drying. Alyami et. al [19] have carried out experimental study on cylindrical specimens under sodium sulphate solutions of 5% and 10% concentrations by imposing alternating wet and dry cycles of 8 hours wetting and 16 hours sun drying and also by 16 hours wetting and 8 hours sun drying. They concluded that 16 hours - 8 hours alternating wetting-sun drying cycles in 10% sodium sulphate solution give worse effects.

In this study, the effectiveness of concrete of ternary blends of OPC , MK and FA has been evaluated against its resistance to sulphate assault by subjecting the specimens to accelerated attack (i.e. by wetting for 16 hour and drying for 8 hour cycles) in 10% solution of sodium sulphate attack. To evaluate the level of sulphate attack the changes in strengths of concrete cubes for compressive strength, prisms for flexural strength and cylinders for splitting tensile strength and also their weight change(in percent) have been measured after certain number of reiterations of accelerated attack. [20]-[23].

II. EXPERIMENTAL PROGRAM

The experimental procedure has been designed to assess the durability of different concrete mixes under accelerated deteriorating environment. The materials, mixtures and the test procedures used to determine strengths are already reported in the previous study [18].Details of the same are briefly presented in the following sections:

A. Materials

Ordinary portland cement classified as OPC (43 grade) as per IS: 269 – 2015,has been used for all the mixtures [24]. Commercially available MK (particle size D50 of 6.5 µm, and fineness of 1342 m^2/kg determined by laser diffraction analyser), has the composition (by weight) of 52% SiO_2, 45% Al_2O_3, 0.7 % TiO_2, 0.7% Fe_2O_3, 0.9% CaO, traces of Na_2O along with K_2O and loss on ignition of 0.5%. The fly ash was collected from Rajghat Thermal Power Station, Delhi (particle diameter D50 of 10.2 µm and fineness of 1343 m^2/kg determined by laser diffraction analyser) has the composition (by weight) of 61.21% SiO_2, 30.07% Al_2O_3, 2.60% TiO_2, 4.17% Fe_2O_3, 0.1% CaO, some traces of Na_2O along with K_2O and loss on ignition of 1.40 % [25].

Good quality aggregates were procured from local market for this study. Crushed granite of 20 mm and down size and stone dust having particle size4.75 mm and below, have been used as coarse aggregate and fine aggregate respectively. Their properties were determined according to relevant IS Code[26].The coarse aggregate is specified as 20 mm nominal size whereas the fine aggregate belongs to the Grading zone I[27].The specific gravity and water absorption of the coarse aggregates were 2.91,0.57% and that of fine aggregates were 2.73, 0.80% respectively. A poly carboxylate ether (PCE) based super-plasticizer (SP) available from local vendor, was mixed in all the concrete mixtures.

B. Concrete Mixtures

A uniform water to binder ratio of 0.32 was adopted to prepare four concrete mixtures (Table 1). Out of these four mixes, one was control mix and the other three were ternary blends of OPC, MK and FA having 10, 13 and 16 percentages of metakaolin alongwith 15% fly ash in each mix. The quantities of MK and FA used to replace cement were calculated on weight basis.

C. Determination of Compressive Strength, Splitting Tensile Strength and Flexural Strength

Concrete cubes were tested according to the procedure mentioned in IS: 516[28]by means of a 3MN capacity compression testing machine. The splitting tensile strength tests have been performed in accordance with IS: 5816[29].Concrete prisms were tested For determination of flexural strength , loads were applied at both ends of the middle third portion of the prismatic beam as specified in IS:516. After water curing for 28 days the specimens were removed , allowed to drain and then tested after wiping with a soft cloth .The sets of three values thus obtained for each test were averaged to get the strengths of all the mix.

D. Scheme for Accelerated Sulphate Attack Testing by Alternate Wetting and Drying Cycles

For obtaining the experimental physical sulphate attack results in shorter duration, the artificial accelerated sulphate attack was designed as alternating wetting and drying in a 10% Na_2SO_4 solution.The wetting-drying cycles were set as alternate wetting and drying periods of 16 hours and 8 hours respectively. Some other researchers have also found this wetting- drying cycle quite

severe[19],[30]. Also, the monthly average day time temperatures in this region as well as in some other regions of the globe lies in the range of 20^0C to 40^0C, which is sufficient for drying of the outer layer where the sulphate ion concentration is significant [31]. Thus, full wetting by submerging the specimens in the solution and sun drying of the specimens to maximum extent has been achieved by keeping them in the open environment for explained duration.

After the 28-day initial water curing, the specimens were transferred into 10% sodium sulphate solution for wetting-thereafter drying and such cycles were repeated at ambient temperatures. These specimens were tested for determination of three key strengths of concrete i.e. compressive strength, flexural strength and splitting tensile strength after 150 cycles,300 cycles and 500 cycles.The average of values obtained for the three specimens for each test after specified number of cycles , has been considered as the residual strength of the mix. Each specimen was brought in saturated surface dry condition and weighed on electronic balance before testing.

Table 1. Details of concrete mixtures

Mix Designation	water/binder ratio	OPC (kg/m^3)	MK %	MK (kg/m^3)	FA (%)	FA (kg/m^3)	Water (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	SP (kg/m^3)
Control	0.32	466	00	00	00	00	144	643	1266	9.32
MK10	0.32	350	10	46	15	70	144	643	1266	9.32
MK13	0.32	336	13	60	15	70	144	643	1266	9.32
MK16	0.32	321	16	75	15	70	144	643	1266	9.32

III. RESULTS AND DISCUSSION

A. Loss of Compressive Strength

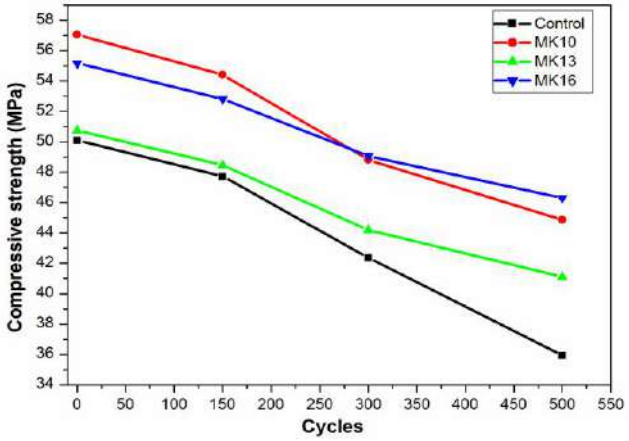


Fig.1 : Compressive strength at various exposure durations

Variations in compressive strength of concrete cubes after alternating wetting-drying in 10% Na_2SO_4solution are shown in figure1.The loss in compressive strength upto first 150 cycles is quite marginal. The percentage loss in control concrete keeps on increasing with increase in number of cycles, whereas in MK concrete it is not at that faster rate. The MK16 mix has been the best performer against sulphate attack by demonstrating the total loss after 500 cycles at only 16.1% as compared to the loss in control concrete at 28.3%.

B. Loss of Flexural Tensile Strength

As shown in figure 2, the total loss of flexural strength in all the mixes is of around 30%, among which 27.9% loss in MK 16 is the lowest. Other MK-FA mix have also performed better than the control mix in which the strength loss is 34.9%. Initially, up to 300 cycles the MK-FA mixes have shown only 12% loss as against 15% loss of strength in control mix. The residual flexural strengths in MK mixes are about 70% or more which is higher than the 65% residual strength of the control mix

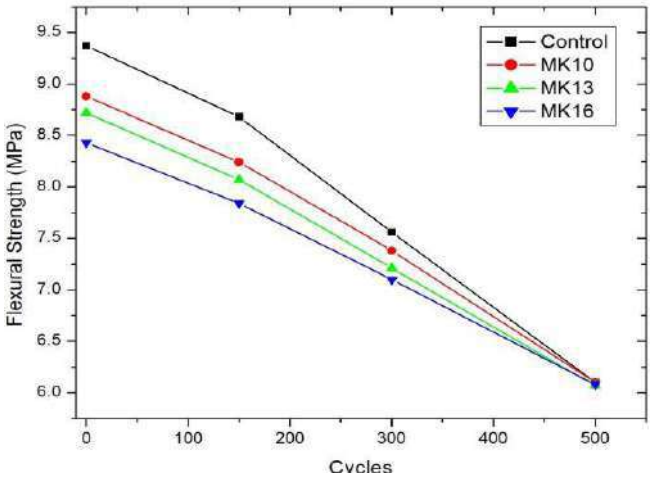


Fig.2 : Flexural tensile strength at various exposure durations

C. Loss of Splitting Tensile Strength

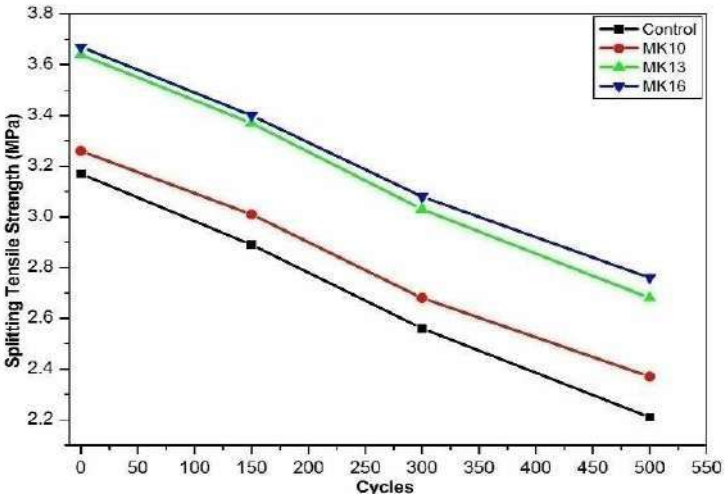


Fig. 3: Splitting tensile strength at various exposure durations

Figure 3 depicts loss of split tensile strength in all the mixes during first 150 cyclesis below 9%. In the next 150 cycles, the increase indeterioration in all the mixesis about 3%. The total loss after 500 cycles in MK16 is 24.8%, which is the least among all the mixes and this is also about 5% lesser than the loss in control mix. The MK concretes have been able to maintain about 70% residual strength after 500 cycles whereas for the control mix it is 63%.

D. Percentage weight loss

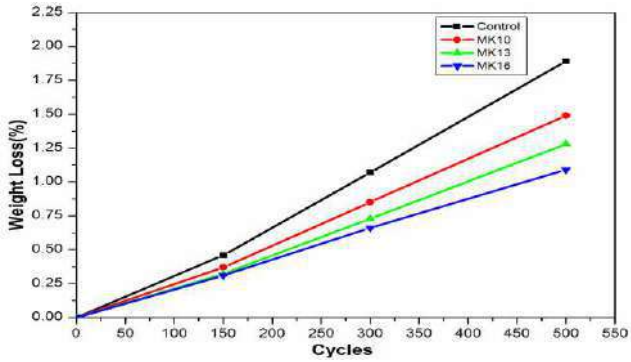


Fig.4: Percentage weight loss at various exposure durations

It is evident from figure 4 that initially the percentage weight loss in all the specimens is quite low. But, after 150 cycles the rate of deterioration keeps on increasing at a rapid rate. The control concrete has suffered highest weight loss of 1.9% after 500 cycles and the MK16 concrete has suffered the least(i.e.1.1 %).

IV. CONCLUSIONS

This study aims at examining the effectiveness of MK-FA blend OPC concrete for improving the resistance against sulphate attack. The specimens underwent accelerated sulphate attack caused by alternate wetting-drying cycles in sodium sulphate solution. The conclusions from this study are mentioned as under:

- Combination of OPC with MK and FA has proved its effectiveness in improving the resistance against sulphate attack in all wetting-drying cycles.
- Smaller loss of strengths, specially in concretes of higher percentages of MK has proved that MK-FA blend cement concrete is an effective supplementary cementitious material for resisting sulphate attack.
- Lower rate of percentage loss of strengths in MK concretes with increase in number of cycles indicates capability of MK concrete to extend service life of structures.

REFERENCES

[1] IS 456: 2000,"Plain and reinforced concrete-Code of practice", Bureau of Indian Standards, New Delhi.

[2] ACI CT-18, "Concrete technology", American Concrete Institute,2018.

[3] Tian W. and Han N. Experiment analysis of concrete's mechanical property, deterioration suffered sulfate attack and drying-wetting cycles. *Advances in Materials Science and Engineering*. 2017: 1-13.

[4] Jiang L.and Niu D. Damage evolution of concrete exposed to sulfate attack under drying-wetting cycles. *The Open Construction and Building Technology Journal*. 2014; 8: 444-449.

[5] Gao R.D., Li Q.B., Zhao S., and Yang X. .Deterioration mechanisms of sulfate attack on concrete under alternate action .*Journal of Wuhan University of Technology, Materials Science Edition*. 2010;25: 355-59.

[6] Roziere E. and Loukili A.,Hachem R.E., and Grondin F. Durability of concrete exposed to leaching and external sulphate attacks . *Cement and Concrete Research* . 2009; 39: 1188-98.

[7] Gao J.M., Yu Z.X., Song L., Wang T., and Wei S. Durability of concrete exposed to sulfate attack under flexural loading and drying-wetting cycles. *Construction and Building Materials*. 2013;39: 33-38.

[8] Sabir B. B., Wild S. and Bai J.Metakaolin and calcined clays as pozzolans for concrete*:* a review. *Cement Concrete Composite.* 2001; 23: 441-454.

[9] Ramezanianpour A.A. and Baharami J. H., "Influence of metakaolin as supplementary cementing material on strength and durability of concretes . *Construction and Building Materials.* 2012; 30: 470-479.

[10] Papadakis V.G. Effect of supplementary cementing materials on concrete resistance against carbonation and

chloride ingress. *Cement and Concrete Researc.* 2000;30(2): 291-299.

[11] Folagbade and Olufemi S. Strength and hydration properties of cement combinations. *International Journal of Engineering Science and Technology*.2013;5(8): 1593-1600.

[12] Bai J., Wild S. and Gailius A. Accelerating early strength development of concrete using metakaolin as an admixture. *Materials Science (MEDZIAGOTYRA.* 2004; 10(4): 338-344.

[13] Wild S., Khatib J. M. and Jones A. Relative strength, pozzolanic activity and cement hydration in super plasticized metakaolin concrete. *Cement and Concrete Research* ;1996 26(10): 1537-1544.

[14] Murat M. Hydration reaction and hardening of calcined clays and related minerals I Preliminary investigation on metakaolinite. *Cement and Concrete Research.* 1983;13: 259-266.

[15] Frias M. and Cabrera J. Pore size distribution and degree of hydration of metakaolin-cement pastes. *Cement and Concrete Research.* 2000; 30(4): 561–569.

[21] Bai, J., Wild, S., and Sabir, B. B. Chloride ingress and strength loss in concrete with different MK-PFA-PC binder compositions exposedto synthetic seawater. *Cement and Concrete Research*. 2003; 33: 353–362.

[22] Güneyisi, E., Gesoglu, M., and Mermerdas, K. Improvingstrength, drying shrinkage, and pore structure of concrete using metakaolin. *Materials and Structures*. 2008;41: 937–949.

[23] Khatib, J. M., and Wild, S. Sulphate resistance of metakaolinmortar. *Cement and Concrete Research.* 1998;28: 83–92.

[24] IS 269: 2015,"Ordinary Portland cement-Specifications", Bureau of Indian Standards, New Delhi.

[25] Kaniraj S.R. and Havanagi V.G. Behavior of cement stabilized fiber reinforced fly ash-soil mixtures. *Journal of Geotechnical and Geo-environmental Engineering, ASCE*. 2000; 127(7): 574-584.

[26] IS 2386 (Part III) – 1963 (Reaffirmed 1990),"Methods of test for aggregates for concrete Part III Specific gravity, density, voids, absorption and bulking", Bureau of Indian Standards, New Delhi.

[27] IS 383: 1970 (Reaffirmed 2002),"Specification for Coarse and Fine Aggregates from natural source for concrete", Bureau of Indian Standards, New Delhi.

[28] IS 516: 1959 (Reaffirmed 2004),"Methods of tests for strength of concrete", Bureau of Indian Standards, New Delhi.

[29] IS 5816:1999 (Reaffirmed 2004), "Splitting tensile strength of concrete - Method of test", Bureau of Indian Standards, New Delhi.

[30] Bassuoni, M. T. and Rahman, M.M. Response of concrete to accelerated physical salt attack exposure. *Cement Concrete Research*. 2015: 1-14.

[31] Zhou, Y., Tian, H., Sui, L., Xing F., and Han N. Strength deterioration of concrete in sulfate environment: An experimental study and theoretical modeling. *,Advances in Materials Science and Engineering*. 2015: 1 – 13.

[16] Frías M., Sánchez M. I., Rojas de and Cabrera J. The effect that the pozzolanic reaction of metakaolin has on the heat evolution in metakaolin-cement mortars. *Cement and Concrete Research.* 2000 ;(30): 209–216.

[17] Poon C. S., Kou C. and Lam L.Pore size distribution of high performance metakaolin concrete. *Journal of Wuhan University of Technology, Material Science Edition*.2002;17(1): 42-46.

[18] Tiwari, A. and Kumar, A..High Early Strengths in Concrete with Flyash and Metakaolin. *Indian Concrete Journal* .2019: 69 – 74.

[19] Alyami, M.H., Alrashidi, R.S., Mosavi, H., Almarshoud, M.A. and Riding, K.A. Potential accelerated test methods for physical attack on concrete.*Construction and Building Materials*. 2019;229: 1 – 10.

[20] Al-Akhras, N. M. Durability of metakaolin concrete to sulfateattack. *Cement and Concrete Research*. 2006;36:1727–1734.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.21

Corn trail analysis with and without Phosphorus use

Weder Ferreira dos Santos[1*], JoênesMucci Peluzio[2], Layanni Ferreira Sodré Santos[3], Fernando Barnabé Cerqueira[4], Talita Pereira de Souza Ferreira[1], Leonardo Alves Lopes[5], Cícero Antonio Sobreira Fidelis[5], Vitor Silva Barbosa[5], Antônio Henrique Camilo Ribeiro[1], Osvaldo José Ferreira Junior[1], Zildiney Dantas da Silva[1], João Victor Rodrigues Fernandes[1]

[1] Federal University of Tocantins, Gurupi, Tocantins, Brazil.
Email: eng.agricola.weder@gmail.com*
[2] Federal University of Tocantins, Palmas, Tocantins, Brazil.
[3] E.M.E.I.F Ullisses Guimarães, Santa Maria of Barreiras, Pará, Brasil.
[4] Faculty Guaraí, Guaraí, Tocantins, Brazil.
[5] Federal Instituteof Pará, Conceição do Araguaia, Pará,Brazil.
*Corresponding Author

Received: 10 Apr 2022,
Received in revised form: 02 May 2022,
Accepted: 07 May 2022,
Available online: 27 May 2022

Keywords **- *Productivity. Path analysis. Maize genotypes. Zea mays.***

Abstract *– The present work was carried out to study, through track analysis, the characteristics that most influence grain yield in corn genotypes. The trials were conducted in 2017/18, in the municipality of Santa Maria of Barreiras – PA, a region located in the Cerrado-Amazon Ecótono. Two competition trials of maize cultivars were installed, one in low phosphorus conditions, with 50 kg ha^{-1}from P_2O_5, and another under high phosphorus, with 100 kg ha^{-1}from P_2O_5. The experimental design used in each assay was randomized blocks with three replicates and ten treatments (genotypes). The treatments consisted of cultivars found in the local market, which were AG8088PRO2, BRS3046, PR27D28, ANHEMBI, CATIVERDE, 2B655PW, BR206, AG1051, AL BANDEIRANTE, and ORION. The characteristics of plant height were evaluated (AP), height of the spike (AE), diameter of spike (DE), length of spike (CE), and number of grains in row (NGE), weight of the spike (PE) and productivity (PROD). The track analysis was done through the computer program Genes. The variable PE presented the greatest direct effect on yield in corn genotypes in the Cerrado-Amazon region, being the most indicated for indirect selection for grain yield.*

I. INTRODUCTION

Over the past few decades, maize has reached the highest agricultural crop level in the world, being the only one to have surpassed the 1 billion tons, leaving behind old competitors such as rice and wheat. Concomitantly with its importance in terms of production, the culture is still noted for its various uses. Estimates point to more than 3.500 applications of this cereal. In addition to the relevance in food safety, in human food and, mainly, animals, it is possible to produce with corn a multitude of products, such as fuels, beverages, polymers, etc. [1].

Corn is the second-largest crop of importance in agricultural production in Brazil, being surpassed only by soybeans which lead to grain production in the country. Brazil stands out as the third-largest producer behind EUA and China, respectively. In the consolidation of the three harvests of 2020/2021 corn, the expected production was 96.4million tonnes. Of this total, 24 were produced. 7

million tons in the first harvest, 69.9 million in the second harvest, and 1.7 million in the third harvest [2].

Genetic research Applied to plant breeding has undergone numerous transformations and challenges over the years. In addition to the high demand, the new needs and competitiveness of the market, the emergence of new diseases and pests, and the ability to adapt to the desired specific environments and characteristics are some examples. Genetic improvement is one of the most expressive techniques that has contributed to the increase in productivity of the corn crop. The development and use of hybrid maize provided, in a short period, a productivity gain of more than 150% [3].

Souza et al. [4] emphasize the importance of studies on trial analysis. Carvalho et al. [5] when analyzing corn hybrids, concluded that the characteristics that most contributed to the production per plant were the number of ears per plant and the grain weight. Mohammadi et al. [6] observed that grain weight and the number of grains per ear were the most important components in predicting grain yield. Other authors such as Oliveira et al. [7], Pinheiro et al. [8], Santos et al. [9], and Silva et al. [10], also studied the direct and indirect effects between corn yield and its primary components.

Track analysis (*path analysis*) consists of the study of the direct and indirect effects of explanatory variables on a basic variable, whose estimates are obtained through regression equations, in which the variables are previously standardized. Although the correlation is an intrinsic characteristic of two variables, in each experimental condition, its decomposition is dependent on the set of variables studied, which are usually evaluated by the researcher through the previous knowledge of its importance and possible interrelationships expressed in "trail diagrams" [11].

Although track analysis is widely used in several crops of great economic importance such as soybean[12 and 13], corn [7, 8, 9, 10, 14, and 15], on the beans [16].

Phosphorus is linked to physiological processes of photosynthesis and respiration but is also a constituent of proteins and coenzymes, and nucleic acids and plays a key role in the storage of energy in the plant. Phosphorus deficiency occurs initially in older leaves, which have a darker green initial color than normal. Later, they acquire reddish or purplish coloration at the tips and margins of the leaf blade and may extend to the stem, the plant also presents growth reduction [17].

However, there are still few studies of this nature involving trial analysis in corn crops with different phosphate fertilization in the State of Pará. Because of this fact, the present work was carried out to evaluate through track analysis the components that most contribute to the productivity of corn grains under high and low phosphorus conditions.

II. MATERIAL AND METHODS

The sowing was carried out on December 23, 2017, in the 2017/18 crop, at Sítio Vitória, located in (8º18'32" S 50º36'58"W) in the municipality of Santa Maria das Barreiras, State of Pará, a region located in the Cerrado-Amazon Ecótono. The climate of the region is classified as Aw according to the köppen classification, which indicates a tropical climate with a dry season in winter [18].

Two competition trials of maize cultivars were installed, one in low phosphorus conditions, with 50 kg ha^{-1} from P_2O_5, and another under high phosphorus, with 100 kg ha^{-1} from P_2O_5. Both doses were applied at sowing, immediately before planting, using the simple superphosphate fertilizer.

The experimental design used in each assay was randomized blocks with ten treatments and three replications. The treatments consisted of 10 genotypes, all of open pollination AG8088PRO2, BRS3046, PR27D28, ANHEMBI, CATIVERDE, 2B655PW, BR206, AG1051, AL BANDEIRANTE and ORION, cultivars found in the local market, described in Table 2.

The experimental plot used was composed of four lines of 5.0 m, spaced 0.9 m between rows. The useful area of the plot consisted only of the two lines discarding 0.5 m from the ends of these lines.

The soil preparation was carried out with a goaler grill followed using a leveling grid. According to the crop requirement, phosphate fertilization was performed manually on the day of planting and applied directly to the groove. The doses were according to the recommendation for the use of correctives and fertilizers 5 the Approximation [19], according to the characteristics obtained in the chemical and physical analysis of the soil, expressed in Table 1.

Table 1 - Chemical and physical characteristics of the soil of the experimental area (Depth: 0-20 cm) at Sítio Vitória, in Santa Maria Of Barreiras, Pará State, 2017/18.1

Clay %	pH $CaCl_2$	M.O. $dagkg^{-1}$	P $mg\ dm^{-3}$	K^+ $mg\ dm^{-3}$	Ca^{2+} $cmol_c\ dm^{-3}$	Mg^{2+} $cmol_c\ dm^{-3}$	Al^{3+} $cmol_c\ dm^{-3}$	CTC $cmol_c\ dm^{-3}$

15	4.8	1.7	4.9	43	1.7	0.3	0.20	5.21

M.O.: Organic matter.

Nitrogen fertilization was done in cover, with a dose of 150 kg ha^{-1} N divided into two applications, the first being performed in stage V4 and the second in V8 (four and eight completely open sheets), having as source the urea (43% of N), totaling 348.83 kg ha^{-1} urea.

Potassium fertilization was covered with a dose of 90 kg $ha^{-1}$from K_2O divided into two applications, the first being performed in stage V4 and the second in V8 (four and eight completely open leaves), having as source potassium chloride (60% from K_2O), Totaling 150 kg ha^{-1} potassium chloride.

The management for the control of weeds, pests, and diseases was carried out according to the technical recommendations found in the literature for corn crops [19].

Table 2. Agronomic characteristics of corn cultivars used in the experiment.

Trade name	Genetic basis	Transgenics	Cycle	Purpose of use	Technological level
AG8088PRO2	HS	PRO2	P	G/SPI	A
BRS3046	HT	C	SMP	G/MV/SPI	M/A
PR27D28	HD	C	SP	G/SPI	B/M
ANHEMBI	PPA	C	P	G/SPI	B/M
CATIVERDE	PPA	C	SP	MV/SPI	M
AG1051	HD	C	SMP	G/SPI/MV	M/A
AL BANDEIRANTE	PPA	C	P	G/SPI	B/M
ORION	HD	C	P	G	B/M
BR206	HD	C	P	G/SPI	M/A
2B655PW	HT	PW	P	G/SPI	B/M

HS: Simple hybrid; HD: Double hybrid; HT: Triple hybrid; PRO2: Technology VT PRO 2™; PW: Tecnologia Powercore™; C: Conventional; P: Precocious; SMP: Semiprecocious; SP: Superprecocious; G: Grain; MV: Green corn; SPI: Silage of the whole plant; A: High; M: Medium and B: Low.
Fonte: Pereira Filho & Borghi [20].

The harvest was performed when the plants reached the ideal physiological stage (R6) for grain production. Based on the useful area of the plot, the characteristics for Plant Height were evaluated (AP), Height of the Spike (AE), Diameter of the spike (DE), Length of the spike (CE), Number of grains in a row (NGE), Weight of the spike (PE) and Productivity (PROD) [21]. Yield: grain mass of each plot corrected to 13% moisture and transformed into kg ha^{-1}.

For each dose of phosphorus (low P and high P), the correlations between the characteristics with grain yield were estimated. Then, these correlations were unfolded in direct and indirect effects, with grain yield being the basic variable [22].

The analyses were performed using the Computational Genes program [23].

The choice of the GENES program for the trial analysis considered the intrinsic factor that the program brings to the variables the direct and indirect effects, positive and negative, between the characteristic taxed as the main and those taxed as secondary [24].

III. RESULTS AND DISCUSSION

The coefficients of trail determination in Table 3 (low P) and Table 4 (high P) explained well the strong cause and effect relationships related to productivity, indicated by the high model determination value, both for low P (0.9999), for high P (1.0000) and by the low residual effect (0.0071) for low P and high P (0.000), indicating that the variables explain the variation found in grain yield.

Table 3 - Estimation of the direct and indirect effects involving the main variable, grain yield in kg ha^{-1} (PROD), and the explanatory (AE, AP, DE, CE, NGE,and PE), for 10 maize genotypes, in Low P.

Characters	Association effects	Estimate
AE	Direct about PROD	-0.0027
	Indirect way AP	0.0012
	Indirect way DE	0.0006
	Indirectway CE	-0.0029
	Indirectway NGE	0.0007
	Indirectway PE	-0.1619
	Full	-0.1651
AP	Direct about PROD	0.0027
	Indirect way AE	-0.0012
	Indirect way DE	-0.0037
	Indirect way CE	0.0018
	Indirect way NGE	0.0003

	Indirect way PE	-0.4019
	Full	-0.402
DE	Direct about PROD	0.0109
	Indirect way AE	-0.0002
	Indirect way AP	-0.0009
	Indirect way CE	-0.0031
	Indirect way NGE	0.0016
	Indirect way PE	0.4363
	Full	0.4446
CE	Direct about PROD	0.0115
	Indirect way AE	0.0007
	Indirect way AP	0.0004
	Indirect way DE	-0.0030
	Indirect way NGE	0.0009
	Indirect way PE	0.3782
	Full	0.3888
NGE	Direct about PROD	0.0028
	Indirect way AE	-0.0006
	Indirect way AP	0.0003
	Indirect way DE	0.0063
	Indirect way CE	0.0037
	Indirect way PE	0.5948
	Full	0.6072
PE	Direct about PROD	0.9897
	Indirect way AE	0.0004
	Indirect way AP	-0.0011
	Indirect way DE	0.0048
	Indirect way CE	0.0044
	Indirect way NGE	0.0017
	Full	0.9999
Coefficient of determination (R^2)		0.9999
Effect of residual variable		0.0071

$r \geq 0.6$ or$r \leq -0.6$, wherer above 0.6 is considered moderate to strong[25].Plant Height (AP), Height of the Spike (AE), Diameter of the Spike (DE), Length of Spike (CE), Number of Grains in Row (NGE), Weight of the Spike (PE),and Productivity (PROD).

When correlation values (*r*) and the direct effect are similar in magnitude and sign, the correlation explains well the association between the variables; if the r was positive and the direct effect is low and/or negative, the correlation that exists is due to indirect effects, indicating that the truncated selection in the auxiliary variable can provide satisfactory gains in the main variable. In this case, the best strategy is the simultaneous selection of variables, with emphasis also on those whose indirect effects are significant; when the value of *r*is low and/or negative and the direct effect was positive and high, the lack of correlation is caused by the indirect effects [26].

Under low P conditions (Table 3), the greatest direct effect on grain yield was from the weight of the (PE) (0.999), which also showed a high correlation (0.9897), indicating that the correlation explains well the association between the characters and, that the PE, can be used in the indirect selection for grain yield. Moreover, for all other characteristics studied, without exception, the indirect effect via PE was the component of the greatest contribution to their correlation, which confirms the importance of PE in the selection process aiming at increasing productivity under low P.

Mundim et al. [27] and Silva et al. [10] report that high values of correlations and right effect reveal a direct, cause-effect association between the attributes used in the analysis.

In the general context, the effects of the developments, through the analysis of the correlation coefficients of AP, DE, CE, NGE, and PE, were positive and showed significance. Only AE was negative about the PROD.

In high conditions P (Tabela 4), as occurred with Low P (Tabela 3), the weight of the spike (PE) showed high correlation and high direct effect with productivity (PROD), indicating a strong relationship between them. Also, similarly to what happened with Low P (Table 3), for all other characters, the indirect effect via PE was the component of the greatest contribution to their correlation with grain yield.

Both in low P and high P, all characteristics, except PE, there was a correlation of considerable magnitude and very similar, but with low direct effect with grain yield, and the PE character, as shown above, was the main responsible for this effect.

Thus, regardless of the P dose, the P doses applied at sowing were not able to promote significant changes in terms of the magnitude of the correlations between the explanatory variables and grain yield.

Table 4 - Estimation of the direct and indirect effects involving the main variable, grain yield in kg ha^{-1} (PROD), and the explanatory (AE, AP, DE, CE, NGE,and PE), for 10 maize genotypes, in high P.

Characters	Association effects	Estimate
AE	Direct about PROD	-0.0001
	Indirect way AP	-0.0035
	Indirect way DE	0.0004
	Indirect way CE	0.0035
	Indirect way NGE	-0.0003
	Indirect way PE	-0.4016
	Full	-0.4016
AP	Direct about PROD	-0.0041
	Indirect way AE	-0.0001
	Indirect way DE	0.0004
	Indirect way CE	0.0031
	Indirect way NGE	-0.0004
	Indirect way PE	-0.5502
	Full	-0.5512
DE	Direct about PROD	-0.0009

	Indirect way AE	0.0006
	Indirect way AP	0.0019
	Indirect way CE	0.0016
	Indirect way NGE	0.0006
	Indirect way PE	0.4426
	Full	0.4458
CE	Direct about PROD	-0.0064
	Indirect way AE	0.0001
	Indirect way AP	0.0019
	Indirect way DE	0.0002
	Indirect way NGE	0.0000
	Indirect way PE	0.2090
	Full	0.2047
NGE	Direct about PROD	0.0010
	Indirect way AE	0.0000
	Indirect way AP	0.0015
	Indirect way DE	-0.0005
	Indirect way CE	0.0001
	Indirect way PE	0.5617
	Full	0.5639
PE	Direct about PROD	0.9989
	Indirect way AE	0.0001
	Indirect way AP	0.0022
	Indirect way DE	-0.0004
	Indirect way CE	-0.0013
	Indirect way NGE	0.0006
	Full	1.0000
Coefficient of determination (R^2)		1.0000
Effect of residual variable		0.0000

$r \geq 0.6$ or $r \leq -0.6$, where *r*above 0.6 is considered moderate to strong [25]. Plant Height (AP), Height of the Spike (AE), Diameter of the Spike (DE), Length of Spike (CE), Number of Grains in Row (NGE), Weight of the Spike (PE), and Productivity (PROD).

IV. CONCLUSION

The variable ear weight showed the highest direct effect on grain yield in corn genotypes in the Cerrado-Amazon region, being the most indicated for indirect selection for grain yield.

REFERENCES

[1] Miranda, R.A. 2018. Uma história de sucesso da civilização. *A Granja*. 74(829): 24-27.

[2] CONAB. *Boletim da Safra de Grãos.* Disponível em: <https://www.conab.gov.br/info-agro/safras/graos/boletim-da-safra-de-graos>. Acesso em: 16 abr. 2022.

[3] Bueno, L.C.S.,Mendes, A.N.G.,Carvalho, S.P. 2006. *Melhoramento Genético de Plantas:* Princípios e Procedimentos. Lavras: UFLA. 319p.

[4] Souza, T.V., Ribeiro, C.M., Scalon, J.D., Guedes, F.L. 2014. Relações entre componentes de rendimento e características morfológicas de milho.*Magistra.* 26(4): 495-506.

[5] Carvalho, C.G.P., Borsato, R., Cruz, C.D., Viana, J.M.S. 2001. Path analysis under multicollinearity in S0 x S0 maize hybrids. *Crop Breeding and Applied Biotechnology*. 1(3): 263-270.

[6] Mohammadi, S.A., Prasanna, B.M., Singh, N.N. 2003. Sequential path model for determining interrelationship among grain yield-related characters in maize. *Crop Science, Madison.* 43(5): 690-1697.

[7] Oliveira, R.M., Oliveira, R.A., Neves, J.C.L., Oliveira, E.M., Botelho, M.E., Oliveira, J.T. 2021. Relação entre índice de colheita do milho e eficiências de fósforo por meio de análise de trilha. *Research, Society and Development.* 10(2): e13510212358-e13510212358.

[8] Pinheiro, L.S., Silva, R.C., Vieira, R.C., Aguiar, R.O., Nascimento, M.R., Vieira, M.M., Sousa, R.F., Oliveira, J.T., Silva, J.N., Silva, V.F.A., Silva, P.A. 2021. Análise de trilha dos atributos físicos de milho (*Zea mays* L.) em sistema de cultivo convencional. *Research, Society and Development.* 10(1): e8010110832-e8010110832.

[9] Santos, W.F., Vaz, P.C.P., Haesbaert, F.M., Ferreira, T.P.S., Sodré, L.F., Soares, L.B., Pereira, J.S. 2018. Análise de trilha em genótipos de milho no Sul do Tocantins. *Revista Tecnologia & Ciência Agropecuária.* 12(3): 49-52.

[10] Silva, Z.D., Santos, W.F., Ferreira Junior, O.J., Maciel, L.C., Santos, L.F.S., Ribeiro, A.C., Dias, V.C., Barbosa, A.S., Fidelis, C.A.S., Borges, T.A.S.L., Peluzio, J.M. 2021. Path Analysis for Maize (*Zea mays*) Silage Cerrado-Amazon Ecoton. *International Journal of AdvancedEngineering Research and Science.* 8(4): 57-63.

[11] Cruz, C.D., Carneiro, P.C.S. 2003. *Modelos Biométricos aplicados ao Melhoramento Genético.*Viçosa: UFV. 585p.

[12] Nogueira, A.P.P., Sediyama, T., Sousa, L.B, hamawaki, O.T., Cruz, C.D., Pereira, D.G., Matsuo, E. 2012. Análise de trilha e correlação entre caracteres em soja cultivada em duas épocas de semeadura. *Journal Bioscience.* 28(6): 877-888.

[13] Zuffo, A.M., Ribeiro, A.B.M., Bruzi, A.T., Zambiazzi, E.V., Fonseca, W.L. 2018. Correlações e análise de trilha em cultivares de soja cultivadas em diferentes densidades de plantas. *Cultura Agronômica.* 27(1): 78-90.

[14] Faria, L.A., Peluzio, J.M., Afférri, F.S., Carvalho, E.V., Dotto, M.A., Faria, E.A. 2015. Análise de trilha para o crescimento e rendimento de genótipos de milho sob diferentes doses nitrogenadas. *Journal of Bionenergy and Food Science.*2(1):1-11.

[15] Faria, L.A., Peluzio, J.M., Santos, W.F., Souza, C.M., Siqueira, G.B., Santos, D.B.R., Naoe, A.M.L., Lima, M.D., Reina, E., Monteiro, F.F., Oliveira, M. 2021. Cause and effect ratio of grain chemical components on soybean yield. *Asian Journal of Microbiology, Biotechnology & Environmental Sciences*. 23(4): 618-625.

[16] Cargnelutti Filho, A., Ribeiro, N.D.,Burin, C.,Toebe, M.,Casarotto, G. 2011. Número necessário de experimentos para a análise de trilha em feijão. *Ciência Rural.*41(4):564-572.

[17] Borém, A., Galvão, J.C.C., Pimentel, M.A. 2017. *Milho do plantio à Colheita.* 2. ed. Viçosa-MG: UFV.

[18] Ely, D.,Dubreuil, V. 2017. Análise das tendências espaço-temporais das precipitações anuais para o estado do Paraná – Brasil. *Revista Brasileira de Climatologia.* 21:553-569.

[19] Ribeiro, A.C., Guimarães, P.T.G., Alvarez V.V.H. 1999. *Recomendação para o uso de corretivos e fertilizantes em Minas Gerais:* 5a aproximação. Viçosa-MG: Comissão de Fertilidade do Solo de Minas Gerais - CFSEMG.

[20] Pereira Filho, I. A., Borghi, E. 2020. *Sementes de Milho:* nova safra, novas cultivares e contínua a dominância dos transgênicos. Sete Lagoas-MG: Embrapa Milho e Sorgo.

[21] Marafon, F., Neumann, M., Ribas, T.M.B.,Reinehr, L.L.,Poczynek, M., Bueno, A.V.I., Fianco, B. 2015.Análise do efeito da colheita da planta de milho em diferentes estádios reprodutivos e do processamento dos grãos sobre a qualidade da silagem. *Semina: Ciências Agrárias.*36(5):3257-3268.

[22] Wright, S. 1921. Correlation and causation. *Journal of Agricultural Research.* 20(7): 557-585.

[23] Cruz, C.D. *Programa Genes* – Aplicativo computacional na área de Genética e estatística experimental. Disponível em: <http://arquivo.ufv.br/dbg/genes/genes_Br.htm>. Acesso em: 16 abr. 2022.

[24] Cruz, C.D., Carneiro, P.C.S. 2003. *Modelos Biométricos aplicados ao Melhoramento Genético.*Viçosa: UFV. 585 p.

[25] Dancey, C., Reidy, J. 2006. *Estatística Sem Matemática para Psicologia:* Usando SPSS para Windows. Porto Alegre: Artmed.

[26] Lúcio, A.D., Storck, L., Krause, W., Gonçalves, R.Q., Nied, A.H. 2013. Relações entre os caracteres de maracujazeiro-azedo. *Ciência Rural.* 43(2): 225-232.

[27] Mundim, G.B., Viana, J.M.S., Maia, C., Paes, G.P., Lima, R.O. 2013. Genetic diversity and path analysis for nitrogen use efficiency in popcorn inbred lines. *Euphytica.* 191: 291-299.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.22

Determination of the rental value of a commercial room in the Place Business Center Building located in the city of Manaus - AM

Rugles Fabiam Mendes de Souza Junior[1], Erika Cristina Nogueira Marques Pinheiro[2]

[1] Graduating from the Civil Engineering Course at NiltonLins University, Brazil
Email: ruglesfabianjr@gmail.com
[2] Teacher of the Civil Engineering Course at NiltonLins University, Brazil

Received: 13 Apr 2022,
Received in revised form: 12 May 2022,
Accepted: 18 May 2022,
Available online: 27 May 2022

***Keywords*—Evaluation Engineering, Multiple Regression, Commercial rooms.**

Abstract*—*The present work seeks to evaluate the rental value of a commercial room in The Business Center building, in Manaus. In order to meet the proposal, a case study was used as well as a quantitative research. A linear regression model was also used, obtained from a sample of 37 data from commercial rooms collected randomly and identified in a spreadsheet, whose independent variables that formed the value were: private area, basic value, neighborhood, neighborhood income, state of conservation, constructive standard and unit value. The model was analyzed according to the degree of justification, according to NBR 14653-2: 2011, where it met 3 items provided for in the standard, 1 for Grade II (Minimum amount of market data, effectively used) and 2 (Significance level (sum of the value of the two tails) maximum for rejecting the null hypothesis of each regressor (two-tailed test) and Maximum significance level admitted for rejecting the null hypothesis of the model through Snedecor's F test) for attribution of Grade III, this being the higher degree of attribution to a regression model. It is recommended that the database of commercial rooms in the city of Manaus is always updated and that this evaluation methodology is used for other typologies, such as: single-family and multi-family homes, land and the like.

I. INTRODUCTION

The real estate market is an important segment of the economy. It is common practice to assess the importance of real estate to society through its prices. In this context, consumer preferences are basically explained by prices. Properties that offer the most features desired by buyers will be priced higher, and properties with fewer features will be priced lower.

It is important to point out that a relevant characteristic of the market is real estate heterogeneity. This makes it difficult or impossible to directly compare your units and suggests using models to calculate the price. Property valuation is developed with different methods, where the comparative method, based on regression analysis, has been considered an option for allowing good precision and objectivity.

In addition to heterogeneity, there are other elements that differentiate the real estate market from other markets, such as product immobility and the time required for the design and construction of new units. These characteristics impact prices when supply and demand conditions change. When demand increases, prices rise in the short term, because spatial reallocation of supply is impossible and it takes time to deal with increased demand. If demand declines, prices fall, because the owner has to reduce

prices to win back potential customers. On the other hand, location, often cited as the most influential factor in rental prices, also depends on societal preferences. As the product cannot undergo spatial relocation, movements in the environment can improve or worsen the conditions of the property. Consequently, it is easy to see that many attributes must be considered simultaneously in the real estate market analysis, which probably have different values for each situation. In this case, hedonic pricing models gain importance.

Certain basic characteristics can be verified and grouped into three main groups that represent attributes of the construction itself (physical elements), the location and the moment of the transaction. The physical attributes are related to size (total area, number of rooms, bathrooms and garages), construction standard, project, technology and construction method, among others. The location aspects represent the quality and accessibility conditions of the neighborhood. In turn, the neighborhood is related to the presence of public services, level of crime, level of education and income of the people who live in the area. Accessibility refers to the distance or time of access to places that are important to society. Finally, information about the terms of the transaction, such as payment method and time of rental, can also affect prices.

Civil engineers play a crucial role in the pursuit of opportunistic values in the built environment sector. According to Chen (2020), valuation refers to the quantitative process of evaluating the credibility or value of any asset. It requires an adequate technique to determine fair value. When measuring a company's value or value tests capital structure, an analyst is expected to consider potential earnings, the market value of assets, and management.

The initial step in the valuation process is to understand the business interests of the individual, company or organization to accurately perform financial analysis calculations such as growth percentage, P/E ratio, dividends, capital structure, equity, future earnings, etc. . Multiple methodologies and techniques such as the asset approach, the income approach or the market approach are used to estimate the value and prepare the report.

In view of this, the following problem arises: How does Valuation Engineering impact the determination of the rental value of a commercial room in The Place Business Center Building located in the city of MANAUS - AM?

The present work is justified due to the growing demand for real estate transactions in the city, thus awakening the need for a greater adequacy in their evaluations by a qualified professional who can serve different clients and sources to obtain a clear view of the situation, especially in the region, which lacks qualified professionals for this purpose and who can offer adequate services in this area.

The development of this work will allow the creation and development of a team specialized in Assessment Engineering as well as the development of the implementation of routines, database creation and implementation of methods capable of meeting the current and growing demand for assessment work.

Thus, the general objective of this article is to evaluate the rental value of a commercial room in The Business Center building, in Manaus. The specific objectives are: 1) Point out the importance of the Property Valuation to be carried out by an Engineer; 2) Present the specific procedures for rent assessment; 3) Analyze the collected data by applying inferential statistics using the SISDEA software for data modeling as a function of the established variables.

II. LITERATURE REVIEW

2.1 Valuation of rentals

The Manaus real estate market has been growing rapidly since the third quarter of 2020, and this growth has continued throughout 2021. Reports show that the number of properties sold or rented in the region has increased in 2021, making it a highly competitive market. This increase in competition is pushing average rents to higher and higher levels – average rental prices grew between 10% and 20% in 2021 (RIBAS; ALFAIA; RIBAS, 2021).

The Covid-19 crisis also played a role here. The pandemic severely disrupted the market in 2020 as real estate investors and homebuyers delayed their transactions. Alarmed, the government reduced interest rates, with the possibility of extending this movement even further in the future. All of this has contributed to the rapidly changing real estate and rental markets. Thus, a real estate investor needs to make sure that the property is launched to reflect current market conditions (NUNES et al., 2020).

It's nearly impossible to do this without expert insight on your side. Unless you have the knowledge, the tools and – perhaps most importantly – the time it takes to carry out in-depth market research and property valuation. This is where the services of an expert appraiser become invaluable. A regular assessment is a good idea, based on the insight gained from the initial analysis. This is because market conditions can vary significantly from year to year, or even from quarter to quarter (MATOS, 2017).

The rental appraisal process is similar to the appraisal of a property. An appraiser will examine the current

market and the property and recommend a price you can charge for the property. It is also useful in determining whether to hire a property manager or hire a real estate agent to manage investment properties. A good rental appraisal letter also helps to determine the estimated monthly rent. In many cases, you will have a clearer view of how much you can expect to earn from the investment based on the rental market (ANTUNES, 2017)

A rental appraisal will be a valuable tool for landlords. It will show you the potential rentals for the property. It will also include useful information about the local market, including vacancy rates and market trends. Finally, a rental appraisal will detail the types of tenants the property can be rented to. It is essential to remember that a rental appraisal can help you decide the price you can charge for your investment. In this way, you can make an informed decision based on your goals and financial situation (DINIZ, 2011; FAGUNDES, 2014).

During market cycles, ensuring the property remains competitive is vital. This can sometimes mean keeping the rent the same rather than increasing it, or even, with proper advice and consultation, reducing it a little. While this may seem counterintuitive, if the property is not priced competitively with similar properties in the area, it could mean the difference between a rental property and a vacant property. If the market is on a downward trend, the property manager can advise on other ways to keep the property competitive, before the notion of decreasing rent arises (ANTUNES, 2017).

It is important to point out that, in Brazil, there is NBR 14653, which sets the guidelines for the evaluation of assets, regarding: a) classification of their nature; b) institution of terminology, definitions, symbols and abbreviations; c) description of basic activities; d) definition of the basic methodology; e) specification of assessments; f) basic requirements of appraisal reports and technical opinions. This part of NBR 14653 presents guidelines for excellence procedures related to professional practice. This part of NBR 14653 is required in all written technical manifestations related to appraisal engineering activities.

In the meantime, it is pointed out that Resolution nº 218 of CONFEA establishes the professional attributions of the engineer, architect and agronomist in the different modalities and, according to Resolution nº 345 of CONFEA, are the exclusive attribution of engineers in their various specialties, of architects , agronomists, geologists, geographers and meteorologists, registered with the Regional Councils of Engineering, Architecture and Agronomy - CREA, the activities of inspections, expertise, evaluations and arbitrations related to movable and immovable assets, their integral parts and belongings, industrial machines and installations, works and public utility services, natural resources and goods and rights that, in any way, for their existence or use, are attributed to these professions.

2.2 Specific Procedures for Valuing Rentals

In most cases, real estate valuation seeks to obtain a market value (or price at which a property would likely be sold or rented in a normal scenario).

In the usual practice of real estate valuation, there are four methods with which such an estimate is made: COMPARISON, RESIDUAL, COST AND UPDATING. Such methods exist independently of major laws relating to valuation practice.

So, in general, in a market assessment there is no reason to strictly comply with any of these regulations, but rather focus on the philosophy of each of the four methods. In essence, the ultimate goal is to get the market value of the property.

The comparison method is the main one of the four assessment methods, as it is usually present in most assessments. This method is based on the "substitution principle" according to which the value of a property is equivalent to that of other goods with similar characteristics that replace it. Thus, in the real estate valuation field, each asset is unique and singular given its fixed and specific position in space, compared to other valuations where assets do not have this quality. In this sense, the application of homogenization coefficients on the consulted values of the different samples, witnesses or comparables obtained by market studies, is essential to be able to assimilate these values to those of the property to be evaluated (DROUBI et al., 2018).

The residual method is used in the evaluation of soils where the application of the comparison method is not possible due to lack of samples or comparables. Unlike the previous method, the property to be evaluated (vacant land) is not offered to individuals, but to developers. Thus, the method bases its philosophy on considering the value of the land, as the residual value resulting from a real estate development promoted by a hypothetical developer. In this way, the sale value of a vacant lot would result from the subtraction of the necessary associated expenses from the expected sale value of the real estate project. These being from three major groups: construction costs, promotion expenses and promoter benefit. Depending on the time period to be considered, one can speak of two types of residual method. The static residue method, oriented to simulations of approximately less than three years. And the dynamic residual method, oriented to longer periods of time (FREITAS, 2017).

The objective of the cost method is to evaluate the replacement of a property with the current prices of labor and materials. Deducting from this value, the depreciation suffered by the passage of time. Its use refers only to buildings and never to land (RIBEIRO, 2020).

Under the discount method, any asset that produces income, or is intended for some economic activity that generates future periodic income over time, can capitalize or update this value now. The value obtained is the so-called 'rent value' of a property. Said restatement or capitalization is carried out on the net income with interest to be calculated. Net rents are understood to be those from which the expenses necessary to carry out the lease or operation were deducted. On the other hand, the aforementioned interest is obtained by adding to the risk-free interest, the risk rate of use of the associated property (FRONZA, 2018).

ABNT (NBR5676/90) divides assessment methods into two large groups: direct and indirect methods. A method is considered direct when the value of the evaluation result is independent of others. The direct methods are subdivided into the comparative method of market data (defines the value through the comparative observation of values with other similar items on the market) and the comparative method of reproduction cost of improvements (appropriates the value of the improvements). There is a preference for the use of direct methods, and whenever there is sufficient market data for their use, they are chosen (STEINER et al., 2008).

The aforementioned authors also emphasize that a method is considered indirect when it requires results from some direct method. The indirect methods are subdivided into the income method (defines the value in terms of an already existing or expected income for the good on the market, that is, by the economic value of the good); involutive method (the value is estimated by technical-economic feasibility studies of its use) and residual method (calculates the difference between the total value of the property and the value of the improvements, taking into account the commercialization factor).

2.3 Technical Standard for Evaluations

This standard applies to typical market situations. In atypical situations, where the impossibility of using the methodologies provided for in this part of ABNT NBR 14653 is proven, the evaluator may use another procedure, provided that it is duly justified.

NBR 14653 will be made up of the following parts, under the general title “Valuation of assets”: - Part 1: General procedures; - Part 2: Urban real estate; Unauthorized copy Page 3 NBR 14653-1:2001 2 - Part 3: Rural properties; - Part 4: Projects; - Part 5: Machinery, equipment, facilities and goods – Part 6: Natural and environmental resources; - Part 7: Historical Heritage.

The standard establishes the following methods: direct comparative method of market data; evolutionary method; involutive method; and income method.

The Comparative Market Method is currently the most used. It consists of researching market offers and comparing them with the property being evaluated. In this sense, it is necessary that the research has consistency in the similarity of variables that will be worked in the form of Factors or by Statistical Inference. The most used variables are: Built-up area of useful area, parking spaces, finishing standard, location, conservation, among other variables that it deems necessary (GONZÁLEZ, 2010).

The aforementioned author also points out that the Evolutionary Method consists of researching land equivalent to the land of the property to be evaluated and assigning the monthly CUB value to the built area. The CUB will be assigned with the same care as to observe the standard of construction and age of the property (depreciation). This method is most suitable for properties where there is a shortage of compatible offers to compare to the property being evaluated. Examples: Farms, sites, sheds, among others.

The Income Method is little practiced, but common in the Real Estate Market. Basically it consists of the Real Estate Valuation taking into account the income value that will be generated by the property. In other words, the value of the property is determined according to the value that the client can obtain from renting it. This method is little used for residential properties, but one of the most popular Property Valuation methods when it comes to hospitals, universities, schools and other ventures (DANTAS, 2017).

The Involutive Method is the most used Property Valuation Method by Builders and Developers. It consists of pricing the property according to the use of the land. The professional who will analyze the space will take into account all the income that the Construction Company will have with commercial rooms, apartments, kitchenettes, industries, among other examples (DANTAS, 2017).

The first part of the standard is used with another according to the purpose of Real Estate Valuation. It provides an overview of what should be included in a Property Appraisal Report, provides clarifications and definitions.

NBR 14653 defines appraisal engineering as: “A set of specialized technical-scientific knowledge, applied to the appraisal of assets”. According to what Dantas (2017) teaches, evaluation engineering aims to support decision-making regarding cost values and investment alternatives,

involving any type of goods. Also according to the aforementioned author, this specialty is characterized by bringing together a set of knowledge in several areas of knowledge, namely: engineering, architecture, and complementary areas, with the purpose of technically determining the value of an asset, its rights, fruits and costs of reproduction.

Item 3.19 of the standard addresses the evaluation engineer and asserts that he must be a professional with a higher level, with legal qualifications and technical-scientific training to carry out evaluations, duly registered with the Regional Council of Engineering, Architecture and Agronomy - CREA.

III. METHODOLOGY

The present study was characterized as a research with a mixed approach, with a concomitant triangulation strategy.

Thus, it is qualitative, because it aims to clarify the complexity of the problem based on conceptual studies, and quantitative, because values were measured, both in the assembly of the data to be evaluated, and in the attribution of value to dichotomous variables.

This research was conducted through bibliographic, documentary and case study research.

The information that served as the basis for this study was extracted through several steps to the company's database, especially concerning the Building The Place Business Center, taking the following devices as guidelines: document analysis; examination of records; correlation between the information obtained and analytical review.

To achieve the proposed objectives, the following steps were developed:

a) Documentary research, through bibliographic consultation of normative documents of periodicals on the proposed theme, in addition to consultation through the internet;

b) Analysis of the information collected in order to identify the problem involved and looking for solutions and conclusions for the deficiencies contacted;

c) Research in the institution's field of activity, with the identification and study of the case found.

Figure 1 presents the flowchart of the methodology adopted in the present work.

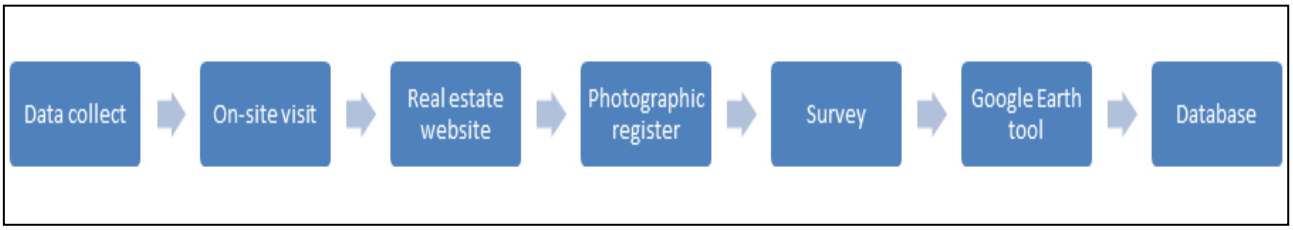


Fig. 1: Figure Title below the figure

With this information, it was possible to build the results of the present work.

IV. RESULTS AND DISCUSSION

First, a database about commercial rooms was created to glimpse some aspects such as area, parking spaces, closets, among others, as shown in Table 1.

Table 1: Result of the case study statistical inference calculation

Residential	Neighborhood	Area	vacancies	Cabinets	Walk	Main road	Value of neighborhoods	Income	Conservation state	Standard	Unit price	Price
Brittania Park Offices	Ponta Negra	32,00	1,00	1,00	9,00	3,00	384,05	12.895,09	2,00	4,00	75,00	2.400,00
Sky Platinum	Chapada	30,00	1,00	1,00	18,00	3,00	331,68	6.173,36	5,00	5,00	126,67	3.800,00
Millenium	Chapada	30,00	2,00	1,00	10,00	3,00	1.973,85	6.173,36	5,00	5,00	100,00	3.000,00
Brittania Park Offices	Ponta Negra	32,00	1,00	2,00	4,00	3,00	572,81	12.895,09	4,00	4,00	109,38	3.500,00
Ed. Atlantic Tower	Chapada	32,00	2,00	1,00	15,00	3,00	1.973,85	6.173,36	4,00	3,00	78,13	2.500,00

Ed. Cidade de Manaus	Centro	23,00	1,00	1,00	3,00	3,00	492,36	3.822,18	4,00	2,00	32,39	745,00
Millenium	Chapada	32,00	2,00	1,00	18,00	3,00	1.973,85	6.173,36	3,00	4,00	78,13	2.500,00
Ed. Empire Center	Chapada	35,00	2,00	1,00	6,00	3,00	546,75	6.173,36	3,00	4,00	51,43	1.800,00
Amazon Trade Center	Adrianópolis	32,00	2,00	1,00	8,00	1,00	179,69	9.083,18	4,00	4,00	78,13	2.500,00
SoberaneCoorporate	Adrianópolis	35,00	2,00	2,00	9,00	2,00	481,53	9.083,18	5,00	5,00	114,29	4.000,00
SoberaneCoorporate	Adrianópolis	35,00	2,00	2,00	10,00	2,00	481,53	9.083,18	5,00	6,00	137,14	4.800,00
Atrium	São Francisco	38,00	2,00	2,00	3,00	1,00	179,69	2.673,73	3,00	3,00	47,37	1.800,00
The Place Business	Adrianópolis	34,00	2,00	1,00	7,00	2,00	481,53	9.083,18	4,00	4,00	72,06	2.450,00
The Place Business	Adrianópolis	41,00	2,00	2,00	11,00	2,00	481,53	9.083,18	4,00	4,00	73,17	3.000,00
The Place Business	Adrianópolis	36,00	2,00	1,00	10,00	2,00	481,53	9.083,18	5,00	4,00	111,11	4.000,00
The Place Business	Adrianópolis	31,00	2,00	1,00	2,00	2,00	481,53	9.083,18	5,00	4,00	83,87	2.600,00
Atlântic Tower	Chapada	33,00	2,00	1,00	7,00	3,00	1.973,85	6.173,36	4,00	4,00	106,06	3.500,00
SoberaneCoorporate	Adrianópolis	35,00	2,00	1,00	5,00	2,00	481,53	9.083,18	5,00	6,00	128,57	4.500,00
Vieiralves Business	Adrianópolis	32,00	2,00	1,00	2,00	1,00	481,53	9.083,18	4,00	3,00	78,13	2.500,00
Amazon Trade Center	São Francisco	32,00	2,00	2,00	11,00	1,00	179,69	2.673,73	4,00	3,00	78,13	2.500,00
The Office	Adrianópolis	41,00	2,00	1,00	8,00	2,00	481,53	9.083,18	4,00	4,00	97,56	4.000,00
Cemom	Nossa Sra. Das Graças	36,00	2,00	2,00	3,00	1,00	481,53	7.246,36	3,00	2,00	55,56	2.000,00
Forúm Business	Adrianópolis	30,00	2,00	1,00	9,00	3,00	481,53	9.083,18	4,00	4,00	73,33	2.200,00
Atlântic Tower	Chapada	33,00	2,00	2,00	3,00	3,00	1.973,85	6.173,36	4,00	4,00	87,88	2.900,00
Mundi	Aleixo	36,00	1,00	2,00	7,00	3,00	412,36	7.450,53	4,00	3,00	91,06	3.278,00
Sky Platinum	Chapada	32,00	1,00	2,00	10,00	3,00	331,68	6.173,36	4,00	4,00	78,13	2.500,00
Forúm Business	Adrianópolis	41,00	2,00	1,00	5,00	3,00	481,53	9.083,18	4,00	3,00	65,85	2.700,00
Sky Platinum	Chapada	48,00	2,00	2,00	8,00	3,00	331,68	6.173,36	4,00	4,00	80,00	3.840,00
Cristal Tower	Adrianópolis	45,00	2,00	1,00	7,00	3,00	1.211,53	9.083,18	4,00	5,00	144,44	6.500,00
SoberaneCoorporate	Adrianópolis	35,00	2,00	1,00	2,00	2,00	481,53	9.083,18	2,00	3,00	100,00	3.500,00
Amazon Trade Center	São Francisco	32,00	2,00	1,00	7,00	1,00	179,69	2.673,73	4,00	4,00	71,88	2.300,00
Millenium	Chapada	35,00	2,00	1,00	11,00	3,00	1.973,85	6.173,36	4,00	4,00	85,71	3.000,00
The Place Business	Adrianópolis	32,00	2,00	1,00	2,00	2,00	481,53	9.083,18	3,00	3,00	71,88	2.300,00
The Place Business	Adrianópolis	32,00	2,00	2,00	8,00	2,00	481,53	9.083,18	5,00	5,00	118,75	3.800,00
The Place Business	Adrianópolis	36,00	2,00	2,00	3,00	2,00	481,53	9.083,18	4,00	4,00	97,22	3.500,00
Sky Platinum	Chapada	26,00	2,00	2,00	9,00	3,00	331,68	6.173,36	4,00	4,00	107,69	2.800,00
Sky Platinum	Chapada	40,00	2,00	2,00	7,00	3,00	331,68	6.173,36	4,00	3,00	87,50	3.500,00

Firstly, as described in the methodology, a Case Study was used, which used the 1st data model – 32 data. It is important to note that the variables were disabled

In terms of Walking, the significance was inverted (the bigger the more expensive and in the first model, the bigger the cheaper);

In relation to the road, it did not work, since practically all the projects are inserted in an urban corridor, that is, those that were placed 2 or 1 are in the zone of influence of urban corridors - Ex: CEMOM was initially classified as 1 (collector), however, it is considered the main neighborhood, as it is 600 meters from an urban corridor (Djalma Batista) inserted in Vieiralves. In this way, as determined by the Manaus master plan, it is influenced by this zone and has guarantees as if they were inserted in this corridor, in the stretch of the master plan it informs border strips up to 300 meters from the urban corridor, but in practice there is the influence of this corridor , as shown in Figure 2.

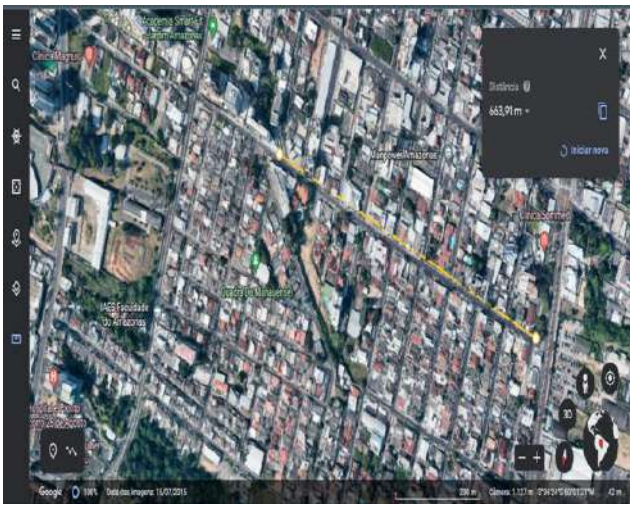


Fig. 2: Case study location

In relation to parking spaces, this variable was not used either, since it did not present variance, that is, practically all projects have a rotating parking space, and in the model this information was clear because it presented high correlation;

As for the Closet Variable, it was not possible to use it initially, as there was no identification through the search site, where the advertisers did not present photos that showed that there would be closets at the place to be inserted in the lease of 10 rooms, however, after the request for information with the advertisers, the cabinets variable was tested again, where the model did not adhere to the specifications to keep it cohesive; Amplitude (Ok).

The calculation of the statistical inference was performed (Figures 3 and 4), where it was possible to verify that some points were not adjusted as the Determination, the closer to 100% the better, and in this first model the mean of the regression and estimate is 70% , in addition, the final value of the rent was above the average of the data collected in the same enterprise.

Fig. 3: Result of the case study statistical inference calculation

Fig. 4: Result of the case study statistical inference calculation

In this case, it was necessary to analyze the database surveyed, where it was concluded that it would be necessary to include more data in the model, especially in the model to improve the sampling and reach a degree of reasoning as close to III, as shown in Table 1, in the NBR 14653-2.

Table 2: Degrees of reasoning in the case of using linear regression models

Item	Description	Degree		
		III	II	I
1	Characterization of the property being evaluated	Complete regarding all analyzed variables	Complete regarding the variables used in the model	Adoption of a paradigm situation
2	Market data collection	Characteristics conferred by the author of the report	Characteristics conferred by a professional accredited by the author of the report	Features provided by third parties may be used
3	Minimum amount of market data actually used	6 (k+1), where k is the number of independent variables	4 (k+1), where k is the number of independent variables	3 (k+1), where k is the number of independent variables
4	Identification of market data	Presentation of information related to all data and variables analyzed in the modeling, with photo	Presentation of information regarding the data and variables actually used in the model	Presentation of information regarding the data and variables actually used in the model
5	Extrapolation	not admitted	Admitted for only one variable, provided that: a) the measurements of the characteristics of the property being evaluated are not greater than 100% of the upper sample limit, nor less than half of the lower sample limit b) the estimated value does not exceed 10% of the value calculated in the limit of the sample boundary, for the aforementioned variable	Admitted, provided that: a) the measurements of the characteristics of the property being evaluated are not greater than 100% of the upper sample limit, nor less than half of the lower sample limit b) the estimated value does not exceed 10% of the value calculated at the limit of the sample boundary, for the aforementioned variables, simultaneously
6	Significance level (sum of the value of the two tails) maximum for rejecting the null hypothesis of each regressor (two-tailed test)	10%	20%	30%
7	Maximum significance level allowed in the other statistical tests performed	1%	5%	10%

In order to increase the reliability of the sample, it was necessary to increase the data collected, from 32 to 37 data, being used 32, and mixing the use of previous and new data, results were obtained within those foreseen in the standard.

With the theoretical domain and Microsoft Office Excel tools, the sample was analyzed in SisDEA Home software, a data modeling program withsupport for comparative evaluations of the real estate market. With this feature,enabled numerous combinations of variables influencing value,based on statistical inference, where the model that best explain the behavior for the present case study.

Commercial Offices available for lease in 2022 were used as a Model, with reference to April 22, 2022. Table 3 presents some Complementary Information:

Table 3: Additional information

Model variables and data	Quantities
Total variables	10
Variables used in the model	6
Total data	37
Data used in the model	32

It is important to point out that there are 10 variables, however, for the present study, only 6 were used (private area, basic neighborhood value, neighborhood income, state of conservation, constructive standard and unit value.

Table 4 highlights the statistical data of the case study, and it is possible to point out Correlation coefficient, Determination coefficient, Fisher – Snedecor and Model significance (%).

Table 4: Case study statistics

Model statistics	Value
Correlation coefficient	0,9048430 / 0,9075667
Determination coefficient	0,8187409
Fisher - Snedecor	23,49
Model significance (%)	0,01

To analyze the degree of dependence between the dependent variables and independent in the regression model, according to Ramos (2013) the use of thecorrelation coefficient, where the result can vary between -1 and +1, the variable withhighest dependency should be as close to 1, and the one with lowest dependencywill have its value closest to 0.

According to Silva (2016) the coefficient of determination indicates in percentage the explanation of this model, that is, it measures the degree of fit of the regression equation.

Table 5 shows the normality of the residues.

Table 5: Normality of waste

Distribution of waste	Normal Curve	Model
Waste located between -1 σ e + 1σ	68%	75%
Waste located between -1,64 σ e + 1,64 σ	90%	90%
Waste located between -1,96 σ e + 1,96 σ	95%	100%

In verifying the distribution of waste, according to Table 5, it was found that in the range [-1.64; +1.64] the value obtained in the model is exactly equal to the theoretical value. In relation to the range -1σ and + 1σ, the value was slightly higher, with a difference of 7%. In the interval 1.96 σ and + 1.96 σ the difference was 5% of the normal curve for the model.

Regarding the outliers of the regression model, they were not detected in the model under study.

Table 6 highlights the results of the analysis of variance from the case study.

Table 6: Analysis of variance

Source of variation	Sum of squares	Degrees of Freedom	Square Medium	F
Explained	42,084	5	8,417	23,488
Not explained	9,317	26	0,358	
Total	51,401	31		

The calculated F value for a significance of 1% was 23,488.

Below is the regression equation / estimation function (mode, median and mean):

Unit value ½ = +5.236837565 -1347.386557 / Private area² +2.198929688E-007 * BasicValueNeighborhood² +1.16367901E-008 * Neighborhood income² +0.7643987514 * State of conservation +0.06795452947 * Constructive standard²

Figure 4 illustrates the Adherence Graph - Linear Regression of the case study.

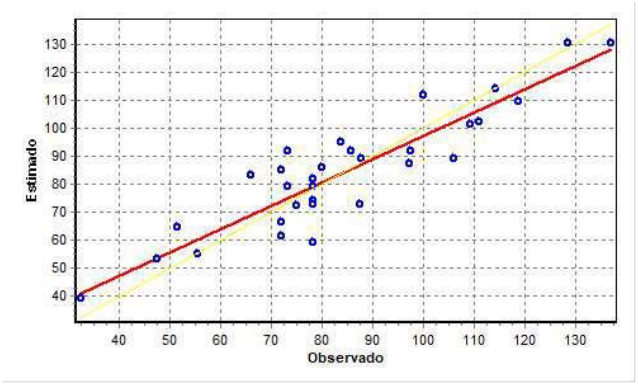


Fig. 4: Adherence Graph - Linear Regression

The adherence of the model can be verified through visualization graph in which observed values versus predicted values are plotted. And the closer the points are to the reference line, the greater the fit of the model to the data.

In figure 5 it is possible to observe the results of the evaluation through the residual graph.

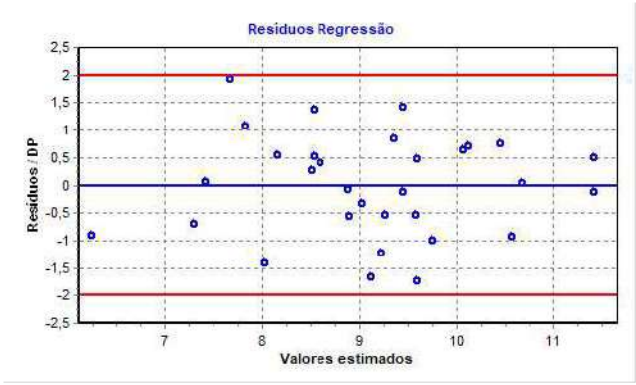


Fig. 5: Residual plot - Linear Regression

According to Levine (2014), the residual graph serves as a strategy for checking the assumptions for regression (linearity, independence, normality, homoscedasticity)

V. CONCLUSION

detailed scientific analysis of the real estate market in the city of Manaus is very important, especially due to the results obtained, for this linear regression was developed through a traditional approach, in search of transforming the existing conditions, in order to confirm of the 06 hypotheses of the model.

The general objective, which was to evaluate the rental value of a commercial room in The Business Center building, was achieved with the application of linear regression. The database that made it possible to generate the model was composed of 37 data from commercial rooms collected, and 06 independent variables were taken into account: private area, basic neighborhood value, neighborhood income, state of conservation, construction standard and unit value.

The model was analyzed according to the degree of justification, according to NBR 14653-2: 2011, where it met 3 items provided for in the standard, 1 for Grade II (Minimum amount of market data, effectively used) and 2 (Level of significance (sum of the value of the two tails) for the rejection of the null hypothesis of each regressor (two-tailed test) and Maximum level of significance allowed for the rejection of the null hypothesis of the model through of Snedecor's F test) for Grade III attribution, this being the highest attribution degree for a regression model.

It is recommended that the database of commercial rooms in the city of Manaus is always updated and that this evaluation methodology is used for other typologies, such as: single-family and multi-family homes, land and the like.

REFERENCES

[1]. ANTUNES, G. Avaliação de imóveis: histórico-cultural x urbano. Trabalho de Conclusão de Curso (Engenharia Civil). Universidade do Sul de Santa Catarina, 2017.

[2]. ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 14653-2. Avaliações de Bens Parte 2: ImóveisUrbanos. Rio de Janeiro, 2011.

[3]. CHEN TH. Theory-driven evaluations. Beverly Hills: Sage; 2020.

[4]. DANTAS, R. A. Engenharia de avaliações: umaintrodução à metodologiacientífica. São Paulo: Pini, 2017.

[5]. DINIZ, J. Avaliação de imóveis: metodologias e aplicação. Monografia (Graduação) – Universidade Federal do Paraná, Setor de EducaçãoProfissional e Tecnológica, Curso de TecnologiaemNegóciosImobiliários, 2011.

[6]. DROUBI, L. F. P.; ZONATO, W.; HOCHHEIM, N. Distribuição Lognormal: Propriedades e aplicaçõesnaengenharia de avaliações. In: 13º CongressoBrasileiro de CadastroTécnicoMultifinalitário e Gestão Territorial. Anais…, 2018. Florianópolis: COBRAC. Disponívelem: http://droubi.me/ cobrac2018 Acessoem: 20 mar. 2022.

[7]. FAGUNDES, F. Homologação de laudos de avaliação de imóveis no âmbito do serviçopúblico. Monografia (Curso de EspecializaçãoemConstrução Civil). Escola de Engenharia UFMG, 2014.

[8]. FREITAS, F. A multiplicidade de empregos para a engenharia no ramo das avaliaçõesDiagnósticas. Monografia (Engenharia Civil). Universidade Federal de OuroPreto, 2017.

[9]. FRONZA, C. Avaliação de imóveisresidenciaisurbanosnaengenharia:

métodocomparativodireto de dados do mercado. RevistaTécnico-Científica do CREA-PR - 10ª edição – Maio de 2018.

[10]. GONZÁLEZ, M. A. S, Avaliação de Imóveis e Metodologias de Perícias. São Leopoldo, 2010. Disponívelem: <http://www.exatec.unisinos.br/~gonzalez/aimp/AIMP-Avaliacoes.ppt>. Acessoem: 19 mar. 2022.

[11]. LEVINE, D. M. et al.. Estatística: teoria e aplicaçõesusando o Microsoft Excel emportuguês. 6.ed. Rio de Janeiro: LTC, 2014.

[12]. MATOS, D. Introduçãoaomercadoimobiliário. Curitiba: InstitutoFederal de Educação, Ciência e Tecnologia, Paraná, Educação a distância, 2017.

[13]. NUNES, J. et al. Análise dos impactos da Covid-19 no mercadoimobiliáriobrasileiro. Research, Society and Development, v. 9, n. 12, e46891211317, 2020.

[14]. RAMOS, LúciaZanoni, Modelo de Regressão Linear Múltipla para osbairrosComerciário, Michel e São Luiz da Cidade de Criciúma, SC - Engenharia Civil – Universidade do ExtremosulCatarinense – Unesc, junho 2013.

[15]. RIBEIRO, L. Estudo de Abordagem do MétodoComparativoDireto de Dados de Mercado para Determinação do Valor de Mercado de um ImóvelUrbano de Acordo com a NBR 14.653. Projeto de Conclusão de Curso (Engenharia Civil) Universidade Federal Fluminense, 2020.

[16]. SILVA, Ariella Zaccaron. Modelo de Regressão Linear Múltipla para Avaliação de Terrenos no PerímetroUrbano da cidade de Morro da Fumaça – SC. Engenharia Civil – Universidade do ExtremosulCatarinense – Unesc, novembro 2016.

[17]. STEINER, M. et al. Métodosestatísticosmultivariadosaplicados à engenharia de avaliações. Gest. Prod., São Carlos, v. 15, n. 1, p. 23-32, jan.-abr. 2008.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.23

From contamination to banning: the legality of asbestos mining in comparison with fundamental rights

Caio Coêlho de Oliveira[1], Cinthia da Silva Barros[2]

[1]PhD Student in Territory, Environment and Society, Catholic University of Salvador, Brazil
Email: profcaiocoelho@gmail.com
[2] Master's in Law, FG University Center. Brazil
Email : cinthiabarros.advogada@hotmail.com

Received: 16 Apr 2022,

Received in revised form: 14 May 2022,

Accepted: 20 May 2022,

Available online: 26 May 2022

Keywords— l***aw, environment, asbestos, fundamental rights***

Abstract— *Beyond the theoretical formations concerning Environmental Constitutional Law, the issue that this work emphasizes is the importance of also analyzing the argumentative structure and the configuration of institutions, under the influence of the Fundamental Rights Theory. Thus, it is intended, based on the analysis of the case of the asbestos ban, to critically analyze the whole normative structure as well as the elements that motivated the Federal Supreme Court (STF) to dismiss the Direct Action for Constitutionality No. 4066. The discussion is then necessary to understand why there are limits on the use of this mineral, besides verifying that the absence of public policies contributes to the invisibility of asbestos-related problems in Brazil. Nowadays, the victims of asbestos do not have their illnesses recognized, and their rights are denied in various instances. It's conclude that the fight to end the use of this fiber and to reduce the diseases caused by it is a political movement, as well as a legal one, since it is faced with the need to guarantee and enforce fundamental rights.*

I. INTRODUCTION

The normative system is in continuous transformation, and it is up to it to ensure the process of social harmonization in view of the good life, as well as the continuity of the living conditions of the human species. Furthermore, it is charged with the potentiality of establishing measures that aim to ensure the prevention of anthropological actions that are unfavorable to the environmental balance, thus preventing them from being the main causes of environmental impasses and unbalance that often endanger the right to life and social coexistence, such as environmental catastrophes that are often announced in the media

On the other hand, the Law, an instrument that regulates human conduct, could not be lowered in relation to the environmental problems immersed in the daily reality of human life. Therefore, aiming to revalue its function as the most appropriate mechanism to normatize and regulate the conducts that harm the environment, it started to get involved in environmental issues. Such involvement is a novelty that also has a technical and scientific character and requires communication with various areas of science for its understanding, such as conflicts arising from mineral exploration that require knowledge that connects geology, biology, physics, chemistry, medicine, and many other areas of science.

In this scenario, the systematization of Environmental Constitutional Law demonstrates the need to positivize the relationship between human beings and the space in which they live, a hard-to-define space that, when conceived in its broad sense, gains dimensions that go beyond all the activities and interactions of individuals. This evident need for limit definitions is fundamental to its applicability, because, according to Antunes (2012, p. 04), the legal

delimitations will serve as an important instrument for delimiting the regulatory and normative frameworks of human activities in relation to the environment. Marked mainly in art. 225 of the CF/1988.

Morever, in order to present an answer to the multiple challenges posed by the so-called environmental crisis, Constitutional Law is invoked as a perspective to present ways out of the threats that may threaten the Democratic State of Law by violating fundamental rights, in order to make an accurate analysis of the exploitation of asbestos and also its use for the processing and production of a variety of products. This problem was the object of the Direct Unconstitutionality Action (ADI) 4066, which requested the invalidity of the provision of Law 9.055/1995, which provided for the possibility of using white asbestos as raw material in industrial elements, thus making its exploitation process and the economy surrounding it viable.

II. THE CONTAMINATION

The initial delimitation of the approach to this work requires an understanding of what exploitation means and the positive and negative impacts, which cross the legal, social, economic and environmental fields. We will retrace the history of chrysotile asbestos from the time it began to be exploited in Brazil, in the mine of São Félix, in the State of Bahia, until the peak of its extraction in the mine of São Félix and Cana Brava in the State of Goiás, with surplus economic balances being the representation of development and temporary progress in the places where it was accumulated. Asbestos and abestos are nomenclatures given to the fibrous ore, easy to extract with a plurality of colors, textures, and chemical compositions that was exploited for decades all over the world. In former times, this ore was classified as a magic mineral due to the quantity of possible uses, since it is the raw material for more than three thousand different types of derivatives or products that it is part of. The physical-chemical properties make possible a wide use that goes from the composition of civil construction materials (roof tiles, coatings, reservoirs, flooring, etc.) to the composition process of vehicular brake discs. For so many conditions, it is understandable that there is a constant dispute for its use, given the fact that:

When dealing with the banning of a mineral good and the artifacts produced with it, we know we are entering the terrain of industrial and commercial disputes that find, face to face, businessmen interested in the continuity of its extradition and transformation and those who count the gains from the production and commercialization of substitute materials (SCLIAR, 1998).

It is certain that mineral exploration has contributed a lot to the building of the complex society in which we are inserted, ensuring from the technological development to the elementary ones that implied in the improvement of the quality of life. It is worth noting that it is a material with secular applicability, having been used since classical antiquity. However, when it comes to the exploitation of asbestos, the scenario changes due to the complexities originated in its extraction and processing processes. Many are the medical theorists who prove that the environmental pollution caused by asbestos causes diseases to human health. At first this impact was not perceptible. It was only after years that cancers and diseases acquired due to the use of asbestos became evident.

Well then, this development begins to be rescinded from the moment it becomes a risk, which, besides commercial disputes over raw material, becomes a collective threat, producing risks within society, as assured by the World Health Organization in resolution WHA60. 26. Therefore, we understand the complexity of this phenomenon, which advances compromising fundamental rights, above all by putting at risk all people exposed not only to the ore extraction process, but also those who have contact with its derivatives. Therefore, the process has gained imaginable contours taking into consideration the holistic phenomena at the ecological level.

The movement to ban the use of asbestos began with the organization of the workers who were most affected by the mine. In Brazil, the Brazilian Association of Workers Exposed to Asbestos (ABREA) and its extensions were created, and it has become an important social movement which has worked together with other socio-environmental movements in an attempt to ban asbestos exploitation. Inspired by the international movements for banning that emerged in Europe in the last decades of the 20th century, they were able to achieve the political strength needed to ban asbestos in some States, since this was not yet a constitutional provision and the competence of the States to legislate on the subject was limited.

III. HOW CONTEMPORARY CONSTITUTIONALISM AND ENVIRONMENTAL LAW ARE POSITIONED

To understand the historical construction process of the environmental law, as well as its insertion in the legal system, it is necessary to immerse ourselves in the evolution process of its normative bases, especially in the elaboration movements of the great constitutional charters. Taking into consideration that Constitutionalism has been subject to constant reinterpretations ever since its

inception. It is clear that the processes of legal positivization have always been related to political, philosophical, and sociological changes throughout history, and many of these have influenced the actions of the State, structuring a diversity of guidelines.

However, for a part of the doctrine, constitutionalism is linked to legal positivism, in which it is conceived as the initial mark in the 18th century. It is possible to counter argue by associating Constitutionalism as a form of popular expression independent of normatization, since these can be imposed merely to maintain power, that is, as a factor to guarantee it. The ancient constitutionalism that aimed to defend the sovereignty of laws linked to the concepts of citizenship and deliberate the emergence of regulatory institutions, being guided by a direct democracy that made the legislative processes a space of collective construction, having Greece and Rome as main examples. As clarified:[...] Athenian democracy consisted basically in the popular attribution of the power to elect the governors and to take directly in Assembly (the Ekklesia) the main political decisions, such as, v.g., the adoption of new laws, the declaration of war and the conclusion of peace or alliance treaties [...] The Roman Republic (V to II BC) was also an important stage for the maturation of constitutionalist ideas, especially because it has instituted a system of checks and balances to divide and limit political power [...]. (CUNHA, 2012, p.33)

Nevertheless, medieval constitutionalism, represented by the English Magna Carta (1215) had as its main intention the limitation of the Absolutist Power, which occurred from the laws that had influence on the environment of the rulers, once they were subordinated to them.

When invoked, modern constitutionalism carries with it a series of influences, the first being that of the Enlightenment, and the second that of positivism, both of which triggered social revolutions that influenced the formation of the Dualist (Liberal/Interventionist) State. The modifying action of the Law and legal relations were directed to the totality or to a considerable part of the social order, which can be vehemently observed in the principles of the French Revolution and American Independence and, consequently, influenced the formation of Social Democracies.

Contemporary times, however, are marked by being a period of global conflicts, in which economic issues are heated, marked by a high value-added burden, the foundations of constitutions, and the failure of Legislative States under the Rule of Law. A complex society needs an analysis of its multiple structures and systems. Understanding this diversity of spaces and fields of action, we will seek the influence of the sociological Niklas Luhmaan in an attempt to understand the normative legal system that is continuously confronted with other systems that are also constituted by their codes, languages, and validation plans, and that in many moments confront and need each other in order to be constituted.

In the same way that we observe the moment the legal and political systems are connected, analogically it can also occur between the legal and ecological system system, so they will always be in dialogue, each one of them established by its own autonomy, being politics, economy, sciences, ecology, religion, etc.

To the exact extent of this understanding, that the 1988 Constitution of the Federative Republic of Brazil is included, because not only in its Title II, but also in several other points of its text ensures a series of fundamental rights based on these principles. Pioneerism that will bring its due prominence by bringing the environmental theme addressed directly, that is, specifically, without linking it to another theme. Debating environmental issues in a broad way and dialoguing with several principles.

IV. PRINCIPLES AND FUNDAMENTAL RIGHTS

Conceiving the structure of a Fundamental Rights Theory for the time being requires a deep reflection of the constitutionalist movements already previously presented in order to justify the whole contribution of the Legal System as the main justifying element for the existence of the state's limits and obligations. The emerging norms of the fundamental rights reach the condition of legitimating the whole legal System in force, therefore thinking democratic state of law from **this** evolution.

When expressing the process of dogmatic construction on the bases that delineate fundamental rights as a practical subject, Alexy (2006) refers that these aim, in its last sense, at the rational substantiation of concrete "should-be" judgments within the scope of fundamental rights. The rationality of the reasoning requires that the path between the fundamental rights provisions and the "ought-to-be" judgments be accessible, to the greatest extent possible, to intersubjective controls, that is, they are the structuring pillars of whatever legal system it is under.

The word principle is multi-conceptual, which makes it a complex word to define. For the legal environment, since this is our focus, a principle is a designating and structuring element of a complex system of ideas that

will culminate in the development of norms, turning them into perfect axioms. Forming a theory of fundamental rights therefore requires the construction of a solid analysis of the process of conformation of the principles that emerge from it. Thinking about a Democratic State of Law makes it necessary to understand that: In terms of justification, the Constitution plays a special role regarding principles in the Democratic State of Law. Although it cannot be conceived as the only repository of them, it is its task, par excellence, to indicate (and preserve) those principles deemed most important by the citizens through the sensitive constituent representative of society. The competition between constitutional principles reveals a fundamental characteristic of the society in which a Democratic State of Law exists: it is not possible to hierarchize constitutional principles because they are all equally valuable for the self-identification of a pluralist society. It is the set of them, and not one or the other, that reveals who we are and who we want to be. (GALUPPO, 1999)

In Brazil, the principles became more effective after the 1988 Constitution, which was based on human dignity. In the legal system, the constitutional principles are at the apex of the legal system, since they will support the normative system and its guidelines, in addition to structuring a series of guarantees.

Understanding these phenomena of concomitance among the principles, we can visualize their effectiveness in the correlation with fundamental rights. Therefore, we analyze that its origin is associated to the English Magna Carta of 1215. However, in this document, there is only the agreement made between the sovereign and the other classes (Nobility and Church), with the purpose of delimiting the sovereign's powers.

The origin of the positivization of the Fundamental Rights can be actually associated to the French Revolution, from the Declaration of the Rights of Man and Citizen (1789) and to the American States' Declarations of Rights through the Bill of Rights of 1776, whose texts served as a reflex for the Constitutional Letters of the 18th and 19th centuries.

When we invoke the right to an ecologically balanced environment, it is salutary to point out that this right is part of the list of fundamental rights of the third generation, which consists of a catalog of rights that are transversal in the scope of the dimensions of rights.

They are subdivided into three dimensions, in which one generation does not exclude the other. The first generation refers to negative liberties, or individual rights and guarantees, such as life, freedom, and property. The second generation rights are related to state intervention, refering to social, economical, and cultural rights in the sense of guaranteeing equality in the material sense between men. Finally, the third generation are the rights of solidarity or fraternity, which are evidenced as follows: These latter rights, which include the right to development and the right to the common heritage of mankind, presuppose the duty of collaboration of all states and not only the active action of each one, and carry a collective dimension that justifies another name for the rights in question: the rights of peoples. (CANOTILHO, 1997, p.386)

As a first perspective, it is about the understanding of diffuse rights or diffuse ownership, once it has the perception of collectivity in face of individuality, in which the legal perception surpasses even the relations between human subjects, but all its complexity and the universe that surrounds it. The object becomes the experience of the collective and its future construction, that is, the need to revisit the founding principles of the collective human experience itself. Other authors also bring two more dimensions in addition to the others mentioned above; the fourth presents subjects about new rights such as euthanasia, bioethics, assisted reproduction, and the fifth generation deals with virtual rights.

V. THE POSITIVIZATION OF ENVIRONMENTAL LAW IN THE CRFB/88

The 1988 Constitution of the Federative Republic of Brazil was avant-garde in dedicating its Chapter VI, Title VIII, to environmental issues as the normative structuring basis for a broad understanding of Brazilian Environmental Law. It dedicates an entire Title to all these rights, in addition to other provisions such as, for example, Article 225, which deals with environmental issues.

In this device, it is possible to verify its degree of comprehension, which confers its scope to all social actors. It becomes an element of integration and comprehensiveness with the rest of the normative system. Gutier (2010) calls them as fraternity or solidarity rights that will culminate in the constituent meaning. In understanding it as a principle rule, it is necessary to broaden the understanding of its spectrum of applicability and the interconnection with other principles.

However, it can be seen that the influences of this fundamental right can radiate its effects throughout the entire legal system, not limited to the strict or conceptual sense, but may encompass other rights, such as: the preservation of health, well-being, safety of the population.

It can even reach the principle of conformity of the economic order that grants it the attribution of a fundamental right, once it involves several public and private activities.

Another point worth mentioning is the broad conception that the environment is essential to the quality of life. Therefore, it will be up to the State to protect this right, a mark that gains credit as a duty and no longer as a mere faculty. Soon this matter leaves the field of administrative discretion and adheres to a country/nation project, and it is up to the State to call upon itself the responsibilities in conducting the guidelines linked to this theme, which ceases to be a merely political agenda, entering the responsibilities of those who constitute the State.

Remember that such responsibility extends to other citizens when legal tools are also available to them that are able to protect and ensure this collective good, such as the plurality of procedural means for its defense, such as the possibility of criminal action, the ordinary civil process, the popular action, the public civil action, among others.

VI. INFRA-CONSTITUTIONAL LEGAL EFFECTS

One of the most relevant topics established as one of the goals for the millennium is undoubtedly linked to the "environmental issue". The concerns surrounding it have approached that go beyond movements and environmental activist groups, reaching the debates between leaders and heads of state and, obviously, in the international community's discussion forums around a collective resolution with the objective of finding an "environmental balance".

To prove such reflections we must understand that the demand for a healthy and balanced environment is, at the same time, a way to highlight the other fundamental rights of human beings, a right whose preservation is recognized as a common interest of Brazilian society since the country has stood out throughout history as an important signatory of multiple international treaties and agreements.

This reflects that by crediting the need for a constitutional amendment, an instrument whose purpose as Silva (2011) considers as a formal process of changing rigid constitutions, through the action of certain bodies, through certain formalities, established in the constitutions themselves to exercise the reforming power. By gaining the attributes of a constitutional device, it reaffirms the normative importance of treaties for the Brazilian legal system.

Recognizing that climate change represents an urgent and potentially irreversible threat to human societies and to the planet, and therefore requires the broadest possible cooperation of all countries and their participation in an effective and appropriate international response, with a view to accelerating the reduction of global greenhouse gas emissions. The last agreement signed by Brazil regarding this issue was the Paris Agreement, a treaty within the United Nations Framework Convention on Climate Change (UNFCCC), which governs measures to reduce carbon dioxide emissions from 2020 onwards. The agreement was negotiated during COP-21 in Paris and was approved on December 12, 2015.

The normative power of the Constitution allows us to analyze the context in which the environmental principles derived from it are inserted. The subject of public policies on the matter cannot be immune to the principle of the universality of jurisdiction, as a means of realizing the value of environmental justice.

The irradiation of its effects is notorious throughout the legal system, causing it to be restructured in light of the values enshrined in the constitutional text. These effects will be noticeable mainly in the state constitutions that, despite not having sovereignty to draw their guidelines, have autonomy in the conduction of their constituent processes, being able to expand the guidelines as long as they preserve the fundamental rights guaranteed by the Constitution.

VII. CONCLUSION

The complementary legislation presents Law 9,055 of June 1, 1995, which regulates extraction, industrialization, use, sales and transport of asbestos/asbestos-containing products, as well as natural and artificial fibers, of any origin, used for the same purpose, and makes other provisions.

Another condition that makes this situation different is the plurality of impacted subjects, as we intend to study. Either because they are directly exposed to the phenomenon originating from the impact, or because of the indirect exposure of the agents that caused the environmental contamination process. Therefore, there is a legal difficulty in identifying third parties that have received the impact beyond the environmental impact generated by mineral exploration.

The availability of legal tools before the court, thus, national, regional and local interests must be harmonized in the legal treatment of these issues, leaving aside hermetic or isolationist legal constructions, contrary to the integration of private interests in the social interest. The precautionary principle means not procrastinating on preventive measures, even if these measures require the

immediate investment of financial resources to avoid pollution and deforestation and to effect recovery.

In fact, as the author states, the precautionary principle should be invoked even before polluters cause damage. Thus, it is important to understand the procedural legal aspects and their availability to impacted societies, so that they can use subsidiary legislation to repair damage, or even foresee possible impacts through precaution with a view to eradication - even if they are often considered impossible - so that the legal system can pay due attention to these problems.

Thus, it is necessary to understand that the duty to recover the environment degraded by the exploitation of mineral resources is under the normative guidance of the CRFB/88 in art. 225 §2. The constitutional text allows us to understand that the recovery procedure must be conducted by technical guidance. This in turn should be carried out in conjunction with the exploratory procedure, a requirement not in the analysis of the case at hand. This allows us to reflect and understand how the restoration should proceed after the exploration.

Seeking to understand the involvement of third parties who were affected only by inhaling waste without having direct contact with the exploratory process since there are particles in suspension, directly affecting the health of people who live and develop their activities in the district, which have similar clinical pictures as pointed out by ABREA asbestosis, mesothelioma and lung cancer.

Understanding the particularity of this case, especially with regard to the obligation to repair environmental damage environmental damage and even identify which phenomena and legal instruments are involved in these cases, it is necessary a theoretical legal immersion in the field of Civil Law, especially in the issues that outline the obligation to repair the damage caused. It is also necessary to invoke the Law of National Environmental Policy (Law no. 6.938, of August 31, 1981) in consonance with art. 225, §3 of the Constitution.

It is necessary, therefore, to investigate the legal tradition, from a critical and in-depth analysis regarding the understanding of the liability process, having as basis of applicability in the concrete case that makes it possible to elucidate the scope of environmental liability. In this way, we will contribute not only to the elucidation, but also to the understanding of possible future problems, ensuring in turn, the protection of an environment that is indeed protected for other generations and a legal system that reaches its goals.

ACKNOWLEDGEMENTS

We are grateful for funding from the Fundação de Amparo a Pesquisa do Estado da Bahia (FAPESB) and the Coordination for the Improvement of Higher Education Personnel (CAPES).

REFERENCES

[1] ALEXY, Robert. **Theory of fundamental rights.** 2 ed. São Paulo: Malheiros, 2014.

[2] ALIER, Joan Martínez. **The ecologism of the poor: environmental conflicts and valuation language. 1** ed. São Paulo: Editora Contexto, 2007.

[3] ANTUNES, Paulo de Bessa. **Environmental Law**. 14th ed. São Paulo: Atlas, v. Único, 2012.

[4] ATIENZA, Manuel; MANERO, Juan Ruiz. **ON PRINCIPLES AND RULES**. Revista de Direito da Faculdade Guanambi, v. 4, n. 01, p. 04-24, 2017.

[5] BAHIA, Carolina Medeiros et al. **Juridicity of environmental causality: Manual of Environmental Law.** São Paulo: Saraiva, 2015.

[6] CANOTILLO, José Joaquim Gomes; LEITE, José Rubens Morato **Brazilian constitutional environmental law**. 6 ed. São Paulo: Saraiva, 2015. 532 p.

[7] COLLEGIUM RAMAZZINI, (Org). **THE GLOBAL HEALTH DIMENSIONS OF ASBESTOS AND ASBESTOS-RELATED DISEASES**. Brazilian Association of those Exposed to Asbestos. Osasco, 2015. 7 p. Available at <http://www.abrea.org.br/CR2015PORT.pdf>. Accessed on: 20.06.2020.

[8] CUNHA JÚNIOR, Dirley da. **Constitutional Law Course**. 6th ed. Salvador: Jus Podivm, 2012.

[9] FIORILLO, Celso Antonio Pacheco. **Brazilian environmental law course**. 10 ed. São Paulo: Saraiva, 2009. 642 p.

[10] GALUPPO, Marcelo Campos. **The legal principles in the Democratic State of Law: essay on how to apply them**. Revista de Informação Legislativa, Brasília, v. 36, n. 143, p. 191-210, 1999.

[11] LASSALLE, Ferdinand. **The essence of the Constitution**. 9th ed. Rio de Janeiro: Freitas Bastos, 2014.

[12] LUHMANN, Niklas; ZAGREBELSKY, Gustavo (Trad.). **The constitution as an evolutionary acquisition. Recht historisches Journal,** Torino, v. 9, p. 176-220, 1990.

[13] MACHADO, Paulo Affonso Leme. **Brazilian environmental law**. 22 ed. São Paulo: Malheiros Editores, 2014. 132 p.

[14] WHO, **World Health Organization.** Available at http://www.who.int/es/news-room/fact-sheets/detail/asbestos-elimination-of-asbestos-related-diseases.Accessed on: 20.06.2020.

[15] ROCHA, Júlio Cesar de Sá da**. Environmental Labor Law: paradigm changes in the legal protection of worker's health.** São Paulo: Atlas, 2013.

[16] SARLET, Ingo Wolfgang; FENSTERSERSEIFER, Tiago. **Environmental constitutional law: Constitution,**

Fundamental Rights and Environmental Protection. 5 ed. São Paulo: Editora Revista dos Tribunais, 2017. 457 p.

[17] SCLIAR, Claudio. **Asbestos: magic mineral or cursed? Human ecology and political-economic dispute**.1 ed. Belo Horizonte: CDI, 1998. 152 p.

[18] SOARES, Ricardo Maurício Freire. **The constitutional principle of the dignity of the human person: in search of fair law.** 1 ed. São Paulo: Saraiva, 2010. 221 p.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.24

Drought in Sisal Territory: Study on the Standardized Precipitation Index (SPI) considering Climate Change Projections for Valente/BA

Tiago Batista Cerqueira[1], Sueline S. De Souza[2], Alexandre Boleira Lobo[3], Marcos Antônio Vanderlei Silva[4], Marcos Victor do Carmo Loiola[5], Luiz Antônio Costa de Santana[6], Marcos Antônio Cerqueira Santos[7], Fábio Del Monte Cocozza[8], Jairton Fraga Araújo[9]

[1,5,7], PhD student (PPGADT) - University of the State of Bahia (UNEB).
Email: tiagobhc@gmail.com; sueliness@yahoo.com.br; mloiola@gmail.com; marcos.antonio@ifbaiano.edu.br;
[6] PhD in Law - University of Lomas de Zamora (Argentina). Professor - University of the State of Bahia (UNEB) and Federal University of the Sao Francisco Valley (UNIVASF). Email: luiz.santana@univasf.edu.br
[2,3,8,9] Permanent professor (PPGADT) - University of the State of Bahia (UNEB/DTCS) - *Campus* III
Email: alopo@uneb.br ; maavsilva@uneb.br; jairtonfraga@bol.com.br ; fabiococcoza@uneb.br

Received: 15 Apr 2022,

Received in revised form: 14 May 2022,

Accepted: 20 May 2022,

Available online: 26 May 2022

***Keywords*—Semiarid, Dry, Desertification, Climate changes, Sisal.**

Abstract*—This article aims to analyze the historical behavior and projections of precipitation and drought incidence for the municipality of Valente in Bahia, also associating climate variability with the variability of sisal production in the region. The research was characterized as exploratory descriptive, having been carried out through bibliographical and documentary survey. It should be noted that meteorological data were obtained through the platforms of the National Institute of Meteorology - INMET and Climate Change Projections for South America regionalized by the ETA - PROJETA model, which were analyzed using the Drought Index and Monitoring System - DIMES, to obtain the Standardized Precipitation Index – SPI and by CLIMAP to understand the trends and temporal distribution of rainfall and temperature for the location. The study concluded that in the 2010s there was one of the most severe and prolonged droughts today, which even influenced the low productivity of sisal in the region, and that, in view of future projections until 2030, the socioeconomic drought scenario tends to worsen.*

I. INTRODUCTION

Climate change and its effects are one of the themes that are at the heart of scientific discussions and global governance, due to the deleterious risks they can cause to society, the environment, and the economy. The breadth of extreme phenomena and climate variability can affect biodiversity, agricultural production, food security, access to quality water, health, employment, and the stability of socio-ecological systems [1].

Drought is one of the natural phenomena that has possibly been aggravated by climate change, presenting with greater constancy and intensity, and consequently increasing the susceptibility of desertification in arid climate regions [2]. Presented by the Pan American Health Organization/World Health Organization – PAHO/WHO [3] as a climatic event capable of permanently affecting several regions of the world, drought is characterized by its long duration and difficulty in stipulating its onset.

As a climatic phenomenon, drought is related to the existing hydrological balance between rainfall episodes, volume of reserves and evapotranspiration rate [3]. Fernandes et al [4] in turn, describe that the occurrence of drought in each region is due to lower levels of precipitation in a certain period when compared with the climatological estimates of the place.

Thus, drought refers to water scarcity on a temporal scale in eachterritoriality and can be classified into four types according to its severity, namely: meteorological, hydrological, agricultural, and socioeconomic. Meteorological drought is characterized as a deviation in the amount of rain expected on short scales, in response to more ephemeral atmospheric conditions. The hydrological drought is recognized by the temporal extension of rainfall deficits, which in turn end up affecting the volume of water available in reservoirs and water courses. Agricultural drought is understood as the insufficiency of moisture in the land to rehydrate the evapotranspiration losses of plants, thus impairing their productivity. Finally, the socioeconomic drought is related to the direct impacts on the daily lives of the populations, due to the lack of availability of water, as well as for the sanitary supply and for supply in the productive chains, among others [5].

One of the methods commonly used to measure the degree of humidity or dryness is the Standardized Precipitation Index - SPI (Standardized Precipitation Index). This is calculated using only the amount of monthly precipitation as a variable, returning values that correspond to categories between extremely dry and extremely humid. The SPI can be analyzed based on different temporal scales of precipitation rates, making it possible to examine meteorological or hydrological drought regimes, as well as their constancy, frequency, and severity within the analyzed period [5] [6].

A report presented by PAHO/WHO [3] points to drought as one of the main threats of natural disasters, with the poorest and developing regions being the most vulnerable to it. In fact, it is known that drought has been a bitter reality for many people across the globe for a long time, and that it manifests itself in various moments, such as poverty, hunger, malnutrition, and death, wherever it is present.

Campos and Studart [7] point out that between 1777 and 1779, Brazil experienced a great drought, with an estimated death of about 500,000 people in Ceará and adjacent areas. However, this reality is not limited to a remote past, the document Declaración de la OMM about the environment in the word in 2019, brings in its body relevant statements about the impacts that drought has brought to populations, whether environmental, social or economic, among which forest fires stand out, with the destruction of several ecosystems; promotion of migrations (eco-refugees); expansion of the exposure of the world population to health risks from heat and pollution; and slowing down of economic growth, especially in developing countries [8] [9].

The drought experienced between 2012 and 2015 was considered one of the worst in the recent period in the history of the semi-arid region, with the occurrence of El Niño and the abnormal position further north of the Intertropical Convergence Zone - ITCZ over the Atlantic being pointed out as aggravating factors, a fact characterized by the heating of these waters [1].

Faced with the problem of climate change and the phenomenon of drought, this study aims to analyze the historical behavior and projections of the Standardized Precipitation Index - SPI, from the survey of official secondary data measured and simulated for future scenarios considering changes in the climate for the city of Valente - located in the sisal territory of the semi-arid region of Bahia, as well as associating climate variability with the production of sisal in the region.

In an article reported by the news portal G1, Mendes [10] portrayed what would become in the mid-2010s, the worst drought since 1960 experienced by the municipality of Valente, making it possible to ascertain the occurrence of a prolonged and severe drought, characterized, therefore, as a hydrological, agricultural and socioeconomic drought, as it seriously affected agricultural productivity and the entire chain of processing of sisal fibers in the region, bringing financial and social losses to the local population.

Valente's economy is based on commerce, the sisal industry, agriculture, and livestock. According to Cerqueira [11], Valente is among the three largest producers of sisal in the territory, but cassava, beans and corn can be found in the locality, the latter two of which have low productivity in the region. In livestock terms, the practice of grazing for sheep, goats and cattle is observed, so that agropastoral activities are identified as those promote greater occupation of land in the sisal territory.

In view of the above, the present study intends to analyze the historical behavior and projections of precipitation and drought incidence for the municipality of Valente in Bahia, also associating climate variability with the variability of sisal production in the region.

II. MATERIAL AND METHODS

The present study is characterized as exploratory descriptive research, having been carried out through a

bibliographic and documentary survey, with consultations to primary and secondary sources. In this way, scientific articles extracted from platforms such as the Scientific Electronic Library Online – SciELO, Google Scholar and Lens.Org.AcademicProductions made available in university repositories; reports and publications from representative organizations and data obtained from platforms that provide climatological information such as the National Institute of Meteorology – INMET [12], National Institute for Space Research - INPE.

Daily historical information on rainfall and temperature variables were downloaded from the INMET Database (https://portal.inmet.gov.br/), observing a time interval of 39 years, corresponding to the 1980s. to 2019. As a reference to obtain the data, the conventional weather station of the municipality of Serrinha/BA was used, located at geographic coordinate's latitude-11.67 and longitude-39, which is also located in the territory of Sisal and is approximately 60km from the administrative headquarters of Valente/BA, being the closest station to the city object of this study.

The data from the climatic variables were first processed in the free software Climap 3.0, which made it possible to carry out statistical, analyzes of the daily meteorological data with consequent inference of trends in the temporal distribution of rainfall and the temperature curve for the location [13].

Precipitation forecasts, considering climate change, were obtained from CPTEC/INPE, through the Climate Change Projections for South America platform regionalized by the ETA - PROJETA model (https://projeta.cptec.inpe.br/#/dashboard).Monthly data with a 10-year interval between the years 2020 to 2030 were sought, using the 20km option, RCP8.5, continental HadGEM2-ES as a reference, using the same geographic coordinates as the INMET meteorological station.

The choice for the RCP8.5 scenario was based on the arguments of Schwalm, Glendon and Duffy [14], who communicate that in this model the accumulation of CO_2 in the atmosphere in a shorter temporal analysis is what is most likely to align with the conventional policies adopted, as well as global efforts aimed at mitigating greenhouse gas emissions, as in the Paris Agreement (Figure 1). Nevertheless, the authors still see that, although the future scenario may seem more pessimistic regarding the fight against climate change, the choice to overestimate, rather than underestimate future scenarios, can serve as a foundation to advise decision makers.

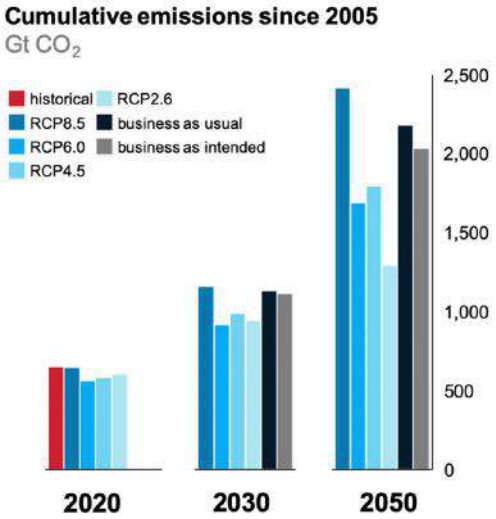


Figure 01: Expected accumulation of CO_2 in the atmosphere according to climate projection models.

Source: [14]

In this way, it should be noted that both INMET's historical data and PROJETA's forecasts were configured to present monthly precipitation values to be able to run in the Drought Index and Monitoring System -DIMES tool, in the Microsoft Excel environment, to verify the occurrence and forecasts of water deficits through the Standardized Precipitation Index - SPI. As for the time scale to calculate the SPI, the 12-month interval was chosen, where the graph curve responds better if there was a drought of the hydrological and agricultural type in the studied territory [5]. The SPI values and their qualification regarding the degree of drought or humidity are presented in Table 01.

Table 01: Dryness or humidity categories according to the SPI value.

SPI	CATEGORY
≥ 2,00	Extremely humid
1,50 a 1,99	Severely Wet
1,00 a 1,49	Moderately Moist
0.01 a 0,99	Incipient Moisture
0 a -0,99	Incipient Drought
-1,00 a-1,49	Moderately Dry
-1,50 a -1,99	Severely Dry
≤ - 2,00	Extremely Dry

Source: [5].

Nevertheless, the research also collected quantitative data on the production of sisal in Valente/BA between the

years 2010 to 2019 to verify if the water variability is associated with the amount of sisal produced in the municipality. Thus, such information was obtained from the digital repository of the Brazilian Institute of Geography and Statistics - IBGE, through economic statistical studies on agriculture, livestock, and others, and more specifically in the product: Municipal Agricultural Production (PAM) (Agricultural Production Municipality - PAM | IBGE).

Finally, the image projection process (desertification map) was performed using the GIMP publishing software version 2.10.8.

The Brazilian semiarid and the territory of Sisal

Covering an area of approximately 1,128,697 km2, the Brazilian semi-arid region comprises almost the entire northeastern territory and a part of northern Minas Gerais. Included in this space are 1,262 municipalities, with a population of about 24 million people, equivalent to 13% of the country's total population. It is also noteworthy that the semi-arid region encompasses 64% of the northeastern territory and 12% of the national territory [15] [16] [17] [18].

The Brazilian semi-arid region is recognized for its low rainfall and high temperatures, which associated with high evapotranspiration rates, constitute a climate with great aridity. Although there is a statement that there is no rainfall in the semi-arid region, the fact is that it occurs at an annual average of 400mm to 800mm, and it is worth noting that it can be concentrated in a period or in a certain location, thus characterizing a dispersion that does not cover the entire territory in a linear fashion [17] [19].

The semiarid vegetation is characterized by xerophilous and tropophilous, which, due to their generally thorny constitution, have high adaptability to the scarcity of rainfall. In addition, deciduous tree and shrub species can be glimpsed, and in some cases, they can store water and nutrients in their root system [18] [19] [20].

As part of the morphoclimatic domain of the semiarid region, the sisal territory according to Cunha et al [21] is characterized by irregular annual rainfall; annual average temperatures of 24ºC, being 29.2ºC maximum temperature and 20.2ºC minimum temperature; and water deficit between -20% and -40%. Based on such information, it is possible to state that the risk of drought in the territory is high, so that annual rainfall averages of about 400mm to 650mm are recorded. The authors also observe that the intertropical geographic location, associated with the characteristics of climate and temperature, as well as the atmospheric clarity verified in the region for most of the year, favor the process of potential evapotranspiration, being estimated at 3,000 mm per year.

It is worth mentioning that the sisal territory also has high levels of insolation and low relative humidity, so it is also possible to say that the dry period is predominant in the area, corresponding to about 6 to 8 months, although it can be reaching the 11-month mark in areas with greater aridity. It should be noted that the high insolation observed in the locality makes it therefore present a high frequency of droughts, as well as torrential rains. That said, these characteristics project 100% of the territory's areas into the drought polygon [21] [22].

The sisal territory corresponds to an area of 20,292.70 km^2, about 3.6% of the area of the state of Bahia, with a population of about 582,329 habitants, spread over 20 municipalities, namely: Monte Santo, Nordestina, Queimadas, Quijingue, Serrinha, Teofilândia, Barrocas, Biritinga, Conceição do Coité, Ichu, Lamarão, Retirolândia, Santaluz, São Domingos, Tucano, Araci, Candeal, Cansanção, Itiúba and Valente [22]. The latter being the focus of analysis in more depth. The geographical delimitation of the territory can be seen in Figure 02.

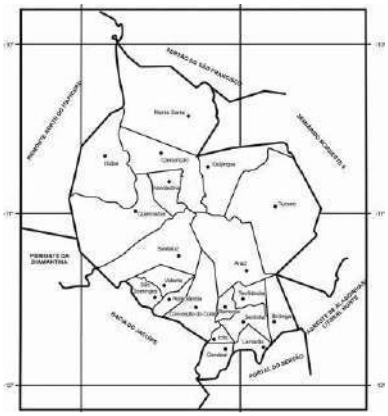


Fig.2: Delimitation of the Sisal Territory – Bahia.

Source:[20].

Lima et al [23] draw attention to the fact that, since 1970, the municipalities that make up the sisal region have undergone marked landscape transformations, a fact mainly attributed to the suppression of native vegetation, especially the caatinga, to make way for agricultural activities, so that an accelerated process of environmental deterioration has been established, which tends to promote desertification processes, which are pointed out as aggravating climate change.

Problematizing drought in the Sisal Territory

According to the World Meteorological Organization - WMO [24], droughts can be characterized according to severity, location, duration, and chronological development, and it is possible to say that it has as its

primary cause, hydrometeorological processes that cause rainfall suppression, as well as they limit the availability of water in surface or underground mode.

Thus, it is stated that drought is mainly related to climatic phenomena related to low and/or irregular rainfall associated with high rates of evapotranspiration and may be closely linked to desertification processes. Silva [25] states that 41% of land cover is in dry regions, and between 10% and 20% of this total is in the process of desertification.

Considered extensive natural disasters, the occurrence of droughts affects not only the Brazilian semi-arid regions, but the entire world, so that of the total of 10,603 environmental disasters recorded across the globe between 1970 and 2014, 577 were drought-related, and more, 21% of deaths resulting from disasters are attributed to events of this nature [3] [26]. In Table 02, a comparison of the impacts of drought in the world and in America can be seen over forty-four years.

Table 02: Comparison of drought impacts in the world and in America between 1970 and 2014.

	World			Americas		
	total of disasters	**drought disaster**	**% drought disaster**	**total of disaster**	**drought disaster**	**% drought disaster**
Events	10.603	577	5,4	2737	128	4,68
Deaths	3330568	700.869	21,0	496.170	77	0,02
Affected	6680448	2067368	30,9	237.232	70.397	29,6
Costs	2687169.357	132809588	4,94	971.986.750	59.457.639	6,12

Source: [3].

According to the United Nations - UN [27], the process of environmental degradation is so increasing that two billion hectares of destroyed land have been identified, a fact that impacts 3.2 billion people worldwide.

When carrying out a more focused analysis on the sisal territory, there is a marked erosion of the vegetation cover, and such circumstances are attributed to the forms of land use in the region (agriculture, livestock, and mining), indicating an imbalance between the natural and anthropic exploitation [11].Understanding the natural and social environment, as a socio-ecological system, it is possible to perceive the relationship established between human action and the occurrence of drought, even if it comes from climatological phenomena.

The above statement is based on several studies that demonstrate that deforestation, the lack of vegetation cover on the soil, favors erosion, as well as an increase in the surface runoff of rainwater, consequently reducing the infiltration capacity of the same on the ground. As a result of this process, there is a higher rate of evapotranspiration, which, associated with issues of rainfall irregularity, leads to a situation of drought, in which the water availability of water courses - surface and underground is affected, impacting natural elements (fauna and flora) and human beings, with the deprivation of the use of this important resource in domestic, subsistence and economic activities [18] [28] [29] [30] [31].

Faced with such placements, it is important to highlight that the sisal region has a geophysical structure that favors the occurrence of drought, its soil types are considered fragile, with high susceptibility to erosion and desertification processes. Dourado [32], conducting research on areas at risk of desertification in Bahia, identified that the central region of the state, where the semi-arid region is located, presented areas that ranged from very high to low risk. It should be noted, however, that the north of the semiarid region is constituted almost entirely by areas of very high risk, and it is precisely in this area of higher prevalence of risk that the territory of sisal is inserted and therefore the municipality of Valente, as can be seen in figures 03 and 04, where the greater the prevalence of reddish tones, the greater the incidence/propensity to desertification.

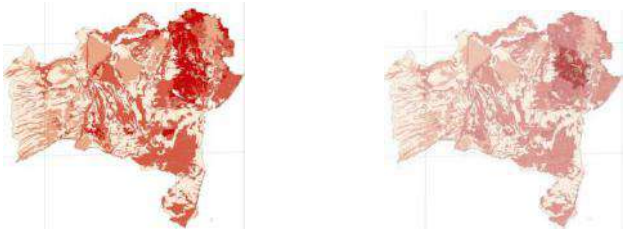


Fig. 3 and 4: Representative scheme of soil fragility and susceptibility to erosion in Bahia.

Source: [33].

The effects of climate change can worsen droughts and consequently intensify desertification processes, especially in more vulnerable regions. Marengo, Cunha and Alves [1] state that the prospect of an increase in both the frequency and duration of drought is worrying, as such factors associated with increased temperature, consequently incur greater environmental degradation and establish a vicious cycle of the socio-ecological system [32], in which the environment, in an attempt to recover, ends up aggravating climate change and these respond in such a way that they end up accentuating drought conditions .

Faced with such concerns, it is relevant to highlight that the state of Bahia currently has 417 municipalities, 97 with a declared state of emergency due to drought and/or drought, twenty of them in southwest Bahia and thirteen in the sisal territory. So that 1,003,975 people suffer directly from this situation, being in the territory of sisal, 164,361 people and in Valente 1,547 people [34].

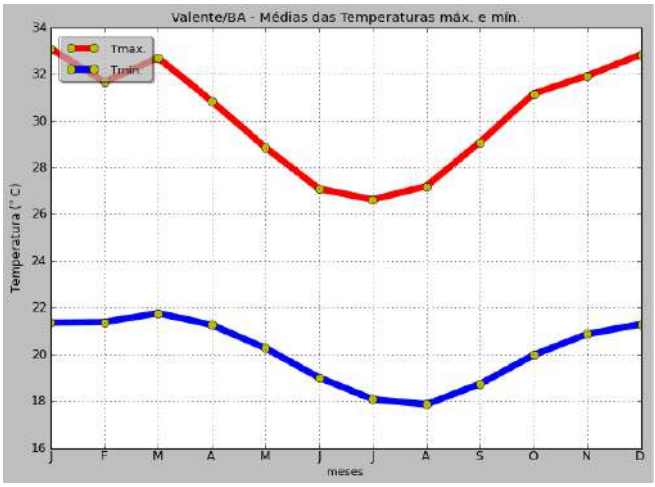
Therefore, this study seeks to verify the occurrence of droughts, as well as to make predictions about the possibility of droughts in Valente/BA considering a possible scenario on the horizon of climate change, as well as to investigate the association between sisal production and water availability.

The drought in Valente - BA

The municipality of Valente/BA is located in the territory of Sisal, which is part of the Brazilian semi-arid region, at an altitude of 358 meters above sea level, with geographic coordinates latitude -11°41'66" and longitude -39°45'51". With a territorial extension of 394.877 km², its estimated population in 2020 was 28,800 inhabitants, and it has a Human Development Index - HDI considered average, at the mark of 0.637 [35]. According to information from CLIMATE-DATA.ORG, the climate in Valente/BA is classified by Köppen and Geiger as BSh, ie hot semi-arid climate.

Based on an analysis carried out by Climap on daily temperature and precipitation data from 1980 to 2019 in the region, monthly meteorological trends and distributions were investigated.Thus, as observed in Graph 01, the average monthly maximum temperature for the municipality ranged from 26.63ºC to 33.09ºC and the average minimum temperature ranged from 17.86º to 21.77ºC, with the months between October and April , those that recorded the highest temperatures, with maximums above 30ºC, and the months between June and August, as those that marked the lowest temperatures, with minimums between 26º and 28ºC.

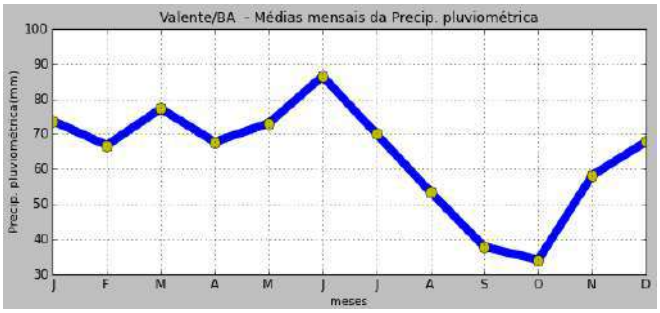
Graph 01: Monthly averages of maximum and minimum temperatures.



Source: Prepared by the authors (2021).

It was also found that the month of June had the highest monthly average of rainfall with 86.43mm, while the months of September and October were the driest, with rates of 37.99mm and 34.24mm, respectively (Graph 02).

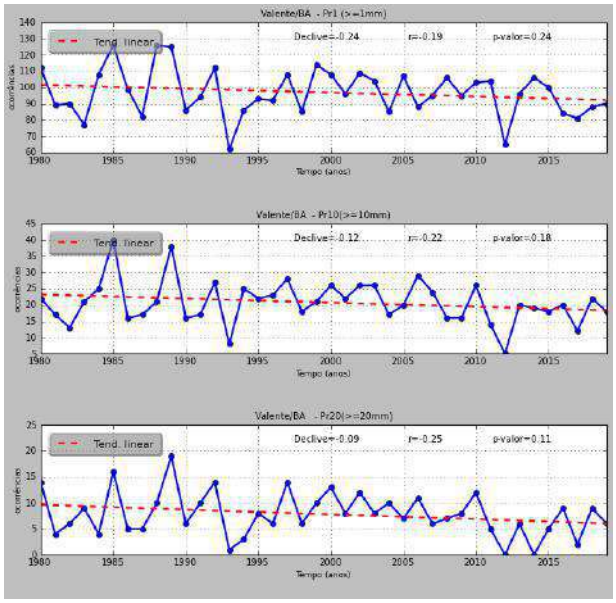
Graph 02. Monthly averages of precipitation



Source: Prepared by the authors (2021).

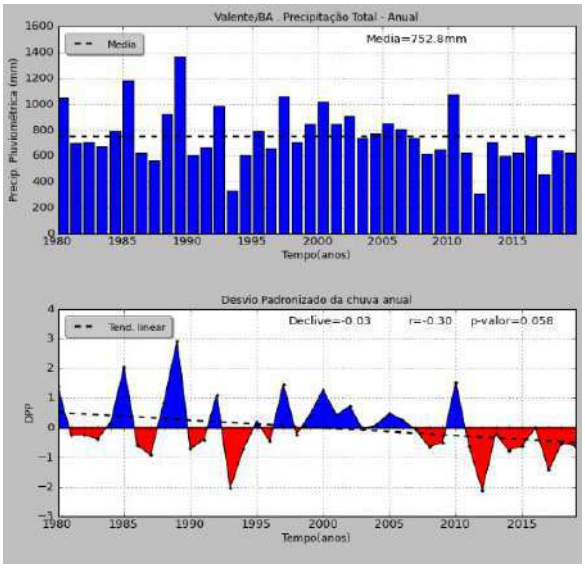
When observing within the delimited historical range, it appears that the average rainfall in days per year, equal to or above 1mm, was 97 days; with precipitation equal to or greater than 10mm were 21 days; and with rains equal to or above 20 mm, it took 8 days (graph 03).

Graph 03: Number of days per year with precipitation ≥ 1 mm/day, ≥ 10 mm, ≥ 20 mm.



Source: Prepared by the authors (2021).

Graph 04: Averages of precipitation and standarddeviation in the historical range between 1980 and 2019

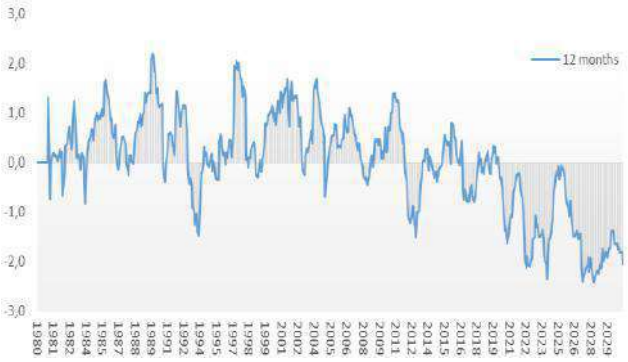


Source: Prepared by the authors (2021).

Through graph 04, in turn, it can be seen that the average annual precipitation between 1980 and 2019 was 752.8 mm. In this way, there is a trend in the decrease of rainfall in the region, verifying that since 2011 the averages of precipitation are below average. Of the entire sample, 60% of the years recorded negative deviations from rainfall and 40% positive deviations from the average. In 75% of the years, rainfall was within plus or minus 1 standard deviation, that is, with rainfall of 210mm more or less compared to the historical average. The years with the most extreme cases were 1985 (1177.4mm) and 1989 (1364.8mm) with the highest rainfall accumulations, and the years 1993 (326mm) and 2012 (309.9mm) with the worst precipitation levels.

After tabulating the daily rainfall data recorded by INMET in monthly values and grouping them with those of simulated projections in the context of climate change in the RCP8.5 scenario by PROJETA, the time series between 1980 and 2030 was worked on in DIMES to obtain the Standardized Precipitation Index - SPI, on a 12-month scale for past and future years, which resulted in the curve shown in Chart 05 and in the records shown in Chart 03.

Graph 05. SPI curve in the range between 1980 and 2030.



Source: Prepared by the authors (2021).

Table.3. Categorization, amount and percentage of SPI of the historical and future series (1980-2030).

Values of SPI	Category	1980-2019		2020-2030		Total	
		Qt	%	Qt	%	Qt	%
≥ 2,00	Extremely humid	5	1%	0	0%	5	1%
1,50 a 1,99	Severely Wet	19	4%	0	0%	19	3%
1,00 a 1,49	Moderately Moist	75	16%	0	0%	75	12%
0.01 a 0,99	Incipient Moisture	238	51%	2	2%	240	40%

0 a -0,99	Incipient Drought	120	25%	34	26%	154	26%
-1,00 a-1,49	Moderately Dry	13	3%	30	23%	43	7%
-1,50 a -1,99	Severely Dry	1	0%	38	29%	39	6%
≤ - 2,00	Extremely Dry	0	0%	28	21%	28	5%

Source: Prepared by the authors (2021).

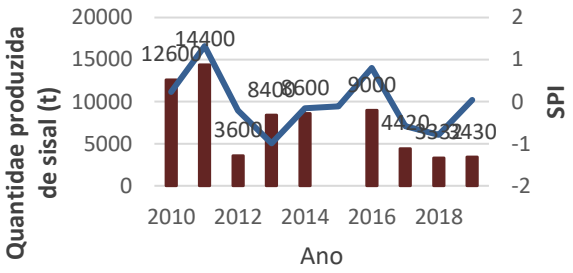
From the information seen in Graph 05, as well as in Table 03, it appears that historically, incipient humidity prevailed in the region (51% of the months), with the SPI fluctuating most of the time between values 0 and 1. It should be noted that there were short passages with a lot of water availability, with 16% of the months reaching SPI considered moderately humid, 4% severely humid and 1% extremely humid, many in response to greater rainfall accumulations, especially in 1985, 1989 and 1997.

In turn, the drought was present in 28% of the time, 25% as incipient drought, 3% as moderate drought and only 1 record of severe drought at the end of 2012. However, the curve shows the occurrence of hydrological drought more accentuated and prolonged between the years 1993 to 1995, 2011 to 2014 and 2017 to 2018. Corroborating the above analysis, Marengo, Cunha and Alves [1], highlight that in the 2010s one of the biggest droughts occurred today.

When analyzing the SPI of this decade, comparing it with the amount of sisal produced in the municipality of Valente/BA, according to Graph 06 , it is possible to infer the association of the influence of the drought climatological phenomenon on agricultural production, so that it is observed that the years of 2012, 2017 to 2019, were those that showed lower sisal productivity, a fact that confirms the hypothesis raised by this research that the water deficit may be linked to the decrease in sisal production in the region [5] [9]. In addition, the data is consistent with the article by Mendes [10], which depicts a scenario of socioeconomic drought in Valente/BA, causing serious socio-environmental, economic, and daily impacts on the local population.

When analyzing the relationship between the SPI and the production of Sisal, through regression, no significance (5%) was found for the analysis of variance, with the "p-value" at the threshold, 0.0577 (Table 4). However, the data suggest a downward trend in Sisal production around 3,547.7 t for each unit in SP (Graph 7).

Graph 06: SPI curve and amount of sisal produced between 2010 and 2019 in Valente/BA.



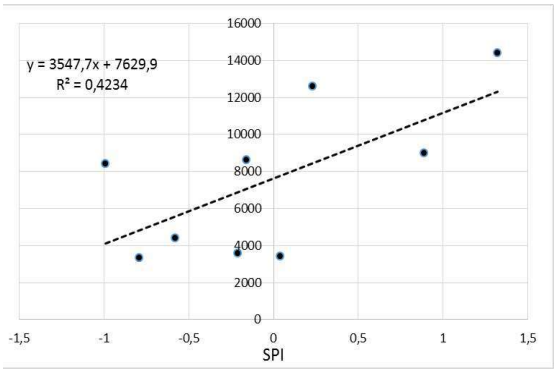
Source: Prepared by the authors (2021).

Table 4. Analysis of Variance of the Sisal Production x SPI Regression.

	gl	*SQ*	*MQ*	*F*	*F de signif.*
Regressão	1	57799153	57799153	5,13995	0,0577
Resíduo	7	78715535	11245076		
Total	8	1,37E+08			

Source: Prepared by the authors (2021).

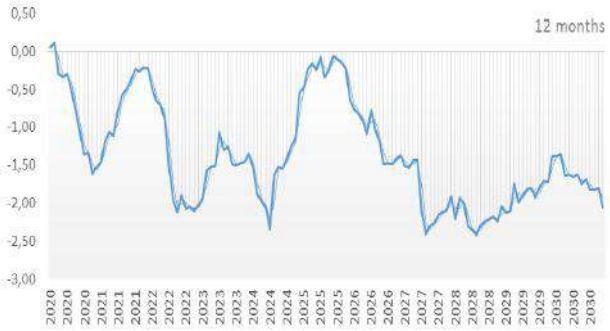
Graph 07: Regression between Sisal production and API (Valente - BA).



Source: Prepared by the authors (2021).

Cutting out Graph 5 and narrowing the SPI analysis for projections between 2020 and 2030 considering the RCP8.5 scenario of climate change, Graph 8 and the notes in Table 3 are the result. The climatological drought tends to be significantly prolonged and worsened in Valente/BA by climate change, since 98% of the simulated SPI values were below zero. By projections, it is estimated that 26% of the months will have SPI categorized as incipient drought, 23% as moderate drought, 29% as severely dry and 21% as extremely dry.

Graph 08: SPI curve in the range between 2020 and 2030.



Source: Prepared by the authors (2021).

In view of the measured, the scenario predicted for the 2020s to 2030s is worrying, so that there is a prospect of more intense and dramatic socioeconomic droughts than the events experienced in the 2010s, such as the episode portrayed in 2017. in Valente/BA by Mendes [10]. From now on, projections in the face of climate change may have repercussions on the increase in socio-environmental vulnerability of socio-ecological systems in the region, translating into greater losses in the production and processing of sisal, impacts on the economy and food security. Nevertheless, Seyffarth and Rodrigues [37] also point out that the effects of climate change, such as drought and desertification, put at risk even the biodiversity of the caatinga, which, although normally adapted to the semiarid region, may not withstand more intense events.

III. FINAL CONSIDERATIONS

Although identified as a climatological event, drought can be aggravated by human action, through different forms, among which are the population density and inadequate use of natural resources, mainly resulting from economic exploitation, therefore including in this list, practices agricultural and extractive activities, which end up having a huge impact on the soil, water and unbalancing entire ecosystems.

It can be seen from this study that the sisal region and especially the municipality of Valente often suffers from meteorological drought and its derivations, and that future perspectives considering the most accentuated scenarios of climate change tend to provide more severe and prolonged droughts. , since 98% of the simulated SPI values were below zero, ranging between incipient drought (26%), moderate drought (23%), severe drought (29%) and extreme drought (21%), which may translate in socioeconomic droughts, increasing the susceptibility to desertification and socio-environmental vulnerability in the region. It is reiterated that, if the simulated SPI projections for the 2020s to 2030s materialize, Valente/BA will suffer one of the worst droughts in its history.

It is noteworthy that, based on the analyzes proposed by the research, there was a relationship between the decrease in rainfall, verified through the SPI, and the fall in the production of sisal in the municipality.Given this narrative, the horizons of climate change must be present in science and in governance decision-making, with a view to mitigating its causes and effects, seeking to increase the resilience of socio-ecological systems.

ACKNOWLEDGEMENTS

IF Baiano – Federal Institute of Education, Science and Technology Baiano, Campus Itaberaba – BA; FAPESB – Research Support Foundation of the State of Bahia; Center for Agroecology, Renewable Energy and Sustainable Development - CAERDES, located at the University of the State of Bahia - UNEB, Juazeiro - BA.

REFERENCES

[1] MARENGO, J. A.; CUNHA, A. P.; ALVES, L. M. (2016). A seca de 2012-15 no semiárido do Nordeste do Brasil no contexto histórico. Disponível em:

http://climanalise.cptec.inpe.br/~rclimanl/revista/pdf/30anos/marengoetal.pdf. Acesso em: 18 maio 2021.

[2] CUNHA, T. J. F. et al. Território do Sisal. (2016). Disponível em: https://www.agencia.cnptia.embrapa.br/gestor/territorio_sisal/arvore/CONT000fckg3dhc02wx5eo0a2ndxy87hfl6e.html. Acesso em: 15 maio 2021.

[3] PAHO/WHO (2015). Atuação do Setor Saúde Frente a Situações de Seca. Série Desenvolvimento Sustentável e Saúde 3. Fundação Oswaldo Cruz – Ministério da Saúde. Brasília.

[4] FERNANDES, D. S.; HEINEMANN, A. B.; AMORIM A. de O.; CARDOSO, A. S. (2009). Índices para a Quantificação da Seca. Documentos 244. Empresa Brasileira de Pesquisa Agropecuária. Embrapa Arroz e Feijão. Goiás.

[5] BLAIN, G. C.; ROLIM, G. D. S.; BRUNINI, O. (2005). DIMES – Software para cálculo e interpretação do Índice Padronizado de Precipitação (SPI) em visual basic for application em ambiente MS-Excel. V Congresso Brasileiro de Agroinformática - SBI-AGRO. Londrina.

[6] ABBASIAN, M. S.; NAJAFI, M. R.; ABRISHAMCHI, A. (2021). Increasing risk of meteorological drought in the Lake Urmia basin under climate change: introducing the precipitation–temperature deciles index. Journal of Hydrology, 592, p. 125586.

[7] CAMPOS, J. N. B.; STUDART, T. M. C. (2001). Secas no Nordeste do Brasil: origens, causas e soluções. In: Fourth Inter-American Dialogue on Water Management, 2001, Foz do Iguaçu. Anais do IV Diálogo Interamericano de. Porto Alegre: Associação Brasileira de Recursos Hídricos.

[8] OMM. (2020). Declaración de la OMM sobre el estado del clima mundial en 2019. OMM nº1248. Disponível em: https://library.wmo.int/doc_num.php?explnum_id=10215. Acesso em: 12 maio 2021.

[9] MARQUES, J. M. M. (2018). O impacte das secas nos ecossistemas: o ensino do uso sustentável da água através de casos. Universidade do Porto.

[10] MENDES, H. (2017). Seca transforma polo mundial de sisal em 'cemitério verde': 'Tudo morrendo'. G1 Bahia. 02 de abril de 2017. Disponível em: http://g1.globo.com/bahia/noticia/2017/04/seca-transforma-polo-mundial-de-sisal-em-cemiterio-verde-tudo-morrendo.html. Acesso em: 20 maio 2021.

[11] CERQUEIRA, M. O. (2015). Vulnerabilidade ambiental do território do sisal-Bahia. Dissertação de Mestrado apresentada ao Programa de Pós-Graduação em Planejamento Territorial - Mestrado Profissional – da Universidade Estadual de Feira de Santana/ UEFS, como requisito para a obtenção do grau de Mestre. UEFS. Feira de Santana.

[12] INMET, Instituto Nacional de Meteorologia (2021). Banco de Dados Meteorológicos. Disponível em: https://bdmep.inmet.gov.br/. Acesso em: 15 maio 2021.

[13] SALVADOR, M. de A. (2017). Climap – Aplicativo para análise de dados climáticos - versão 3.0. Revista Brasileira de Climatologia, v. 20.

[14] SCHWALM, C. R.; GLENDON, S.; DUFFY, P. B. (2020). RCP8.5 tracks cumulative CO2 emissions. Proceedings of the National Academy of Sciences, 117(33), p. 19656-19657.

[15] BAPTISTA, N. de Q.; CAMPOS, C. H. (2013). Caracterização do semiárido brasileiro. In: Convivência com o semiárido brasileiro: autonomia e protagonismo social. CONTI, I. L.; SCHROEDER, E. O. (org.). Editora IABS: Brasília – DF.

[16] BRASIL.(2017). RESOLUÇÃO Nº 107, DE 27 DE JULHO DE 2017. Estabelece critérios técnicos e científicos para delimitação do Semiárido Brasileiro e procedimentos para revisão de sua abrangência. Disponível em: https://www.in.gov.br/materia/-/asset_publisher/Kujrw0TZC2Mb/content/id/19287874/do1-2017-09-13-resolucao-n-107-de-27-de-julho-de-2017-19287788. Acesso em: 30 abr 2021.

[17] ARAÚJO FILHO, J. C. de; CORREIA, R. C.; CUNHA, T. J. F.; OLIVEIRA NETO, M. B. de; ARAÚJO, J. L. P.; SILVA, M. M. de L. (2019). Ambientes e solos do semiárido: potencialidades, limitações e aspectos socioeconômicos. In: Tecnologias de convivência com o semiárido brasileiro. XIMENES, L. F.; SILVA, S. L. da; BRITO, L. T. de L. (editores técnicos). Fortaleza, CE: Banco do Nordeste do Brasil.

[18] COSTA, J. A. da. (2016). Indicadores de qualidade do solo em diferentes modelos de agricultura familiar no semiárido pernambucano. Dissertação apresentada à Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Serra Talhada, como parte das exigências do Programa de Pós-Graduação em Produção Vegetal, para obtenção do título de Mestre em Produção Vegetal. Serra Talhada – PE.

[19] SILVA, F. C.; CRUZ. M. L. B. (2016). Análise da fisionomia da cobertura vegetal em ambientes semiáridos: o caso do município de Jaguaratema, estado do Ceará. REGNE, Vol. 2, Nº Especial.

[20] CUNHA, A. P. M. do A. et al. (2017).Avaliação de indicador para o monitoramento dos impactos da seca em áreas de pastagens no semiárido do Brasil. Revista Brasileira de Cartografia, 69(1).

[21] Plano de Desenvolvimento Territorial Sustentável e Solidário do Território do Sisal – PTDSS. (2016). Núcleo de Extensão em Desenvolvimento Territorial / Universidade Estadual de Feira de Santana. – Valente, 88 p.

[22] LIMA, K.C.; SANTOS, J. M dos.; RODRIGUES, D. Da P. (2008). Análise do uso e ocupação do solo e tendências a desertificação no Território de identidade do sisal: município de Valente (BA).

[23] OMM. (2016). Manual de indicadores e índices de sequía. WOMM nº 1173. Disponível em: https://library.wmo.int/index.php?lvl=categ_see&id=11355&page=4&nbr_lignes=137&l_typdoc=n%2Ct%2Cv%2Cy%2Cz#.YLb8qvlKh0w. Acesso em: 12 maio 2021

[24] SILVA, C. V. S.; SILVA, J. L. B. da; MOURA, G. B. de A.; LOPES, P.M. O.; NASCIMENTO, C. R.; SILVA, L. C. da. (2019) Monitoramento da cobertura vegetal por sensoriamento remoto no semiárido brasileiro através de índices de vegetação. Nativa, Sinop, 7 (6), 708-717.

[25] OPAS/ OMS. (2015). Atuação do Setor Saúde Frente a Situações de Seca. Série Desenvolvimento Sustentável e Saúde 3. Fundação Oswaldo Cruz – Ministério da Saúde. Brasília.

[26] ONU. (2018). Nações Unidas: degradação de terras impacta 3,2 milhões de pessoas no mundo. Disponível em: https://news.un.org/pt/story/2018/06/1627442. Acesso em: 03 de maio de 2021.

[27] ALMEIDA, T. A. de. (2016). Impactos decorrentes das mudanças ocasionadas pelo uso e ocupação do solo na bacia hidrográfica urbana da UFJF: campus JF sobre o escoamento superficial. Trabalho Final de Curso apresentado ao Colegiado do Curso de Engenharia Ambiental e Sanitária da Universidade Federal de Juiz de Fora, como requisito parcial à obtenção do título de Engenheira Ambiental e Sanitarista. Juiz de Fora – BH.

[28] SILVA, F. G. M. (2019).Alterações morfológicas de horizontes superficiais sob processo de desertificação após pousio. Dissertação apresentada ao Programa de Pós Graduação em Ciência do Solo do Departamento de Ciências do Solo da Universidade Federal do Ceará, como parte dos requisitos para obtenção do título de Mestre em Ciência do Solo. Fortaleza.

[29] MONTENEGRO, A. A. A; LOPES, L.; ALMEIDA, T. A. B.; LIMA, J. L. M. P. de; MONTENEGRO, H. G. L. A.; ARAUJO, B. G. (2020). Impacto de métodos naturais para conservação de água e solo no semiárido brasileiro. Revista FAVE - Ciências Agrarias 19 (2).

[30] NASCIMENTO, K. R. P.; ALVES, E. R.; ALVES, M. V, da S. GALVÍNCIO, J. D. (2020). Impacto da precipitação e do uso e ocupação do solo na cobertura vegetal na Caatinga. Journal of Environmental Analysis and Progress. 05 (02), 221-231.

[31] DOURADO. C. da S. (2017). Áreas de risco de desertificação: cenários atuais e futuros frente às mudanças climáticas. Tese apresentada à Faculdade de Engenharia Agrícola da Universidade Estadual de Campinas como parte dos requisitos exigidos para a obtenção do título de Doutora em Engenharia Agrícola, na área de concentração Água e Solo. Campinas.

[32] FIGUEIREDO, R. A.; et al. (2017). Resiliência em sistemas socioecológicos, paisagem rural e agricultura. Revista Ciência, Tecnologia e Ambiente. 5 (1), 49-57.

[33] SUDEC. (2021).Municípios em situação de emergência: seca e ou estiagem. Disponível em: http://www.defesacivil.ba.gov.br/municipios-em-situacao-de-emergencia-seca-e-ou-estiagem. Acesso em: 01 de junho de 2021.

[34] IBGE. (2021). Instituto Brasileiro de Geografia e Estatística. Produção Agrícola Municipal – PAM. Disponível em: https://www.ibge.gov.br/estatisticas/economicas/agricultura-e-pecuaria/9117-producao-agricola-municipal-culturas-temporarias-e-permanentes.html?=&t=o-que-e. Acesso em: 01 jun. 2021

[35] CPTEC/INPE, Centro de Previsão de Tempo e Estudos Climáticos / Instituto Nacional de Pesquisas Espaciais. (2021). Projeções de mudança do clima para a América do Sulregionalizadas pelo modelo ETA – PROJETA. Disponível em: https://projeta.cptec.inpe.br/#/dashboard. Acesso em: 18 maio 2021.

[36] SEYFFARTH, J. A. C.; RODRIGUES, V. (2017). Impactos da seca sobre a biodiversidade da Caatinga. Parcerias Estratégicas, 22 (44), 41-62.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.25

Technology and Agribusiness – The Ethical Search for Increase Food Production

Lúcio Cândido de Oliveira Júnior[1], June Faria Scherrer Menezes[2], Rildo Mourão Ferreira[3]

[1]Mestrando em Direito do Agronegócio e Desenvolvimento pela Universidade de Rio Verde-GO. Especialista em Direito Público pela Pontifícia Universidade Católica de Goiás - PUC-GO. Graduado pela Faculdade de Direito de Franca-SP. Promotor de Justiça do Ministério Público do Estado de Goiás.
Email: luciomestrado@hotmail.com
[2]Doutora em Fitotecnia (Produção Vegetal) pela Universidade Federal de Viçosa. Mestra em Fitotecnia (Produção Vegetal) pela Universidade Federal de Viçosa. Professora titular da Faculdade de Agronomia na área de Nutrição de Plantas da Universidade de Rio Verde - UniRV. Docente permanente dos programas de Pós-Graduação Stricto Sensu em Produção Vegetal e Direito do Agronegócio e Desenvolvimento da Universidade de Rio Verde – UniRV.
Email: june@unirv.edu.br
[3]Pós-Doutor em Desenvolvimento Sustentável pela UnB. Doutor em Ciências Sociais pela PUC/SP. Mestre em Direito Empresarial pela Universidade de Franca. Pós-Graduado em Direito das Relações do Trabalho pela Universidade Mogi das Cruzes. Professor Titular da Faculdade de Direito da UniRV. Professor Titular do Mestrado em Direito do Agronegócio e Desenvolvimento da UniRV. Membro do Grupo de Pesquisa – Direito, Agronegócio e Sustentabilidade – UniRV, certificado pelo CNPq.
E-mail: rildo.mourao@unirv.edu.br.

Received: 13 Apr 2022,
Received in revised form: 12 May 2022,
Accepted: 18 May 2022,
Available online: 26 May 2022

Keywords*— *Agribusiness, Brazil, Technology, Sustainability.

***Abstract*—** *Man found in agriculture an effective way to satisfy hunger and produce wealth, however, such implementation came at the expense of the health of the natural environment, directly impacting the natural cycle of seasons and climates and thus adversely affecting the entire planet earth. The problem of the present research lies in presenting techniques that may represent a common denominator between producing more and with quality, using less soil, concomitantly meeting the needs indicated in the 2030 agenda of the United Nations Organizations. With the advancement of research in the agribusiness sector, as well as the introduction of technology in agriculture, there is a potential means to find a balance between producing and protecting the natural environment. In this way, the present study is justified because the balance between producing and repairing the environment is the key to maintaining the planet for the next generations, in this sense, academic production is necessary to discuss techniques that bring producers, researcher and society in general. To this end, the methodology used was qualitative bibliographic research, in which books, scientific articles, as well as content available on virtual channels of various bodies that deal with the theme were used. In the end, it was possible to verify that the indiscriminate use of soil and agricultural inputs imply the depletion of natural resources, however, the implementation of technology in food production represents the way to sustainable production, preserving and repairing the environment.*

I. INTRODUCTION

Man and the environment have always maintained the relationship of interdependence and coexistence. For the primitive human being, nature was the provider of food and from where they manifested divinities, through natural phenomena.

With the discovery of soil preparation tools, man was no longer dependent on hunting, finding another way of subsistence in the natural environment. What was dependence on nature becomes domination of the former in relation to nature.

And, as suggested by Suzana Albornoz[1], a cycle of consumption and environmental degradation begins, as "By developing agriculture, human ingenuity already disturbs the balance of nature. Discovering in planting a new source of food for themselves and their children, men multiply." In this sense, it appears that the availability of food directly impacts the multiplication of the human race, and the former impacts it.

In this cycle suggested by the illustrious author, the calculations that involve food production and restoration of the environment are not always mathematical, because in practice what is seen is that "Numerical expansion leads to conquering new areas of forest for cultivation. As it takes a long time to restore a strip of forest to full cultivation capacity, the jungle is being destroyed and transformed into undergrowth or pasture land."[1].

With the advent of the Industrial Revolution, man, delighted and concerned with the need to increase the mechanical production of goods, relegated the environment to the second plan of priorities. In this same understanding, Franco, Druck and Seligman-Silva[2] mention that, in addition to environmental degradation, human health was seriously affected in this period.

The increase in the world population requires public policies to be implemented in order to prepare environments for the impacts that will arise. According to the Department of Economic and Social Affairs of the United Nations, the population projection for the year 2025 is 8,184,437 billion people, and for 2050, 9,735,034 billion people[3].

Such population demand will generate a need to increase production systems, especially in the food sector (raw material and final product), which, in turn, will impact the use of natural resources, with significant impacts on the environment.

In this area, agribusiness presents itself as the main protagonist, having to reconcile the increase in production with respect for the environment, conforming, therefore, to the concept of sustainability. The challenge, and this is the objective of the present work, is to draw attention to the struggle of agribusiness to develop an increase in sustainable production, in accordance with the needs indicated in the 2030 agenda of the United Nations Organizations[4].

The problem lies in verifying the balance between exploring, caring for and protecting the environment during the stages of food production, since agribusiness has to make use of resources, which can often affect the environment in some way. environment. So, the desired ethics will be on how to increase production so that the impacts generated by the activity are mitigated and/or repaired in a satisfactory way.

In the search for a solution to the problem, the work will be developed in 02 stages. In the first one, basic concepts about the presented theme will be discussed. Afterwards, technologies introduced in production will be indicated, which seek to mitigate environmental damage and reduce resource consumption and CO_2 emissions into the atmosphere.

At the end, the work presents the conclusions reached and their collaboration. It is noteworthy that the methodology used was qualitative bibliographic research, which used books, scientific articles, as well as content available on virtual channels of various bodies dealing with the theme.

II. ENVIRONMENT, ECOLOGY, SUSTAINABILITY AND AGRIBUSINESS

2.1 Environment

The concept of the environment is not easily found in doctrine. Because it is constantly changing, the expression is "more easily intuited than definable, due to the richness and complexity it contains"[5].

It is argued that the expression environment, used in Brazil, brings redundancy, since both terms, environment and environment, would be the same thing, in addition to clarifying the theme Edis Milaré[5] brings important notes, for the author:

> Both the word milieu and the word environment have different connotations, whether in scientific or vulgar language. neither of these terms has a univocal meaning (having a unique meaning), but both are equivocal (same word with different meanings). Medium can mean? Arithmetically, half of an integer; a given physical or social context; a resource or input to achieve or produce something. Environment can represent a geographic or

> social, physical or psychological, natural or artificial space[5].

Despite the academic discussion about the expression, and considering that the Federal Constitution itself uses it, it is certain that the environment can be seen in several aspects: natural environment, work environment, artificial environment etc., and, for for the purpose of the present study, only that first aspect will be considered.

Along with the clarification highlighted above, the environment is conceptualized as the "sum total of the surrounding external conditions within which an organism, a condition, a community or an object exists. The environment is not a unique term; organisms can be part of another organism's environment."[6].

Considering these aspects, it is worth highlighting the understanding brought by the legal text, such as by Law No. 6,938, of August 31, 1981, which provides for the National Environmental Policy, its purposes and mechanisms of formulation and application, whose article 3, item I, defines the environment as "the set of conditions, laws, influences and interactions of a physical, chemical and biological order, which allows, shelters and governs life in all its forms"[7].

Also, in the same diploma, in article 2, item I, because it is for collective use, it raises the environment to the condition of Public patrimony.

2.2 Ecology

According to Gilge and Prestes[8], the term " oecologie ", which was translated into Portuguese as "ecology", was coined by Ernst Haeckel in 1866. The excerpt that presents the term is a footnote:

> By expanding the concept of Biology in this broad and understandable scope, we close the narrow and limited sense in which Biology is often (especially in entomology) confused with Ecology, [...] with the way organisms relate to each other. and with the external environment etc.[9].

Therefore, ecology ("*oikos"* and "*logos*" = house and study = study of the house of living beings), is understood as the science that studies the relationships of living beings with each other and with the environment.

More than a science, from the 1960s onwards, with the pacifist movements, ecology began to gain a political bias, with a concern, especially among young people, with the environmental quality that would be left for other generations.

Given the concern with the theme, in 1972 the Stockholm Conference was the starting point for the race to preserve the environment, since it was the first worldwide mobilization for this purpose.

From there, global ecological thinking developed more vigorously, causing the United Nations to create the United Nations Environment Program.

Later, in 1992, the realization of ECO-92 in Rio de Janeiro culminated in the creation of Agenda 21, a document used as an instrument that guides strategies and planning for the development of sustainable societies regardless of their geographical bases, in this sense the merit of the document is in the concern to reconcile both environmental protection and economic efficiency, whose practices reach the whole of society as a form of social justice, through Agenda 21 s , the term "ecology" was consolidated at a global level.

2.3 Sustainability

Boff[10] teaches that, in 1560, in the German province of Saxony, the word *Nachaltingkeit appeared*, which translated from German means sustainability. The term came about because of the residents' concern regarding the use of forests, so that, using them rationally, they would gain time for regeneration, and, in this way, there would always be wood.

If it is necessary to explore, this exploitation cannot go to the extreme of using resources until they are completely exhausted, so that future generations are deprived of the use, enjoyment and fruition of these same resources.

The vision on production and on the man who produces and for whom it is produced gains a new vision. It is not enough for the producer to simply produce at any cost. It is necessary that, in the face of this awareness of preservation, production uses natural resources in order to allow its renewal. What's more, this production guarantees the renewal of what was extracted from the environment. And more, that seeks to improve the quality of life and narrow the social distance between people.

The concept of sustainability, introduced by John Elkington, in the 1990s, in his book **Sustainability** – cannibals with a knife and fork, then, is based on three foundations, namely: environmental concern, financial concern and social concern[11].

Sustainable development, which is understood by the United Nations as "development capable of meeting the needs of the present generation without compromising the ability to meet the needs of future generations."[12].

In 2015, representatives from 193 countries signed a document called - Agenda 2030, in which they agreed on measures to promote sustainable development until 2045. The plan has 17 objectives and 169 targets for eradicating

poverty and improving quality of life. to all people on the planet.

2.4 Agribusiness

The term agribusiness *was* created by John Herbert Davis and Ray Allan Goldberg, and is found in the work "*A concept os agribusiness*", which Caio Pompeia[13] translated as:

> [...] The sum of all farm operations, plus the manufacture and distribution of all agricultural production inputs provided by the business, plus the total of operations performed in connection with the handling, storage, processing and distribution of commodities agricultural. In short, agribusiness refers to the sum total of all operations involved in the production and distribution of food and fiber[13].

More than the simple activity carried out within the rural property, agribusiness encompasses all activity prior to agricultural production, involving the machinery and input industry. Also, after production, agro involves the storage, processing and exportation of the product.

According to a technical statement from the Confederation of Agriculture and Livestock of Brazil (CAGED), the agribusiness sector generated, in the first half of 2021, about 151,252, and, if considered "in the accumulated of the first half of 2020, only Agriculture recorded net creation number of jobs (62,419), all other sectors of the economy lost jobs in the period."[14]. Thus, it is observed that the sector absorbs 1 in 3 Brazilian workers.

Compared to 2019, exports of Brazilian products in 2020 suffered a considerable drop. However, the agricultural sector, on the other hand, grew by 6.0%, with values totaling US$ 45.27 billion, with special emphasis on soybeans (10.5%) and raw cotton (23.1%)[15].

These data demonstrate the importance of the sector in the Brazilian economy and also the prominent role of agribusiness in food production worldwide. According to the Food and Agriculture Organization of the United Nations (FAO), about 690 million people worldwide are hungry, representing 8.9% of the world's population[15].

Faced with this sad situation, the role of the Brazilian agricultural sector is of considerable importance, since, standing out as the largest producer of food on a global scale, it must be the protagonist of the attempt to reduce inequalities, reducing poverty, eradicating hunger, these goals delimited by the 2030 Agenda.

III. AGRIBUSINESS SUSTAINABILITY TECHNOLOGIES

In the 1960s and 1970s, small farmers from southern Brazil migrated to the Brazilian Midwest in search of larger properties that could provide greater agricultural productivity, a fact that coincides with the growth of the biotechnology industry, and with genetic manipulation. of plants and living organisms[16].

In the same period, as mentioned by Rodolfo F. Alves Pena, "the high mechanization and expansion of the agricultural frontier allowed the advancement of agriculture and livestock, which, on the one hand, increased the country's productivity in the countryside, but, on the other hand, contributed to the remarkable deforestation of the original vegetation"[17]. It was the so-called "green revolution", which incorporated new technologies into production, from planting to harvesting[18].

For Wandell Seixas[19], the development of agribusiness in Goiás is mainly due to the soybean crop, which is the main *commodity* produced in the state which, in 2020, produced 13.7 million tons, making it the 4th largest Brazilian producer, responsible for 10.1% of all national production.

Considering that the soil of the cerrado region is oxisols, has high acidity, is poor in essential nutrients and has high aluminum toxicity, the development of soybean cultivation, in particular, was only possible due to the use of technologies made available. from the producer. The acidity, for example, was attenuated with the application of limestone (liming), and the lack of nutrients, with the use of targeted fertilization[20].

Several technologies used enabled agricultural advancement in the cerrado. Some, which I refute to be the most important, will be dealt with separately below.

3.1 No-Till

Of all the technologies used in Brazilian and global agribusiness, none was as impactful and as conservationist as the no-tillage system. Used in England and the United States since 1950, this technique arrived in Brazil only in 1970[21].

The direct sowing system was introduced to Brazil by farmers from the north of Paraná, where it presented satisfactory results, so much so that, until the present day, it is used in about 80% (eighty) percent in the production of agricultural commodities in Brazil[22].

The no-tillage technique basically consists of sowing under the straw left by the previous crop, without moving the soil through plowing, harrowing or scarification. In the same sense, Paulino Motter and Herlon Goelzer de

Almeida, explain that "the term "no till" originates from the concept of "no till ", which in English means precisely the practice of cultivation inserted directly into the land, without the need to turn the soil"[21].

The no-tillage system, due to the dry cover on the soil, avoids the action of water, preventing the appearance of erosive systems; retains soil moisture for a longer time, bringing less suffering to crops in times of prolonged drought; improves soil quality compared to conventional planting[21].

Still, and the most important of the benefits brought by the no-tillage system, is the control of CO2 emission into the atmosphere, which directly contributes to the prevention of the increase in global temperature, one of the Brazilian commitments signed at COP15 – Copenhagen, Denmark .

Cordeiro et al demonstrate that:

> The accumulation of SOM in the No-tillage System (SPD) and, consequently, its potential for CO2 removal in Brazil, for example, has already been proven by several authors in the 35 Global Warming and Low Carbon Agriculture. different ecoregions. This process of fixing carbon in the soil in the form of humified (stable) organic matter over a long period of time is popularly known as carbon sequestration. Thus, soils managed under SPD without tillage and with the addition of straw pass from the condition of source of CO2 towards the atmosphere to the condition of drain or assimilation of CO2 to the soil[23].

And keeps going:

> Another effect of reducing GHG emissions in the SPD is related to the decrease in mechanized operations. Estimates indicate a reduction of 40 liters of diesel oil per hectare per year with the elimination of one plowing and two harrowing[23].

It can be seen, therefore, that the benefits brought to the environment by the no-tillage system make food production more sustainable, protect the soil from the action of rainwater, preventing runoff and loss of the fertile soil layer. Also, due to the decrease in machine traffic, CO2 emissions into the atmosphere and fuel consumption significantly decrease.

3.2 Biological Nitrogen Fixation In the Soil

Biological nitrogen fixation in the soil is an important technology for food production, considered clean, it replaces commonly used fertilizers, which are harmful to human health and costly for the producer.

This technology allowed the extremely acidic cerrado soil to become fertile, due to the biological fixation of nitrogen in the soil. Research by agronomist Johanna Döbenreine indicates that the use of *Rhizobium bacteria*, in a natural process of plant-bacteria interaction, incorporates the nitrogen available in the air into the plant's nutrition mechanism[24]. With this, there is the replacement of nitrogen-based fertilizers, which have a high price and are highly polluting.

Also, according to Hungria et al.[25], biological nitrogen fixation in the soil is a low-carbon technology, and credits can be commercialized in the international market, in addition to bringing the advantage of adopting clean technology, providing a positive perception. both nationally and internationally.

3.3 Other technological advances

Just to illustrate the progress that agribusiness has been achieving, in search of better sustainable development, only a few technologies will be addressed, since, to go deeper, other spaces will be needed, such the breadth of matter and speed of technological events.

3.3.1. precision agriculture

Antuniasse[26] explains precision agriculture as the localized management of agricultural systems, using resources how mapping From factors in production, tools in Support The decision and application located in inputs.

In terms economic, The use of this technology makes it possible The prioritization of investments in areas where the production potential is more effective, ensuring greater economic returns.

From an environmental point of view, the rationalization and reduction of the use of inputs should be evaluated as one of the main benefits of precision agriculture[26]. With the use of the global satellite monitoring system, the rural producer can make a detailed management of his crop, from before planting to harvest, providing a better rationalization of the production stages, which, consequently, will bring fuel savings, reduction of manpower, better use of inputs and pesticides, and, in the end, the production of a sustainable product, with low impact on the environment.

Also, automation systems in irrigation devices, which allow a rational use of water; intelligent sprayers, which detect only the weed plant and allow less product to be thrown into the soil, preventing waste and preserving the environment; planters and harvesters coordinated by GPS, which avoid wastage of seeds, in the planting, and grains, in the harvest, etc.

3.3.2 Genetic improvement of seeds

Genetically modified organisms (GMO), or transgenics, are organisms that have received a gene from another donor organism, altering its DNA and allowing it to show a characteristic that it did not have before. The application options are endless and can cover the most diverse areas.

In sustainable agriculture, for example, Biotechnology makes it possible to produce more food, with quality, at a lower cost and without the need to increase the cultivation area[27]. In this way, there are germination resistant to pests, to prolonged drought, to the use of herbicides, causing the products to use less inputs, with greater production, without, however, expanding their planting area.

Law No. 11,105, of March 24, 2005[28], establishes safety standards and inspection mechanisms for construction, cultivation, production, handling, transport, transfer, import, export, storage, research, commercialization, consumption, release into the environment and disposal of genetically modified organisms - GMOs and their derivatives, having as guidelines the stimulus to scientific progress in the area of biosafety and biotechnology, the protection of life and human, animal and plant health, and the observance of the precautionary principle for the protection of the environment.

The agribusiness entrepreneur has at his disposal an infinite range of technological products, aimed, in particular, for work inside the gate, which will lead to increased productivity, cost reduction, better management of property and resources, respect for the environment and sustainable development, a goal pursued by Brazil, within the 2030 Agenda.

IV. FINAL CONSIDERATIONS

Through the study carried out, it became evident that the need to increase world food production is a worrying factor and a topic on the political agenda of all countries, since food security is a globalized collective problem.

Since the Industrial Revolution, the population has been experiencing a worrying growth, and by 2030 it may reach numbers close to 10 billion people, which represents, in just under nine years, an increase of one third in the global population. Given this situation, producing a greater amount of food is essential for human survival.

However, this need to increase food production comes up against the consumption of non-renewable resources and the indiscriminate use of soil and agricultural inputs, which can cause negative impacts on the environment. In view of this situation, the UN, with the endorsement of 193 countries, presented the 2030 Agenda to the world, containing sustainability objectives and goals, whose objective nº 02 is the end of hunger, with the achievement of food security and improvement of nutrition, as well as promoting sustainable agriculture.

To achieve this goal, the rural producer has been using new technological instruments, which seek to increase production without the need to increase the arable area.

Examples are the development of research in the area of biotechnology and genetic manipulation, the use of information technology in the management of property and products, artificial intelligence in the use of machines and implements.

All the efforts have been giving increasingly significant results in the Brazilian agricultural trade balance, making agribusiness a sustainable activity, both from an environmental, social and economic point of view. This generates income for the producer, food security for the population, preservation of the environment, with the search for the evident sustainable development desired by countries committed to the Global Agenda 2030.

REFERENCES

[1] Albornoz, S. (2004). *What is Work.* ed. Brasilian.
[2] Franco, T., Druck, G., Seligman-Silva, E. (2010). The new work relationships, the worker's mental exhaustion and mental disorders in precarious work. *Brazilian Journal of Occupational Health*, 35(122); 229-248.
[3] UN. (2019). *Department of Economic and Social Affairs Population Dynamics*: World Population Prospects. Retrieved from: https://population.un.org/wpp/Download/Probabilistic/Population/.
[4] UN. (2015). *Agenda 2030 for sustainable development*: transforming our world – Agenda 2030 for sustainable development. 2015. Retrieved from: https://brasil.un.org/pt-br/91863-agenda-2030-para-o-development-sustentavel.
[5] Milaré, E. (2013). *Environmental law*. (8th ed.). São Paulo: Journal of the Courts.
[6] ART, Henry W. (1998). *Dictionary of Ecology and Environmental Sciences*. São Paulo: UNESP/Improvements.
[7] BRAZIL. Law no. 6,938, of August 31, 1981. Provides for environmental policy, its purposes and mechanisms of formation and application, and other provisions. Official Gazette [of] the Federative Republic of Brazil, Brasília, August 31, 1981. Retrieved from: http://www.planalto.gov.br/ccivil_03/leis/l6938.htm
[8] Gilge, M. V., Prestes, M. E. B. (2014). Ernst Haeckel in the Biology collections approved by the PNLD 2012. *Brazilian Journal of the History of Science*, 7(2); 325-335.
[9] Haeckel, E. (1866). *General Morphologie der Organisms.* Berlin: Georg Reimer.
[10] Boff, L. (2012). *Sustainability: what is - what is not.* Petrópolis, RJ: Voices.

[11] Elkington, J. (2012). *Sustainability, cannibals with knife and fork*. Sao Paulo: M. Books do Brasil Editora Ltda.

[12] CMMAD. World Commission on Environment and Development. (1988). *Our common future*. Rio de Janeiro: Fundação Getúlio Vargas.

[13] Pompeia, G. (2020). "Agro is everything": Simulations in the agribusiness legitimation apparatus. *Anthropological Horizons. Horiz Magazine. Anthropol. Year*, 26(56). Available at: https://www.scielo.br/j/ha/a/xjhwQdTB5jVzgPqjnSCfGvQ/?lang=pt

[14] CAGED. Register of employees and unemployed. (2021). *Technical Community*. Retrieved from: https://www.cnabrasil.org.br/assets/arquivos/artigostecnicos/Comunicado-Tecnico-CNA-ed-21_2021.pdf.

[15] Bueno, S. (2021). *Trade balance 2020*: The last year of the second decade of the 21st century was marked by the Covid-19 pandemic and all its consequences. Despite this, 2020 ended with more surplus in the Brazilian trade balance. 2021. Retrieved from: https://www.fazcomex.com.br/blog/balanca-comercial-de-2020/

[16] Vieira Filho, J. E. R., Silveira, J. M. F. J. (2016). Organizational skills, technological trajectory and local learning in agriculture: the Prebisch paradox. *Published in Economy and Society*, 25(3);599-630.

[17] Pena, R. F. A. Cerrado soils: Cerrado soils are generally characterized by their acidity, porosity, depth and weathering changes caused by leaching. *Brazil School Magazine.* Retrieved from: https://brasilescola.uol.com.br/brasil/solos-cerrado.htm

[18] Gaud, W. S. (1968). The green revolution: accomplishments and apprehensions. *Speech before the Society for International Development*, Washington, DC.

[19] Seixas, W. *Valor da produção agrícola cresceu 22,9% em Goiás.* set. 2021. Retrieved from: http://abrindoaporteira.com.br/valor-da-producao-agricola-cresceu-229-em-goias/.

[20] Sanzonowicz, C. *Solos do cerrado.* Retrieved from: http://www.agencia.cnptia.embrapa.br/Agencia16/AG01/arvore/AG01_14_911200585231.html.

[21] Motter, P; Almeida, H. G. (2015). *Plantio direto: a tecnologia que revolucionou a agricultura brasileira.* Foz do Iguaçu: Parque Itaipu.

[22] Copragil. (2013). *Plantio direto: técnica paranaense revolucionou a agricultura mundial.* 2013. Disponível em: https://www.copagril.com.br/noticia/420/plantio-direto-tecnica-paranaense-revolucionou-a-agricultura-mundial.

[23] Cordeiro, L. A. M. et al. (2012). *O Aquecimento Global e a Agricultura de Baixa Emissão de Carbono*. Brasília: MAPA/EMBRAPA/ FEBRAPDP.

[24] MAPA. Ministério da Agricultura, Pecuária e Abastecimento. *Programa ABC*: Fixação Biológica de Nitrogênio. Retrieved from: https://www.gov.br/agricultura/pt-br/assuntos/sustentabilidade/plano-abc/arquivo-publicacoes-plano-abc/fixacao-biologica-do-nitrogenio.pdf.

[25] Hungria, M. et al. (2013). *A fixação biológica do nitrogênio como tecnologia de baixa emissão de carbono para culturas do feijoeiro e da soja*. Londrina: Embrapa Soja.

[26] Antuniassi, U. R., Baio, F. H. R, Sharp, T. C. (2016). *Agricultura de precisão*. Retrieved from: http://www.agencia.cnptia.embrapa.br/Repositorio/1622_000fkl0f2ta02wyiv80sq98yqf7fpgf0.pdf

[27] Embrapa. (2021). *Transgênico*. Perguntas e respostas. Retrieved from: https://www.embrapa.br/tema-transgenicos/perguntas-e-respostas

[28] Brazil. Law n. 11,105, of March 24, 2005. Regulates items II, IV and V of § 1 of art. 225 of the Federal Constitution, establishes safety standards and inspection mechanisms for activities involving genetically modified organisms - GMOs and their derivatives, creates the National Biosafety Council - CNBS, restructures the National Technical Commission on Biosafety - CTNBio, provides for the National Policy of Biosafety – PNB, revokes Law No. 8,974, of January 5, 1995, and Provisional Measure No. 2,191-9, of August 23, 2001, and arts. 5th, 6th, 7th, 8th, 9th, 10 and 16 of Law No. 10,814, of December 15, 2003, and other provisions. Official Gazette [of] the Federative Republic of Brazil, Brasília, March 24, 2005. Retrieved from: http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2005/lei/l11105.htm.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.26

Asset Surveillance— Case Study

Dr. Luciano Bendlin[1], Doutoranda Marcelle Werka, Mestrando Angelo Marcelo Pires, Mestrando Ricardo Tiago de Sá,

[1]Contestado University, BRA

Email : bendlin@unc.br

Received: 25 Apr 2022,

Received in revised form: 18 May 2022,

Accepted: 23 May 2022,

Available online: 28 May 2022

Keywords*— *Feasibility analysis. Surveillance. Safety.

***Abstract*—** *Over the years, the occurrences of vandalism against the school have increased, according to data from APEOESP. Scarce monitoring environments provide acts of vandalism, sexual harassment, bullying , physical aggression, theft, among others that are becoming increasingly routine in school environments. Schools should not only provide quality education, have good teachers and a variety of extracurricular activities, but also provide security and peace of mind for students. In this context, the dissemination of security services has increasingly attracted the attention of society and subject matter experts in recent years. Thus, cameras are installed to maintain the feeling of security and confidence for the population, and this surveillance is expanded on the streets, in condominiums, hospitals, residential facilities, prisons, among others. The security system needs to adopt a systematic set of processes in order to create value through alignment before actually starting the technical process. For this, it is necessary to review several pre and post monitoring steps, so that it runs successfully. This study aims to analyze the types and different monitoring systems, their surveillance and control technologies. In addition to presenting a budget analysis of cost-benefit investments for the acquisition and installation of security camera equipment, in the control of environments for care, in the use of modern and high-tech equipment. In addition, finding solutions for more accessible and effective security, which actually prevents and protects the environment with real-time actions in an investment analysis with the help of digital surveillance.*

I. INTRODUCTION

Violence and crime are not recent issues, nor a contemporary brand, it is a social problem as old as society itself, but, at each time, it manifests itself in different ways and circumstances (PEREIRA, DA SILVA, 2019).

In view of the insecure and violent times, private security has been considered an essential service for property and personal security in organizations. It has grown linearly in Brazil since its inception, having its greatest growth since the 1990s, noted by the number of surveillance companies, street guards, and the dissemination of technologies aimed at the electronic security industry.

In many organizations, the use of organic surveillance services, starting to directly hire, within their functional framework, professionals to meet the demands of their corporate or residential property, bearing all the bureaucracy of registration with the competent bodies as

well as all the continuous process of training and recycling of the desired professional, as well as the use of technologies and equipment of permitted use (ALBUQUERQUE, 2013).

However, physical resources have limitations, risk analysis and the technologies used to be implemented and guidance for employees are essential measures that must be analyzed by managers, in addition to the purchase of all accessories and work tools, such as bullets, batons, communication radios, among others.

With this, a technology has stood out and gained strength when it comes to knowledge and control of spaces, it is monitoring by cameras, where security has had more robust ways to protect heritage assets, as well as offering a security system for individuals. .

In the area of security, it is essential that the company works with cutting-edge technologies, especially if it offers electronic surveillance services. Private security stands out in the installation and sale of security equipment, especially those related to monitoring (LOURENÇO, 2019).

In the school environment, security cameras are increasingly present, they have been used as behavioral inspectors. Acts of vandalism, sexual harassment and violence, exposure of or to nudity, bullying , physical aggression, theft and others are becoming more and more routine, generating a feeling of unease in students and teachers, harming the development of their educational activities. routine.

According to Anísio Teixeira, school education is necessary, constituting a public problem, a public interest, a right of each individual and a duty of politically organized society. It is not an advantage or individual success, but a condition for the functioning of society itself (TEIXEIRA, 2009, p. 44-48).

Since the first internal circuit was created by the German company Siemens to monitor the launch of rockets during the war in 1942, closed circuit television cameras have been disseminated throughout the world.

At first it was not possible to record the images, but only to monitor live what was happening next to the cameras, years later, in the 1970s, analog tape recorders (video cassettes) began to become popular and began to be used in CCTV systems. Since then, closed-circuit television cameras - CCTV, also known by the acronym in English closed-circuit television (CCTV), have spread to several cities around the world. In Brazil, cameras began to be part of landscapes in the 1980s, initially as a strategy for monitoring traffic (Balbim , 2003), later being used for security purposes. The first to employ camera surveillance as a security tool were banks. The oldest record in Brazilian legislation of this type of monitoring appears, in 1983, in Law 7,102 (Kanashiro, 2008) which provides for the operating rules for banking establishments.

In the book “1984” by George Orwell, the author highlights that all people are under constant surveillance by the authorities, mainly by telescreens . Even though it was written in 1949, all the forms of surveillance described are present in everyday life, sometimes in a veiled way. Technology has increasingly contributed to increasing citizen control and there is a loss of privacy. The use of surveillance cameras has been proliferating in various environments aiming at security.

The surveillance society is experiencing a considerable increase and new products are created and sold in the global market. Gradually, parks, homes, offices, hospitals, schools, universities and other institutions – including families – start to use technological systems focused on electronic surveillance. This growth includes the different types of closed circuit television (analog, digital, network or IP), biometric systems (digital, retinal, iris, voice and facial recognition), radar systems (connected through satellites) and geolocators .

The State of Mato Grosso do Sul enacted Law nº 3,946/2010, authorizing the installation of a security system based on monitoring by video cameras in public and private schools of that entity of the federation, with the objective of preventing and investigating the authorship of acts criminal or harmful to the safety of the school community and to preserve the school's property. The law allows the installation of cameras in places of internal or external circulation of schools, with the exception, however, of changing rooms, bathrooms, teachers' rooms and classrooms. Although it is considered by many to be a great alternative in the repression and prevention of crimes, even though it is already part of the routine of Brazilians, the adoption of Electronic Monitoring receives very pertinent criticisms, disturbing the private life and violating the privacy of the people being observed (BRAZIL). , 2010).

1.1 POSSIBILITY OF INSTALLATION - IMPORTANCE OF PRIVACY

In opinion 15426/2010, the State Public Domain Attorney of Rio Grande do Sul, Dr , Andrea Trachtemberg Campos, clarifies in her opinion that there is no fence for installing cameras in places where there is no reservation of privacy, as there is no if talking about violation of private life – 'intimacy and image – in a public environment with movement of people, that is, in certain areas in schools, such as patios, corridors, sports courts, strategic points outside schools and next to turnstiles

entrance and exit from schools, provided that the equipment is used strictly for the surveillance and safety of students and teachers in a moderate, generalized and impersonal way.

The prosecutor reports that it is legitimate to install cameras to reduce violence and vandalism, as long as the images are not disclosed and there are signs of their existence in places that are easy to see.

It is concluded that it is not possible to install cameras in places where privacy is reserved, such as, for example, in bathrooms, classrooms, teachers' rooms, environments for the private use of workers, work rooms or offices, changing rooms, among others. others. He warns that "In these spaces, the intimacy and image of students and servers must be preserved".

It is noted that the issue involving monitoring is not new, but it constantly returns to public debate, precisely because it does not find unanimity among authors or in the legal sphere itself.

Fig1: Monitoring Equipment Model

Source: Google photos, 2021.

Fig.2 - Monitoring Room Model

II. THEORETICAL FRAMEWORK

2.1 SAFETY IN BRAZIL

Article 144 of the CRFB/88 is a reference on Public Security and presents the exhaustive list of bodies that compose it: federal police, federal highway police, federal railway police, civil police, military police and military fire brigades, in addition to the possibility of municipalities to constitute municipal guards, intended to protect their goods, services and facilities, as provided for by the Law (BRASIL, 1988).

The National Public Security Policy began with the implementation of the Single Public Security System (Susp) for the period from 2018 to 2028, approved by the National Congress, after years of study. According to data from the National Public Security Plan (PNSP), states, with fiscal crises for decades, in 2016 paid 85% of spending in the area, in contrast to 9% for the federal government. In 2018, pursuant to Provisional Measure nº 841, of 2018, public security will have permanent, predictable and growing resources, with funds from lotteries managed by Caixa Econômica Federal (CEF), estimated at 1 billion reais. For the year 2022, the projected figure could reach 4.3 billion for investment and funding for states and municipalities – preferably through objective, public and verifiable indicators. (BRAZIL, 2018).

In a position of complementarity, private security activities end up meeting the emerging demand for security, also resulting from moments of crisis and growing and organized crime, which is not exclusive to Brazil.

A study of private security activity comprises a characterization of its social and economic context and the development of concepts and relationships. For Sapori (2007) the mechanisms of social control are diversified, as the creation of the need for public order is part of the process of emergence of conceptions of crime recognized and categorized by public authorities and professional specialists. It follows the administrative expansion of the State and its gradual acquisition of the effective monopoly of force.

Valente (2017) considers security as a collective need provided regularly and continuously by public bodies and servants under the terms established by law,

Using the theory of collective needs as a basis for public interest

[...], we consider that security is one of those collective needs, the regular and continuous satisfaction of which must be provided by the typical activity of Public Administration bodies and individuals, under the terms established by the applicable legislation, and for that purpose they must obtain the resources most appropriate and use the most convenient forms, either under the direction or supervision of the political and executive power, or under the control of the courts.

2.2 ELECTRONIC SECURITY

According to Cubas (2002), the expansion of electronic security benefits both from the cheaper equipment and from the intense technological evolution in this type of service. The replacement of men by machines, however, is limited by the need for interaction with visitors and the judgment of occurrences by workers.

When we enable the use of monitoring systems in place of access restrictions, electronic security can promote efficiency in surveillance related to the correction of deviations through a rigorous and repetitive routine of exercises, as was peculiar to a “disciplinary regime”.

The installation of cameras in places where people circulate leads the person being watched to believe that they are always being watched. Therefore, the mere presence of a surveillance camera generates intimidation to any conduct, whether the offender or the questioner, after all, the electronic gaze does not differentiate the internal intention of those being watched. In this sense, with reference to this surveillance model, the State starts to monitor the population at all times, preventing criminal actions through the monitoring system, ensuring that its sovereignty is maintained and respected (PITZER, 2009).

Investment in security is something essential in people's lives, thus, Lordello (2021), justifies;“It is important to emphasize that the so-called security cameras have several benefits: a) Psychological factor of deterrence, because the criminal knows he is being watched and his images are stored. b) inhibits the action of invaders, predators, taggers and malicious people. c) facilitates prompt response work (police and private surveillance) by providing details of the crime that is taking place. d) Integration with alarm systems. e) Access to images via the internet” .

Corroborating this information, a survey carried out by the Instituto Locomotiva Pesquisa e Estratégia, commissioned by Apeoesp (Sindicato dos Professores do Ensino Oficial do Estado de São Paulo), with students and teachers from the state public school system, found that 79% of the population of São Paulo was aware of any recent case of violence in schools in São Paulo in 2019 — nationally, the rate was 77%. Occurrences of bullying , discrimination and vandalism were the most noted in the past year.

Bullying was the type of violence most suffered by students in the last school year (22%), while verbal aggression was the main abuse reported by educators (48%). There were also reports of physical aggression, theft and robberies inside school premises in the State of São Paulo (SACHETO, 2020).

According to the research, violence in schools implies a safety problem for both teachers and students, severely impacting the learning process.

However, the implementation of an efficient system for monitoring and asset management has a fluctuating cost, due to new technologies and depreciation of current equipment, which must be considered for a feasibility analysis of implementing electronic security systems.

2.3 STRATEGIC COST MANAGEMENT

A long time ago, the origin of costing systems may have originated in man's need to count and identify his survival needs, and over time they were improved according to economic and financial growth.

With the growth of companies and the consequent increase in the complexity of the production system, it was found that the information provided by cost accounting was potentially useful to management assistance, extrapolating the mere accounting determination of the result for the period. (BORNIA, 2010, p. 12).

It is necessary for companies to identify and interpret this information through the management system to face the current competitive environment.

[..] the cost system must be in line with the management system, so that the information generated produces good results. In other words, the cost system must adapt to the needs of the management system in order for managers to be able to fully utilize the information provided. (BORNIA, 2010, p. 32).

The correct treatment of information enables the planning of new investments, development of new products and control of expenses, and that through applied strategies can direct competitiveness.

Decisions based on reliable data make it easier for the administrator to develop these strategies.

The strategy can be treated as project elaboration, to reach an objective, but for the company to be able to invest, a financial disbursement is necessary, and it is at this moment that the need for strategic cost management arises, contributing to consumption. control of this financial capital without it being wasted, and that it is used where it is really needed.

According to Souza and Clemente (2008) investment decisions are at the base of strategic cost management because they largely define the agenda and magnitude of costs and expenses.

Strategic cost management can be seen as a strategy tool that aims to identify the types of costs, and direct them in order to reduce them to the maximum, increasing the organization's competitiveness in the macroeconomic

scenario, without minimizing the profitability, and that the company has the ability to invest in new projects.

The decision to invest is only possible when it arises through a successful strategy. The feasibility and consequently the return must be initially evaluated through concrete indicators that allow the administrator a detailed view of where the capital will be applied and if the company has sufficient capacity and own resources for the investment project. When the organization establishes itself in a level of profitability, it is possible to identify that the interaction between the cost system, the strategic management, and the return of the investments, are the factors that propitiate this positioning.

2.4 MULTI-INDEX METHODOLOGY

Multi-Index Methodology is based on the use of indicators and variables which allow the analysis of investment projects, and the reasoning of the decision-making process regarding its acceptance or rejection. According to Souza and Clemente (2008) "The decision to make a capital investment is part of a process that involves the generation and evaluation of several alternatives that meet the technical specifications of the investments".

This methodology consists of, from the discounted cash flow and the analysis of the context, generating two groups of indicators.

The first group is used to assess the perception of return and is composed of the PV (present value); NPV (net present value); VPLa (annualized net present value); IBC (benefit/cost ratio) and ROIA (additional return on investment).

The second group is used to improve the perception of risk, it is composed of the TMA/IRR (minimum rate of attractiveness/minimum rate of return); Pay-back /N (investment payback period / project horizon in periods); Degree of revenue commitment (GCR); management risk and business risk. In this methodology, risk is not incorporated as a spread over the discount rate and, therefore, must be analyzed separately through other indicators.

developed investment projects provides the company with a stream of future benefits, hence the importance of having the multi - index methodology as a basis. According to Souza and Clemente "The investment project, in a broad sense, can be interpreted as an effort to raise the level of information (knowledge) about all the implications, both desirable and undesirable, to reduce the level of risk".

The prior analysis of investments allows a better measurement of capital resources, administrators must determine the company's objectives in relation to the investment decision, and which variables will influence this process.

Painting I -Multi-Index Methodology

	Indicadores	Descrição
Indicadores de Retorno	VP (VALOR PRESENTE)	Considera a soma de todos os fluxos de caixa na data zero.
	VPL (VALOR PRESENTE LÍQUIDO)	O Valor Presente Líquido, como o próprio nome indica, nada mais é do que a concentração de todos os valores esperados de um fluxo caixa na data zero.
	VPLa (VALOR PRESENTE LÍQUIDO anualizado)	No VPLa o fluxo de caixa representativo do projeto de investimento é transformado em uma série uniforme.
	IBC (ÍNDICE BENEFICIO/CUSTO)	O IBC é uma medida de quanto se ganha por unidade de capital investido.
	ROIA (RETORNO ADICIONAL DECORRENTE DO INVESTIMENTO)	O ROIA é a melhor estimativa da rentabilidade para um projeto de investimento representa em termos percentuais a riqueza gerada pelo projeto.
Indicadores de Risco	TAXA MÍNIMA DE ATRATIVIDADE/TAXA MÍNIMA DE RETORNO	TMA é a taxa a partir da qual o investidor considera que está obtendo ganhos financeiros, e para que um novo investimento seja atrativo deve render no mínimo, a taxa de juros equivalente a rentabilidade das aplicações correntes e de pouco risco. TIR calcula a taxa de juros para a qual manter o dinheiro investido seria o equivalente a utilizá-lo em um novo projeto.
	PAYBACK/N (PERIODO DE RECUPERAÇÃO DO INVESTIMENTO HORIZONTE DO PROJETO EM PERIODOS)	É o período de tempo necessário para que as entradas de caixa do projeto se igualem ao valor a ser investido, ou seja, o tempo de recuperação do investimento realizado.
	GCR (GRAU DE COMPROMETIMENTO DA RECEITA	É usado para avaliar o risco operacional, isto é, para avaliar o percentual da receita máxima que está comprometida com o pagamento dos custos e despesas.
	RISCO DE GESTÃO E RISCO DE NEGÓCIO	O Risco de Gestão é usado para avaliar o grau de competência do grupo gestor para realizar com sucesso o empreendimento. O Risco de negócio é usado para quantificar, mesmo que subjetivamente, as análises clássicas PEST, 5 forças de Porter e SWOT.

Source: Adapted from Souza and Clemente (2008)..

III. INDENTATIONS AND EQUATIONS

The research regarding its degree of application reveals itself as applied research, presenting a descriptive character, as it aims to describe, interpret and analyze data on the impact of technology in the analysis of an investment project in an electronic surveillance system. According to Gil (1999), research of this type has as its primary objective the description of the characteristics of a certain population or phenomenon or the establishment of relationships between variables.

As for the approach to the problem under study, this work was configured as a quantitative research, as it is characterized by the use of statistical instruments, in the collection and processing of data.

Richardson (1999 apud BEUREN, 2006, p. 92) states that the quantitative approach:[...] is characterized by the use of quantification both in the modalities of information collection, and in the treatment of them through statistical techniques, from the simplest such as percentage, average, standard deviation, to the most complex, such as correlation coefficient , regression analysis, etc.

As for its temporality, it can be characterized as a transversal nature, as the information considered a period of time, limited to the scope of the research.

The methodology used in this study has the typology of a case study, as it gathers several important information, facts and values being numerous and detailed with the objective of informing the researcher about the totality of a situation. According to the author ,

"The case study is an empirical study that investigates a current phenomenon within its context of reality, when the boundaries between the phenomenon and the context

are not clearly defined and in which various sources of evidence are used." (GIL, 1999, p. 73).

The choice and selection of the topic to be studied took place according to the criteria of the needs of the organization considered to monitor its physical assets in a more efficient way and through the analysis of investment projects, providing the unfolding of the calculations, allowing the reader to understand the expected from this study. After selecting the electronic surveillance equipment, the technologies necessary for its proper implementation were consulted.

Subsequently, the costs and investments necessary for the business were budgeted, while the commercialization values were obtained from a market survey, using various data sources such as catalogs, internet, commercial proposals from suppliers and others.

Electronic spreadsheets were also used, using the EXCEL software to determine and calculate the VP, NPV, VPLa , IBC, ROIA, IRR and Payback indicators . Also to compose the study, the Average Rate of Attractiveness TMA, considered for the project, was raised, totaling 12%.

After the calculations, using a Risk and Scenario Analysis spreadsheet, prepared and provided by Souza and Clemente (2008), the results presented were reached..

IV. DEVELOPMENT

Considering the concepts exposed above, in an illustrative format, a scenario of a University with 7 units was considered, where it is desired to implement electronic monitoring in order to increase property security. The institution currently has outsourced surveillance, in physical and face-to-face format, which, as presented above, has its legal and security disadvantages. Annual surveillance costs are around BRL 800,000.00 and for investment analysis purposes, an investment of BRL 900,000.00 was considered in an electronic security system that could monitor all units in real time. .Through the investment analysis, we sought to find the budget viability regarding the resources used in the project. Table 1 shows the list of materials with pricing considered for the calculation of the investment analysis

Table 1 - Equipment List: An acknowledgement section may be presented after the conclusion, if desired.

Equipment	The amount	Unitary value	Amount
Bullet Intelbras IP Camera VIP 1230b Full HD 1080p	103	390.00	40,170.00
Intelbras Dome IP Camera VIP 1230d Full HD 1080p	116	436.70	50,657.20
Camera IP Bullet Vip 1430 B 3.6mm 4mp 30m	73	550.00	40,150.00
IP Dome Vip Camera 1430 D 2.8mm 4mp 30m	59	450.00	26,550.00
NVR 64 channels - iNVD 9064 FTU	6	25,200.00	151,200.00
NVR 32 channels - iNVD 9032 PE FTU	3	14,068.84	42,206.51
10TB hard drive	31	3,200.00	99,200.00
decoder for 9 screens - 144 Cameras	two	16,964.86	33,929.72
Professional monitor 55" - MWL 7255	8	7,000.00	56,000.00
TV/Monitor Support	8	100.00	800.00
Windows 10 computer for VMS software	1	15,000.00	15,000.00
Overlay box 9.5X9.5X5	351	10.00	3,510.00
furukawa cat5e network cable box	46	700.00	32,200.00
Patch cord cat5e 50 cm	351	7.00	2,457.00
RJ 45 male	351	2.00	702.00
Patch panel 24 ports cat5e	32	250.00	8,000.00
Rack Organizer 1u x 19"	32	23.00	736.00
Rack 8U 19"	28	335.00	9,380.00
Cage nut + M5 screw for fixing racks	384	0.65	249.60
manageable POE switch	10	4,000.00	40,000.00

POE switch 16 ports manageable	22	2,450.00	53,900.00
UPS 1200va	30	1,200.00	36,000.00
VMS software license	1	20,000.00	20,000.00
Furniture for surveillance center	1	8,000.00	8,000.00
Installation materials	1	20,000.00	50,000.00
Labor for installation	1	50,000.00	80,000.00
Total			**900,998.03**

Source: Own authorship, 2022.

For effective monitoring, four employees were considered, called heritage watchmen, responsible for operating the electronic monitoring system. The salary cost of each guard for illustrative purposes was considered R$ 1,508.90 monthly, without charges. Other monthly expenses were also considered through average values based on the organization's estimate.

Through Table 2 we have the income statement referring to the incident values in the project. For the purposes of equipment depreciation, a useful life of 6 years was considered.

Table 2 - Income Statement

DRE	
Savings with service replacement	69,401.59
(-) Expenses	
SALARY	6,035.60
FGTS	482.85
13TH SALARY	502.97
FGTS	40.24
VACATION	670.62
FGTS	53.65
INSS	2,076.25
OTHERS	1,479.33
Landline	15.00
Internet	0.00
Electricity	300.00
maintenance	200.00
Cleanliness and conservation	1,050.00
Equipment Maintenance and Replacement	500.00
Depreciation of equipment in 72 Months	12,513.86
	-25,920.36
Result	**43,481.24**

Source: Own authorship, 2022.

The income statement shows that the savings generated by the digitization of the surveillance service generates a monthly revenue of R$ 69,401.59, from which the operating costs and replacement of installed equipment in the amount of R$ 25,920.36 will be discounted. In this way, the project, after being fully implemented, will generate monthly cash of R$ 43,481.24 for the institution.

In this sense, the discounted cash flow was calculated, presented in Table 3, so that it is possible to visualize the evolution of cash until the moment of project payback , that is, according to the expected cash generation, in how many periods (months) we may consider the project as paid.

Table 3 - Discounted Cash Flow

Cash flow							
Month	**Investment**	**Revenue**	**Disbursement**	**Cash flow**	**Accumulated**	**Present value**	**payback**
0	-900,998.03	0.00	0.00	-900,998.03	-900,998.03	0.00	0.00
1	0.00	69,401.59	43,481.24	25,920.36	-875,077.68	25,600.35	25,600.35
two	0.00	69,401.59	43,481.24	25,920.36	-849,157.32	25,284.30	50,884.65
3	0.00	69,401.59	43,481.24	25,920.36	-823,236.96	24,972.15	75,856.80
4	0.00	69,401.59	43,481.24	25,920.36	-797,316.60	24,663.85	100,520.65

5	0.00	69,401.59	43,481.24	25,920.36	-771,396.25	24,359.36	124,880.01
6	0.00	69,401.59	43,481.24	25,920.36	-745,475.89	24,058.62	148,938.63
7	0.00	69,401.59	43,481.24	25,920.36	-719,555.53	23,761.60	172,700.24
8	0.00	69,401.59	43,481.24	25,920.36	-693,635.17	23,468.25	196,168.49
9	0.00	69,401.59	43,481.24	25,920.36	-667,714.82	23,178.52	219,347.01
10	0.00	69,401.59	43,481.24	25,920.36	-641,794.46	22,892.37	242,239.37
11	0.00	69,401.59	43,481.24	25,920.36	-615,874.10	22,609.74	264,849.12
12	0.00	69,401.59	43,481.24	25,920.36	-589,953.74	22,330.61	287,179.73
13	0.00	69,401.59	43,481.24	25,920.36	-564,033.39	22,054.92	309,234.65
14	0.00	69,401.59	43,481.24	25,920.36	-538,113.03	21,782.64	331,017.29
15	0.00	69,401.59	43,481.24	25,920.36	-512,192.67	21,513.72	352,531.01
17	0.00	69,401.59	43,481.24	25,920.36	-460,351.96	20,985.80	394,764.93
18	0.00	69,401.59	43,481.24	25,920.36	-434,431.60	20,726.71	415,491.64
19	0.00	69,401.59	43,481.24	25,920.36	-408,511.24	20,470.83	435,962.47
20	0.00	69,401.59	43,481.24	25,920.36	-382,590.88	20,218.10	456,180.57
21	0.00	69,401.59	43,481.24	25,920.36	-356,670.53	19,968.49	476,149.06
22	0.00	69,401.59	43,481.24	25,920.36	-330,750.17	19,721.97	495,871.03
23	0.00	69,401.59	43,481.24	25,920.36	-304,829.81	19,478.49	515,349.52
24	0.00	69,401.59	43,481.24	25,920.36	-278,909.45	19,238.01	534,587.53
25	0.00	69,401.59	43,481.24	25,920.36	-252,989.10	19,000.51	553,588.04
26	0.00	69,401.59	43,481.24	25,920.36	-227,068.74	18,765.93	572,353.97
27	0.00	69,401.59	43,481.24	25,920.36	-201,148.38	18,534.25	590,888.23
28	0.00	69,401.59	43,481.24	25,920.36	-175,228.02	18,305.44	609,193.66
29	0.00	69,401.59	43,481.24	25,920.36	-149,307.67	18,079.44	627,273.11
30	0.00	69,401.59	43,481.24	25,920.36	-123,387.31	17,856.24	645,129.35
31	0.00	69,401.59	43,481.24	25,920.36	-97,466.95	17,635.79	662,765.14
32	0.00	69,401.59	43,481.24	25,920.36	-71,546.59	17,418.07	680,183.21
33	0.00	69,401.59	43,481.24	25,920.36	-45,626.24	17,203.03	697,386.24
34	0.00	69,401.59	43,481.24	25,920.36	-19,705.88	16,990.65	714,376.89
35	0.00	69,401.59	43,481.24	25,920.36	6,214.48	16,780.89	731,157.77
36	0.00	69,401.59	43,481.24	25,920.36	32,134.84	16,573.71	747,731.48
37	0.00	69,401.59	43,481.24	25,920.36	58,055.20	16,369.10	764,100.58
38	0.00	69,401.59	43,481.24	25,920.36	83,975.55	16,167.01	780,267.60
39	0.00	69,401.59	43,481.24	25,920.36	109,895.91	15,967.42	796,235.02
40	0.00	69,401.59	43,481.24	25,920.36	135,816.27	15,770.29	812,005.31
41	0.00	69,401.59	43,481.24	25,920.36	161,736.63	15,575.60	827,580.90
42	0.00	69,401.59	43,481.24	25,920.36	187,656.98	15,383.30	842,964.21
43	0.00	69,401.59	43,481.24	25,920.36	213,577.34	15,193.39	858,157.60
44	0.00	69,401.59	43,481.24	25,920.36	239,497.70	15,005.81	873,163.41

45	0.00	69,401.59	43,481.24	25,920.36	265,418.06	14,820.56	887,983.97
46	**0.00**	**69,401.59**	**43,481.24**	**25,920.36**	**291,338.41**	**14,637.59**	**902,621.56**
47	0.00	69,401.59	43,481.24	25,920.36	317,258.77	14,456.88	917,078.44
48	0.00	69,401.59	43,481.24	25,920.36	343,179.13	14,278.40	931,356.83
49	0.00	69,401.59	43,481.24	25,920.36	369,099.49	14,102.12	945,458.95
50	0.00	69,401.59	43,481.24	25,920.36	395,019.84	13,928.02	959,386.97

Source: Own authorship, 2022.

Considering the discounted cash flow, presented in Table 3, we realize that the evolution of the project's cash generation will make it reach its payback point after 46 months.

With this information, some indicators are calculated for project feasibility analysis, such as present value (PV), considering the period of 72 months (equipment useful life), net present value (NPV), annualized net present value (NPV) , benefit/cost ratio (IBC), added return on investment (ROIA), internal rate of return (IRR), and payback .

In Table 4, we have the indicators referring to the values presented in the previous tables.

Table 4 - Calculated Indicators

VP	1,225,837.84
NPV	324,839.81
NPV	25,920.36
IBC	1.36
ROIA	0.43%
IRR	2.328%
TMA/IRR Index	0.54
P.BACK	46
Payback Index /N	0.64

Source: Own authorship, 2022.

The multi - index indicators show that the project's internal rate of return for the institution will be 2.328% per month, a total of 1.328% higher than the 1% attractiveness rate considered for this analysis. In this way, the project has budgetary feasibility for the institution, in addition to the technical and management gains that the monitoring system will allow the organization.

V. CONCLUSION

For organizations that have physical environments with high traffic of people, the risk of security incidents has increased over time, crime, harassment, theft and breakdowns are concerns that are discussed by managers.

Electronic security technology presents itself as a tool to reduce these risks, through constant monitoring, recording of images, audio and identification of faces or even sudden or non-standard movements.

However, the implementation of technology in large environments, such as the company considered for the study, has a high cost due to the amount of equipment and infrastructure necessary for the operation of the monitoring system.

In this sense, the present study sought to analyze the budgetary feasibility of implementing a monitoring system, considering 350 cameras monitored 24 hours a day through 4 employees, heritage watchmen.

Through the calculations performed, with the values considered, the feasibility of the project for the organization is concluded, a statement that is taken from the interpretation of the multi-index indicators for budget analysis of a project.

REFERENCES

[1] ALBUQUERQUE, José Deocleciano Bezerra. Private security in Ceará: which is the best option, to outsource or provide your own service (organic) . 2013.

[2] APEOESP - Union of Official Teaching Teachers of the State of São Paulo Available at: APEOESP - In SP, 79% of the population knew about violence in schools, says survey ,

[3] BALBIM, Renato Nunes. Spatial practices and computerization of circulation space: everyday mobility in São Paulo . 2003. Doctoral Thesis.

[4] BORNIA, Antonio Cezar. Management Cost Analysis: application in modern companies. 3rd Edition. Sao Paulo: Atlas, 2010.

[5] BRAZIL. Legislative Assembly of the State of Mato Grosso do Sul. Law No. 3,946 of August 11, 2010 . Available at: https://www.legisweb.com.br/legislacao/?id=139223 . Access on: 10 Dec. 2021.

[6] _____ Ministry of Public Security. National Plan for Public Security and Social Defense 2018-2028 . Brasília: Ministry of Public Security, 2018.

[7] _____ Constitution of the Federative Republic of Brazil. Brasília, DF: Senate, 1988.
[8] CUBAS, VO The expansion of private security companies in São Paulo . São Paulo, 2002. 167p. Dissertation (Master's), Faculty of Philosophy, Letters and Human Sciences, University of São Paulo.
[9] GIL, Antonio Carlos. Methods and techniques of social research. 5th ed. Sao Paulo: Atlas, 1999.
[10] KANASHIRO, Marta Mourão . Surveillance cameras in brazil : exclusion, mobility regulation, and the new meanings of security. Surveillance & Society , v. 5, no. 3, 2008.
[11] LOURENCO, Paloma. Has private security become a necessity in Brazil? 2019 Available in: https://www.primemonitoramento.com.br/blog-item/a-seguran-a-privada-se-tornou-necessidade-no-brasil-#:~:text=Hoje%2C%20a%20seguran%C3%A7a%20private%20se,spec%C3%ADfics%2C%20or%20same%20on%20streets . Access on: 10 Dec. 2021.
[12] LORDELLO, J. Security Cameras Benefits and Prohibitions . Available in: http://tudosobreseguranca.com.br/portal/index.php?option=com_content&task=view&id=753&Itemid=168 accessed on: 07 dec. 2021.
[13] MACHADO, Arlindo. Surveillance Machines IN: Machine and Imaginary . Sao Paulo: EDUSP, 1993.
[14] MEIRELES, NR of M. Balanced Scorecard and the Management of the Security System . Sao Paulo: Sicurezza , 2013.
[15] PEREIRA, Ayla Campos; DA SILVA, Matheus Rodrigues . School bullying : School Physical Education in focus. **Annals of the Physical Education Journey of the State of** Goiás (ISSN 2675-2050) , v. 1, no. 2, p. 28-32, 2019.
[16] PITZER, RMZ Surveillance cameras – A system of social control. 2009. Available in: http://www.publicadireito.com.br/artigos/?cod=048e2f1447691907 accessed on: 04 dec. 2021.
[17] SACHETO, Cesar. Violence Observatory . Available at: http://www.apeoesp.org.br/publicacoes/observatorio-da-violencia/em-sp-79-da-populacao-soube-de-violencia-em-escolas-diz-pesquisa/ access at: 08 dec. 2021.
[18] SAPORI, LF Public security in Brazil: challenges and perspectives . Rio de Janeiro: FGV, 2007.
[19] TEIXEIRA, Anisio. Education is a right. Rio de Janeiro: Editora UFRJ, 2009.
[20] VALENTE, MMG General Theory of Police Law. 5th ed. Coimbra: Almedina, 2017.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.27

Governance, Sustainability and Collaboration Analysis Model

Carlos Honorato Schuch Santos[1], Cláudia Brazil Marques[2], Ricardo Garcia Letizia[3], Fabrício Moraes de Almeida[4], Carlos Alberto Paraguassú-Chaves[5], Carla Dolezel Trindade[6], Simão Aznar Filho[7], Ruy Drummont Smith[8], Simão Dolezel Aznar[9], Marcélio Rodrigues Uchôa[11], David Lopes Maciel[12], Márcia Maria Rodrigues Uchôa[11] and Reinaldo Rosa dos Santos[13]

[1]PhD in Production Engineering from the Federal University of Santa Catarina. Professor at the Federal University of Rio Grande (FURG).
[2]PhD in Agribusiness – Federal University of Rio Grande do Sul – UFRGS. Volunteer researcher at the Research Group on Policies, Public Management and Development at UERGS/CNPq. Professor at the Federal University of Rio Grande (FURG).
[3]Post-Doctorate in Public Policy - Universidade Nova de Lisboa. Professor at the State University of Rio Grande do Sul
[4]PhD in Physics (UFC), with post-doctorate in Scientific Regional Development (DCR/CNPq). Researcher of the Doctoral and Master Program in Regional Development and Environment (PGDRA/UNIR).
[5]Post-Doctorate in Health Sciences -University of Brasília - UnB, Brazil; Post-Doctor in Health Sciences - UnB and Degli Studi D'Aquila University - Italy. Full Professor at the Rio de Janeiro Institute Faculty, Brazil
[6]PhD in Law - Universidad Nacional de Lomas de Zamora (Argentina). Post-doctorate - Universita deli Studi di Messina (Italy). Full Professor at the University Institute of Rio de Janeiro - IURJ, Brazil.
[7]PhD in Law - Universidad Nacional de Lomas de Zamora (Argentina). Post-doctorate - Universita deli Studi di Messina (Italy). Full Professor at the University Institute of Rio de Janeiro - IURJ, Brazil.
[8]Master in Legal Sciences from the Autonomous University of Lisbon. Adjunct Professor at the Faculty Instituto Rio de Janeiro, Brazil.
[9]Graduated in Law. Master of Law Student, Specialist in Law. Professor at the University Institute of Rio de Janeiro, Brazil.
[10]PhD in Social Sciences from the Pontifical Catholic University (PUC/SP). Adjunct Professor at the Federal University of Rondônia, Brazil.
[11]PhD in Education from the Pontifical Catholic University of São Paulo (PUC/SP). Associate Professor at Faculdade Instituto Rio de Janeiro, Brazil.
[12]Professional Master in Master of Science in Emergent Technologies in Education. MUST UNIVERSITY, MUST, EUA.
[13]PhD in Social Function of Law - By the Autonomous Faculty of Law of São Paulo- FADISP. Professor at Federal University of Acre (UFAC).

Received: 28 Apr 2022,
Received in revised form: 16 May 2022,
Accepted: 24 May 2022,
Available online: 28 May 2022

Keywords— public management, legitimacy, systemic, structure, collaborative.

Abstract— *The public management and its organizational structure underwent, throughout the 20th century, different changes in its architecture, due to the strong influences of the different ideological currents that followed one another over the years. The objective of the study is to theoretically build arguments that show the relationship between collaboration and sustainability in public management and governance as an interlocutor between public systems, the private sector and society. The methodology was a systemic analysis of a qualitative approach using systemic models to understand the evolutionary or retrograde movements of the economic man. It concluded that public management focused on sustainability is a management process with strategic characteristics in the sense of reconfiguring the culture and knowledge of society, soon reaching public bureaucracy, politics and the regional governance initiatives.*

I. INTRODUCTION

Sustainability, collaboration and governance are concepts strongly linked to the management of public affairs, they emerged with great force at the beginning of the 21st century. They still have a conceptual basis that requires a review and updating, according to new social and economic behaviors and discussions of the valuation of natural resources, so that, when using them, their conceptual basis is aligned with their use in practice. Given this, the concept of collaboration can be interpreted with a strong political and sociological link. Its use can serve to leverage issues such as "management", whether private or public. The use of the term sustainability is sometimes more linked to a "fashion" than to the practice of sustainable and conscious actions with nature and with living beings. The term "Governance" is often associated with resolving social and political issues in a "Welfare State" alignment. Thus, the term has two strands of understanding in two parallel sectors, the private and the public. Governance, in the private sector, brings the way in which organizations are managed and controlled, and how they relate to the interested parties "Stakeholders". In the public environment, public governance can be defined as the ability to decide, govern and implement public policies [1].

In a company, when the manager, in addition to the attributes of leadership, incorporates leadership characteristics, for example, he is able to more easily implement what can be called a collaborative environment. In a public organization or even a local government, it is possible to achieve more significant social results when it is possible, in some way, to create an environment of collaboration. Wherever it is, then, it is possible, theoretically, to think that there is a positive relationship between collaboration and results, whether business or social. Sustainability is sometimes not properly used, which generates a certain wear and tear due to its misunderstanding in the public, private and third sector as well. This can cause wear and tear. This can cause strain on relations between sectors and on the alignment of public policy propositions. What can be considered new is the search for the relationship between collaboration and sustainability, in its broad and systemic view, which involves economic, social and environmental aspects [2]. A collaborative environment facilitates sustainability and the latter, in some way, makes it possible for individuals and social groups to collaborate with each other, especially when the focus is on the "common good". It follows, then, that the sustainable system, or systemic sustainability, can also be an element that links collaboration and sustainability itself. The role of governance would be to promote the articulation between the systems and the awareness in the use and in the adequate form of the concepts and their insertion in the social, economic and environmental dynamics. However, in order to understand and seek a systemic architecture, which links collaboration and sustainability, as well as to establish conceptual conditions for governance to fulfill its role of articulation in the geographical and historical macro system in which the public and private sector converge, it is necessary necessary to promote the conceptual application of these terms in practice. The important thing is that what we are going to call in this analysis of system variables and subvariables are identified and understood. For this, two elements that encompass the different subvariables will be used. They are: a) precondition for effective public management; and b) structural pillars of collaborative public management. Another important element in this theoretical construction will be the relationship between growth and development. These are different concepts, but fundamental to understanding the theoretical package that supports the larger system called "collaboration-sustainability". For Schumpeter [3], development is a distinct phenomenon, entirely new to the usual circular flow, in the tendency towards balance or our routine.

The objective of this work is to theoretically build arguments that show the relationship between collaboration and sustainability so that it can be absorbed, understood and applied by all social actors and governmental and non-governmental organizations. As this is a relationship that goes beyond organizational rules, both in the public and private spheres, the concept of "collaborative public management" will be used as a central elemento [4]. This will certainly be the terrain of most theoretical vulnerability, as the organizational "pros" is almost always supported by what can be called managerial authoritarianism. In public organizations, authoritarianism has as its source, almost always, the bureaucracy or the political-bureaucracy set. In private organizations, authoritarian management has other bases, and its power can range from ownership of capital and its indications to authoritarianism, the result of the arrogance of the so-called experts. Be that as it may, the "pros" of collaborative management is a problem, as it is hardly present in current organizations, or in the historical trajectory of most of them [5].

II. PUBLIC ADMINISTRATION

The public administration and its organizational structure underwent, throughout the 20th century, different changes in its architecture, due to the strong influences that it suffered from the different ideological currents that followed one another throughout the period. Both

totalitarian ideologies, on the left (socialism) or on the right (fascism), as well as those considered more democratic, theoretically more liberal, have fattened the State. All ideological strands, however, had the same argument: to improve the living conditions of citizens and society as a whole. This argument was often packed with populist and opportunist speeches. The result, however, was a bloated state, increasingly less efficient and dislocated from its good intentions, whatever they were. Aguilar Villanueva [6], when describing the dysfunctions of public management in the 20th century, recalls, among others, the "...financial disorder and inefficient provision of goods and services...that erode the confidence of citizens in their governments...". Aguilar Villanueva [6] shows that the inefficiency in the functioning of the public machine generates what can be called the "legitimacy" of the public machine, or rather, the lack of legitimacy. In addition to the lack of legitimacy, and strongly related to it, there is the issue of capacity. The Public Administration compromises its capacity when its resources, tangible and intangible, are unable to face the problems of different communities or are structurally insufficient to fulfill the promises of the political discourses that were used to obtain the political orientation of the State bureaucratic machine. Populist governments, for example, are adept at promising unattainable results, as well as talking about resources, which are actually non-existent.

The different communities of society, know or should know, as the managers of public affairs themselves forget or insist on not knowing is that the government and its bureaucratic processes are not capable of controlling all the key variables of well-being and social prosperity. These variables are, at a minimum, the following: a) Economic growth; b) Employment and income; c) Social security; d) Overcoming poverty; e) Emancipation of citizens. This, in fact, is a problem that has been discussed for a long time under the heading of "governance", and it brings questions related to the resources necessary for the direction of society, which are: a) Economic resources; b) Information; c) Intellectuals; d) Morals; e) Technological; and f) the managerial capacity of both the State and private property. In some cases, inefficiency in business results or in the public sector is alleged mismanagement or lack thereof. But, what is "good management" or, for some, "sustainable management"? Who really cares about the results to the State; entrepreneurs or society as a whole?

In this sense, it is necessary to consider the regime of government and ideology adopted in a territory, as they will determine the structuring models and the movements that a society will make in the evolutionary process and characterize its actions in the economy, in the concern with natural resources, with culture and social demands. Samoggia [7], discussing public governance, shows that it is high time to replace the hierarchical mode with a government "...more associative and coordinating." By showing this necessary change, the author signals the change in the direction of what is being called, here, "collaborative". On the other hand, public managers often adopt an egocentric behavior, prioritizing their needs and considering only their ideological and partisan issues [3]. In addition to the lack of legitimacy and the structural lack of capacity, there is another issue that hinders the functioning of public bureaucracy, which is the lack of a "public value". When focusing on this point, it is always opportune to remember what Sennett [8] shows when he states that "The notion that human beings have a right to happiness is specifically a modern and western idea. The public value referred to here is precisely this happiness to which the author refers. Discussing from different angles the decline of the public man and the troubled relations between the public and the private throughout the 20th century, the author states that a "secular charisma: a psychic striptease was largely, responsible for the "incivility" that we have today, which, in other words, shows the loss of public value on the part of public management itself.

Fig.1 - Preconditions of Public Management

Public administration, then, in order to achieve the goals that society expects of it, needs to be supported by what can be called the precondition of public management (Figure 1). The major complicating factor of these preconditions is that they form a system that is permanently self-reinforcing, thus generating trends that can be directed to meet social needs or in the opposite direction. In the same line of reasoning, it is good to remember that, because it is systemic, the set of elements is dynamic and needs to be, somehow, monitored and

strategically realigned to achieve the desired objectives. It is this point that will be rescued later to justify the need for social collaboration. In parallel with the systemic set called preconditions of public management, it is important that the public bureaucracy itself is adequately supported by a legal structure (legal framework) that provides sufficient stability for the system to function. This legal framework, however, needs to be flexible to adapt to the different operating technologies that may be incorporated into the system. It also needs to be operated with efficient tools for it to be effective. The legal framework and the operative tools can actually be considered within the same sub-variable, as the legal framework needs to contemplate the regulation of the operative tools themselves. These two sets of elements, the preconditions and the legal framework, will be fundamental for the effective functioning of what will be called, here, the "structural pillars" of collaborative public management, formed by at least 3 elements: a) connection; b) collaboration and c) engagement. Schumpeter [3] warns that changes take time, involve different aspects and systems must adapt to survive.

2.1 FORMAL STRUCTURE

For Evans [9], the central elements of the formal structure of collaborative public management are, therefore, connection, collaboration and engagement. The first two elements are heavily dependent on both the precondition system and the legal framework. The third element, engagement, is a function of the systemic preconditions of management, but also a function of the transparency of management itself. It is important to remember that transparency is different from communication, as it implies an adequate and sufficient understanding of the acts of organizational bureaucracy. Now, having said that, transparency, which has the potential to create opportunities for social control and social participation, presupposes knowledge on the part of society, since it, society, is the focus of the actions of public organizations. In other words, society needs to be able to understand what is shown so that actions can be considered transparent. Calling the central elements of the formal structure of collaborative public management "structural pillars" it is possible, then, to establish and show the connections of these pillars with the elements identified here and called preconditions, legal framework, and transparency and operational tools. These elements can be called infrastructural, as they are elements that, in some way, will or can support the structural pillars. It can also be said that the structural pillars that support collaborative public management, similarly to the precondition systems, is a system where its elements strongly influence each other. This actually works this way because management itself needs to act in a systemic and adaptive way.

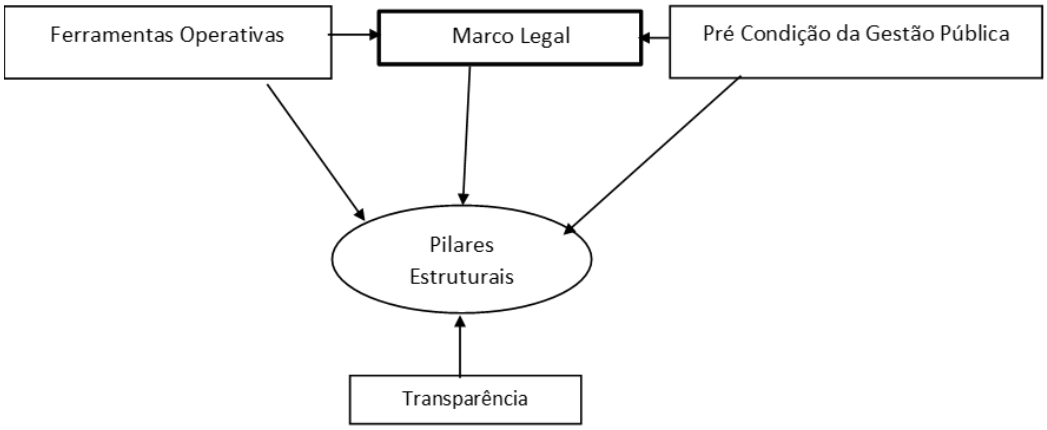


Fig.2 - Infrastructural elements (preconditions)

Any imbalance, lack of function or poor functioning of one of the pillars can destabilize the entire system, causing damage to organizational management. It is important, therefore, that management and managers simultaneously focus on all pillars, giving them attention and reorienting their strategic actions in order to keep each pillar vigorous and thus balance the system, but the pillars need to be known to all stakeholders. actors in the system and aligned with the legal framework that also serves as a regulatory instrument for the management model. It is important to always make it clear that any imbalance, lack of function or poor functioning of one of the pillars can destabilize the entire system, causing damage to organizational management. It is important, therefore, that management and managers focus simultaneously.

III. BUILDING A MODEL

Surely, collaborative public management is directly dependent on, at least, 3 elements (collaboration, connection and engagement) that here have been called "pillars of collaborative management". This dependence occurs both in the cultural-behavioral field and in the procedural field. The values that sustain this dependence, as well as the very praxis associated with the institutionalization of the different processes, guarantee what is called legitimacy. In parallel, the other two precondition elements (capacity and public value) solidify the system as a whole, harmonizing values and processes. It follows, therefore, that collaborative public management, which in essence is the guarantor of sustainable management, is a function of the cause-effect relationship of close elements, which were called structural pillars here, and more distant elements, which were called precondition, legal framework and transparency.

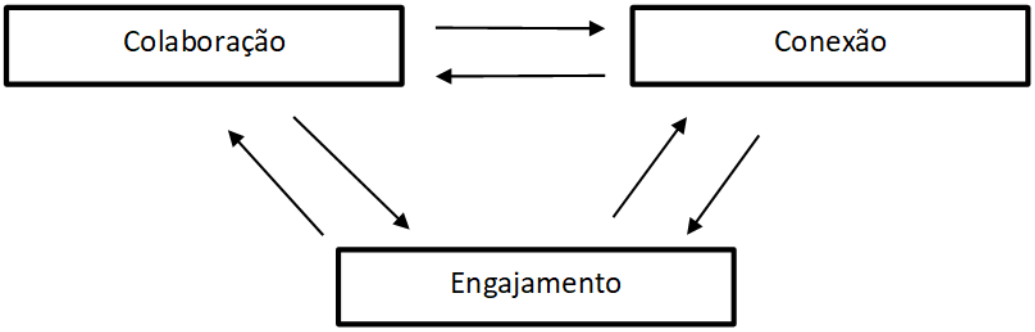


Fig.3 - Collaborative Management Structure (Structural Pillars)

Using a terminology of Marxist origin, it can be said that the close elements form the structure and the distant elements form the infrastructure. All these elements need to be managed from their theoretical specificities and need to be on the management radar on an ongoing basis. Thus, a control panel, with adequate performance indicators, is essential for these elements to be managed (Figure 4).

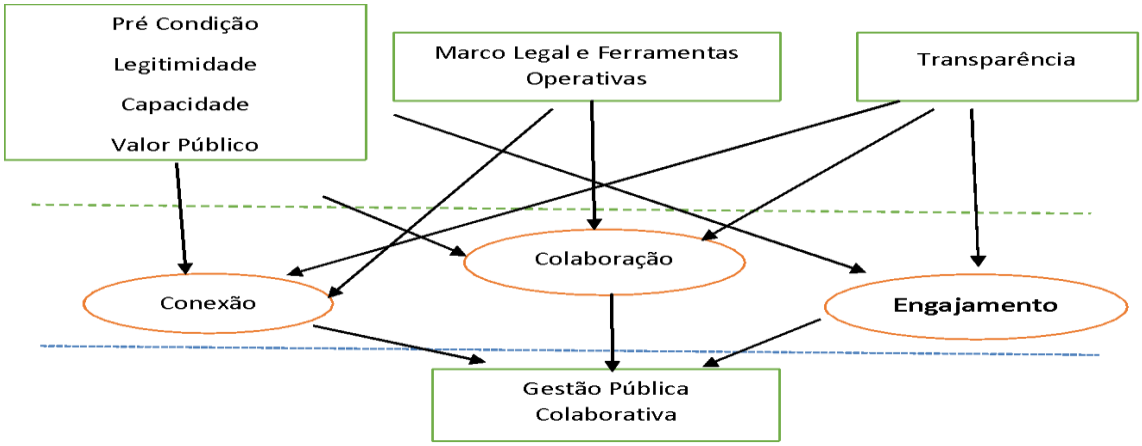


Fig.4 - Structure and Infrastructure of the Collaborative Management System

The performance indicators (ID) that monitor conditions and structural and infrastructural elements need, at the very least, to assess, in some way, the individual performance of the variables and their relationships. Once the structural and infrastructural variables are being properly evaluated and managed, one can expect, as a consequence, an environment conducive to growth and development, in its different conceptions, which are economic, social and environmental. It cannot be forgotten that here there is also a relative cause-effect relationship when it comes to growth and development. Although they are different concepts, it is known that growth facilitates and provides opportunities for development (Figure 5).

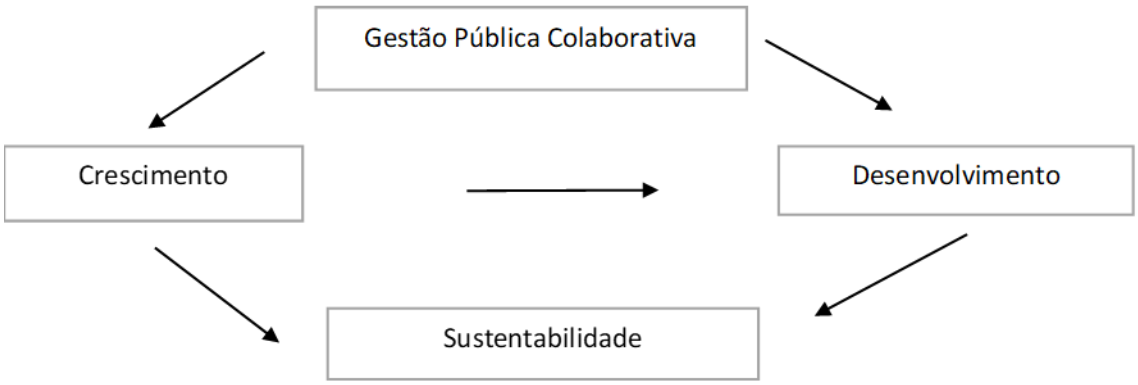


Fig.5 - Collaboration and Sustainability

With the dynamics of growth-development implemented and being sustained over time both by management and by society itself, there are then the necessary and sufficient conditions for sustainability to be adopted as a social culture, as it is assumed both by public management as well as by society itself, as the system works collaboratively [10], (Figure 5).

IV. FINAL CONSIDERATIONS

By way of conclusion, it would be important to remember that public management focused on sustainability needs to start with what are called structural and infrastructural elements, to establish collaborative public management itself, as well as the growth-development binomial. Finally, it is considered that the management of operational elements of sustainability is almost a consequence of a management process with such characteristics that need to be implemented in a strategic way in order to reconfigure the culture of society. Therefore, somehow they affect both public bureaucracy, politics and the community as a whole.

The cultural-behavioral change needs, therefore, to be capillarized in all the elements of the model presented here. For this, governance must exercise its functions of articulation and representation in the management of interests and in the visibility of local actions to promote collaboration between actors, as well as to strive for systemic sustainability in all governmental spheres and together with non-governmental organizations. To act and manage the infrastructural elements is to act on the "causes of causes" and to manage the structural elements is to act on the "causes". Governance is effective when it manages to simultaneously manage all elements of the model (structure and infrastructure). As a desired result, there is the growth-development binomial, which form the necessary conditions for achieving sustainability in a broad way (economic, social and environmental).

When broad sustainability is achieved, the conditions are created to reinforce collaborative public management itself, through proper management of all structural and infrastructural elements. Therefore, the proposed model is systemic and, to be implemented, it needs to be monitored not only in its elements but also in its relationships between the elements of the system.

REFERENCES

[1] DASSO JÚNIOR, A. E. Nova Gestão Pública (NGP): a teoria de administração pública do Estado ultraliberal. **XXIII ENCONTRO NACIONAL DO CONSELHO NACIONAL DE PESQUISA E PÓS-GRADUAÇÃO EM DIREITO NO BRASIL. Anais... Florianópolis: CONPEDI**, p. 394-420, 2014.

[2] BERTALANFFY, Ludwig von. General system theory: Foundations, development, applications. 1969.

[3] SCHUMPETER, Joseph Alois. Teoria do desenvolvimento econômico: uma investigação sobre lucros, capital, crédito, juro e o ciclo econômico (1934). **Tradução de Maria Sílvia Possas. Coleção Os Economistas. São Paulo: Nova Cultural**, 1997.

[4] SACHS, Jeffrey. The End of Poverty: Economic possibilities for our time. **International Journal**, v. 60, n. 3, p. 849, 2005.SENNET, R; O declínio do homem público, RJ; Record; 2014.

[5] HEIDEMANN, Francisco G. Do sonho do progresso às políticas de desenvolvimento. **Políticas públicas e desenvolvimento: bases epistemológicas e modelos de análise. Brasília: UNB**, p. 23-39, 2009.

[6] AGUILAR VILLANUEVA, L.F. (2006). **Gobernanza y gestión pública.** México: FCE.

[7] SAMOGGIA, Giusini. Luis F. Aguilar Villanueva: Gobernanza y gestión pública. Fondo de Cultura Económica, México, 2006. **Foro Interno**, v. 7, p. 163-166, 2007.

[8] SENNET, R. **O declínio do homem público**, RJ; Record; 2014.
[9] EVANS, Peter. El hibridismo como estrategia administrativa: combinando la capacidad burocrática con las señales de mercado y la democracia deliberativa. **Revista del CLAD Reforma y democracia**, v. 25, p. 1-15, 2003.
[10] POLLITT, Christoph. **Public Management Reform**: A Comparative Analysis. Christopher Pollitt and Geert Bouckaert. 2000.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.28

Entrepreneurship and Nursing: Opening of Long Stay Institutions for the Elderly

Kayo Felipe Ribeiro Lima[1], Marcelle Fernandes Gomes[1], Andréia de Carvalho Andrade[2]

[1] Bachelors in Nursing (Graduates), Universidade Cruzeiro do Sul, São Paulo (SP), Brazil.
Email: zophize@gmail.com, marcelle.fernandes@hotmail.com
[2] Nursing Professor, Universidade Cruzeiro do Sul, São Paulo (SP), Brazil.

Received: 25 Apr 2022,

Received in revised form: 15 May 2022,

Accepted: 22 May 2022,

Available online: 28 May 2022

***Keywords*— Health services for the aged, Homes for the Aged, Nursing Administration Research, Nursing Care, Geriatric Nursing.**

***Abstract*—** *This work aims to know the fundamentals that led to the opening of a business for the elderly and to identify the challenges faced by nurses, making it possible to discuss the topic in an academic context and reflect on the challenges faced by entrepreneurial nurses in opening a business for the elderly. Eight entrepreneur nurses from São Paulo (Brazil) were interviewed. As an instrument, an exploratory-descriptive interview was conducted with a qualitative analysis of the data. Regarding the fundamentals, the categories "autonomous work / being an entrepreneur" and "autonomy in the care of the elderly / job satisfaction" are thematically presented. The challenges faced for this process had as a thematic category: "professional fulfillment versus quality of care for institutionalized elderly people"; "unpreparedness for the business management" and "legislation requirements and financial resources for the business".*

I. INTRODUCTION

In Brazil, the concern with the creation of lasting microenterprises and the need to reduce the high mortality rates of these enterprises are reasons for the popularity of the term "entrepreneurship", which receives special attention from the government and class entities. Thus, after many attempts to stabilize the economy and the imposition of globalization, large Brazilian companies looked for alternatives to increase competitiveness, reduce costs and remain in the market. As a result, the unemployment rate increased in large cities, where there is a greater concentration of companies. This scenario allowed the growth of new ventures, in which people without employment, often without experience, took the risk of opening their own business (Dornelas, 2016).

It was from the 1990s that Brazil turned its attention to entrepreneurship, a period in which the need for practices and policies to stimulate the opening of micro and small businesses, which account for 57.3% of formal jobs, was perceived and account for 20% of the Gross Domestic Product (GDP). The great difficulty in getting jobs in all areas, including health, has made researchers alert to the need to redesign the profession, opening their own business, even if for this they must continue as a salaried person, but acting and thinking like an entrepreneur (Andrade, Ben, & Sanna, 2015).

For Kraemer, Duarte and Kaiser (2011), the self-employed nurse is one who follows his professional conduct, aware of the spaces in which he can work, seeking personal satisfaction and that of his clients, knowing the importance of his practices for people. Nursing, since its inception, has been idealized as a charitable assistance practice, aimed at doing good for free, not being considered entrepreneurial. Little by little, however, it has been conquering space, being essential the self-valorization by the nursing professionals, whom must be recognized as important members in a field of diverse possibilities in entrepreneurship (Alexandre et. al, 2019).

Nurses are understood as liberals, which means, they can exercise their functions independently and have free professional practice guaranteed by the Brazilian Federal Constitution, being the 21st profession registered with the National Confederation of Liberal Professions (In portuguese: Confederação Nacional de Profissões Liberais/CNPL) since 1962. CNPL is an entity higher degree that has a union structure that covers all the states, 600 unions representing 51 professions. It serves the purposes of study, coordination, protection, claims and legal representation of liberal professionals, in the sense of professional solidarity and national interests (Andrade & Sanna, 2017).

In general, entrepreneurship adds value to a country's economy, as it enables the generation of jobs and income, generates economic growth and, consequently, improves the population's quality of life. In nursing, entrepreneurship is already a reality in the commitment to the Brazilian economy. The study by Andrade, Ben and Sanna (2015) indicated the registration of 170 companies for the nursing activity in the last decade (An increase of 86.7% in the Brazilian state of São Paulo), which may be associated with dissatisfaction at work or the search for new perspectives associated with the development of an entrepreneurial personal profile.

The growth field for entrepreneurial nursing is varied and includes different areas, which favors the prospects for success. Nurses have legal and ethical support to develop autonomous and liberal activities, being able to manage their own business. The demand for specialized care creates greater tranquility in the patient's family, and as care managers, nurses assess patients' needs in all aspects of health status (physical, mental and social) and build care plans. Thus, they offer or organize services to prevent growing frailty in the elderly (Silva, Xavier, & Almeida, 2020).

Currently, employment registered under the Consolidation of Labor Laws (CLT), with all labor rights, is increasingly scarce. In the area of health, including nursing, vacancies are heading towards extinction in Brazil, that is, vacancies in hospitals and other health services will be increasingly scarce due to the lack of updating of professional knowledge, the financial crises of the sector and of a representative increase in the training of these professionals due to more courses in the country's universities (Roncon & Munhoz, 2009).

With the increase in life expectancy, there are consequences for the growth in demand for new services to meet the needs of the elderly population, such as long-term care facilities for the elderly (Costa & Mercadante, 2013). With the perspective of an increasing number of elderly people in Brazil, visionary nurses, with administrative experience, saw in this niche a promising area to undertake a new business. Through this scenario, the entrepreneurial activity of nurses was associated with the large number of long stay institutions for the elderly (Lsifte/also known as Nursing Homes in other countries) opened in the city of São Paulo. Therefore, it is worth asking: what are the foundations for opening a business for the elderly and what are the challenges faced by entrepreneurial nurses?

The objective of this work is to know the fundamentals that led to the opening of a business for the elderly and to identify the challenges faced by nurses in opening this business. This work is justified by enabling discussion and reflection on this theme in the academic environment.

II. METHODOLOGY

This is a field analysis, with exploratory, descriptive and qualitative approach. According to Polit and Beck (2002), the objective of nursing research is to answer questions that solve problems relevant to the area. The descriptive study aims to observe, describe, sketch, elucidate and classify a wide variety of phenomena. In the exploratory examination, we seek to investigate, based on a phenomenon of interest, its nature, mode of manifestation and other related factors, especially those that may be its cause.

In a qualitative approach, the verification of data depends on many nuances, including the nature of the information collected, the sample's size, research instruments and the guiding theoretical assumptions. We can define it as a sequence of activities that involve data reduction, categorization, interpretation and report writing (Gil, 2002).

The selection criteria of the participants aimed to establish a fundamental homogeneity, conceptualized by the adoption of pre-established criteria according to the research objectives, being fundamental for involving participants with basic characteristics in common (Nicolaci-da-Costa, 2007), these characteristics were: being a nurse and having a long stay institution for the elderly in the East Side of São Paulo City, where the study took place.

Through the internet, a survey was made of these institutions in the East Zone of São Paulo City that had a nurse as their owner. Thus, eight professionals were initially identified in the region. Then, a telephone call was made to schedule a visit and invite them to participate in the study, everyone then accepted to participate in the study.

With the approval of the project by the Ethics and Research Committee (In Portuguese: Conselho de Ética e Pesquisa/CEP), with the registration No. 2.870.150 in the Universidade Cruzeiro do Sul, data collection was carried out upon acceptance of the participants, who signed an Informed Consent Form, which contains the nature of the research, objectives and methods, as provided for in Resolution MS/CNS 466 /2012 (National Health Council [CNS], 2012).

We chose the theoretical saturation sampling criterion, used to determine when the researcher must complete the data collection process and belongs to the spheres of objective validation and inductive inference (Falqueto, Hoffmann, & Farias, 2019), therefore the data collection was finalized when similarities were identified and the crossing of empirical data enabled the identification of patterns and consequently the organization of data into thematic categories, considering that the answers led to common conclusions for all respondents, not being necessary to invite new participants beyond the eight that were previously selected.

In order to preserve the identity of the participants, they were identified by the abbreviation E followed by ascending numerical order.

For data collection, an unstructured interview was conducted with two guiding questions:

1) What were the reasons that led you to open a business for seniors?

2) What are the positive and negative challenges you faced as a nurse when opening your business?

This type of interview is conducted as a non-directive guideline; it develops with what emerges in the moment, without a well-established plan, but it has direct interaction with the research objective (Dyniewicz, 2014). According to Minayo and Gomes (2002), an interview is, above all, a conversation that can involve several interlocutors, carried out at the initiative of the interviewer. Its purpose is to gather pertinent information to research objectives. Data were obtained through recorded interviews, which were then transcribed and analyzed. It is a referential based on the qualitative character of the social sciences and on the methodology that was appropriated to theoretically construct its meaning according to the analysis.

Therefore, the interviews were transcribed in full. The content analysis was continued and with all the data collected at the time of collection, that is, the corpus. Floating readings of the entire material were carried out, in order to apprehend and organize in an unstructured way important aspect for the next phases of the analysis, in order to capture the main ideas and their general meanings in a global way (Campos, 2004).

After capturing the ideas expressed during the analysis of the empirical data, the analysis units were selected. In qualitative studies, the investigator is guided by the research questions that need to be answered. Most often, units of analysis include words, sentences, sentences, paragraphs or a full text of interviews. Among several options in choosing the cuts to be used, we noticed a greater precision and didactic explanation in thematic analysis (themes), which leads us to the use of sentences as units of meaning, which will explain the central ideas that were obtained in theoretical saturation of empirical data and correlated with scientific data. (Moraes, 1999)

According to Silva and Fossá (2015), it is also necessary to have a certain degree of intuition, imagination, and creativity, especially in defining the categories of analysis. Never forgetting, rigor and ethics, which are essential factors. The initial categories were grouped thematically, and after being grouped according to the occurrence of the themes, they resulted in the final thematic categories, that is, the text of the interviews was cut into registration units (sentences), grouped thematically forming final thematic categories, the which made the inferences possible. Through this inductive and inferential process, the aim is not only to understand the meaning of the interviewees' speech, but also to explore the different meanings, as shown below.

Thematic categories regarding the reasons for opening the business, and it's meaning units are:

1) Self-employed/Being an entrepreneur

- Investment
- Perception of a field of work
- Market opportunity
- Want to undertake
- Own business
- Dream of an own business
- Financial Independence

2) Autonomy in elderly care/Professional satisfaction

- Act of caring
- Lack of identification with other areas of the profession
- Religious reasons
- Differential in assistance
- Need care improving

Thematic categories referring to the challenges faced by the entrepreneur and its meaning units are:

1) Professional achievement and quality of care for institutionalized elderly

- Quality of care/rehabilitation of the elderly
- Take care of the elderly
- Dignity to the elderly
- Elderly satisfaction
- Contribute to the quality of life for elderly
- Report of elderly victims of abuse
- Difficulties in the relationship with the family
- Loss of the elderly

2) Unpreparedness to manage your own business

- Work overload
- Responsibility
- Difficulty with management
- Difficulties with the team
- Uncommitted team
- Difficulties of being an entrepreneur

3) Unpreparedness on legal requirements and financial resources for own business

- Bureaucracy in opening a business
- Requirement of Health Surveillance and other legislation
- Difficulties with specific furniture for the elderly
- Financial difficulties
- Onerous taxes
- Inadiplence

III. ANALYSIS AND DISCUSSION OF RESULTS

The category "self-employment/being an entrepreneur" enabled the discussion on the fundamentals for opening a business for the elderly, being demarcated by reports referring to the perception of a field of work, market opportunity, wanting to undertake, investing need, financial independence and dream of owning a business.

The 2017 Code of Ethics for Nursing Professionals and Decree No. 94.406, of June 8, 1987, which regulates Law No. 7,498, of June 25, 1986, which provides for the exercise of nursing, allow and guarantee autonomous practice of the nurse in the interpretation of its reading:

Art. 8 – The nurse is responsible for:

I – Privately:

a) direction of the nursing body that is part of the basic structure of the health institution, public or private, and head of nursing services;

b) organization and direction of nursing services and their technical and auxiliary activities in companies providing these services;

c) planning, organization, coordination, execution and evaluation of nursing care services;

d) consulting, auditing and issuing an opinion on nursing matters;

e) nursing consultation;

f) prescription of nursing care;

g) direct nursing care for seriously life-threatening patients;

h) nursing care of greater technical complexity and that requires adequate scientific knowledge and the ability to take immediate decisions [...]

What can characterize “being an entrepreneur” are several elements that make a business successful. Some people are born with the gift of entrepreneurship, the so-called “native entrepreneurs”. However, there are those who are influenced by the environment in which they live and become entrepreneurs by their education, family influence, market opportunities, study and administrative practice (Zampier & Takahashi, 2011).

“[...] I created this perception of a field of work where there were few people, I started getting a taste for the thing and then I went to work in a private house where everyone paid “x” amount of money to be taken care of and then one of the partners left and I had the possibility of becoming a member of the business, that was my first nursing home and then I conquered my nursing home alone.” (E7)

The nurse needs to develop various skills to become a successful entrepreneur. Thus, it is necessary to understand marketing, finance and operations management, in addition to having a vision of opportunity, listening skills, communication skills, teamwork skills, planning skills, change management and company growth (Baggio & Baggio, 2015).

“[...] so it was a dream, but let's say it was a distant dream, we thought about having a business, but we had just gotten married, it wasn't something that would be immediate, and, I joked a lot that it was something for retirement, because I really like the hospital area, but this opportunity arose, in the beginning it worked very well, it was very fast, we worked together so growth was easier.” (E6)

With the search in the job market, nurses identify new opportunities, recognize the Lsifte as a field to undertake

with their own financial investment and achieve financial independence with self-employment. However, what motivates them to become entrepreneurs is the dream of having their own business. Nurses have been acquiring increasingly greater competences and aptitudes, enabling entrepreneurship in the field of nursing. The nurses who own Lsifte are an example of this growth.

The category "autonomy of care/professional satisfaction" enabled the discussion on how the long stay institutions for the elderly should work, based on the act of caring, the lack of identification with other areas of the profession, religious reasons, the differential in care and need to improve it.

"[...] I was acquiring love for the elderly generation and then I'm also a pastor, that's why the name of the house is biblical, because when I opened the house, I consecrated it to God, that's why I don't feel as an entrepreneur, I feel more like an employee and God the boss. And the other reason was that I am a teacher as well as a nurse, I have already taught at a university and also followed many internships and one of the internships I did, was in a nursing home, so I saw a lot of battered old people and that hurt my soul, then I said: I'm going to open a nursing home that will be different from all those I've been through. And that's what I did." (E4)

There is a regulatory norm in Brazil to assess the standards necessary for the functioning of the Lsifte and that also indicates how the service should be provided to residents. This standard is described in RDC No. 283 of September 26, 2005, prepared by the National Health Surveillance Agency (Anvisa, 2005).

For the elderly, institutionalization can bring numerous dangers that are directly associated with non-compliance with the standards set out in RDC No. 283/2005, also considering that this population has levels of dependence (Kletember, 2010).

For the functioning of Lsifte, horizontal constructions are preferable. If the institution has several floors and does not have the appropriate equipment for movement, clients with locomotor or psychological problems or those who are immobilized in bed must be accommodated on the ground floor (Anvisa, 2005). The Lsifte must also have a responsible technician, with a university degree, who must work at least 20 hours a week and will be responsible for the institution with the health authority. All nursinh homes need to register with the appropriate health agency, and institutions that do not meet the standards may lose their business license. According to the rules, institutions must keep monthly reports on file for each inmate, so that they can be presented to the health authority if requested.

For nurses to achieve professional autonomy, it is essential to have knowledge, skills and competences that enable decision-making in the workplace. Correct behavior and conducts can ensure such autonomy (Fentanes, 2011).

"[...] and the house appeared when I was studying at college too, I started to see the elderly issue a little, I've always liked elderly people, I've taken care of my mother, I took care of my mother-in-law. And then I would visit some houses and I could see the needs that were there, unfortunately we can't only see the good things, we also find precarious things even though it's private, how can I say? Something like that, with no quality at all, for being private, I always thought I could give more. Then this desire arose and then, with my husband's agreement, we started the construction." (E3)

In order to emphasize the importance of nurses in the Lsifte, it should be recognized that these institutions aim to provide assistance. According to the law, the professionals who make up this team – technicians in nursing, nursing assistants and caregivers – can only exercise their functions under the direction and supervision of a nurse (Santos, 2008).

Autonomy is the responsibility and control of each individual over their decision-making. Motivation and productivity lead to dedication and quality of service, with autonomy being the most important component in job satisfaction (Siqueira & Kurcgant, 2012). In other words, nurses are more satisfied with aspects such as responsibility, autonomy and recognition, which are intrinsic (Cura & Rodrigues, 1999).

"Initially my husband and I always worked in the healthcare field, and we wanted to start our own business. [...] so our focus is this, so that way we can contribute to this, both to improve care and to undertake, so this led us to open our business, so we opened an institution. [...] so, in short, what led us to really open a business was to make a difference and work with the profession that we chose." (E1)

One of the most important indicators of job satisfaction is motivation. It is noted that motivated professionals develop their activities better, as well as professional and psychosocial satisfaction, showing commitment and seriousness in their work environment (Castro, Dehrun, & Carreira, 2013).

"What motivated me was the act of caring, which is very important in our profession, and I've studied the investment market since 2010, but I didn't identify with any area, both in commerce and in other areas, I could never fit in on one, I researched insurance companies to invest, a lot of other options and not one of them seemed to fit in, until in 2015, the nursing home option came up

and after a brief market study, I decided that this was what I would invest, the nursing home for adding value to me. [...] and the nursing home would add the value of the investment to me along with the act of taking care of people." (E5)

Everyone brings with them experiences arising from attitudes, beliefs and values that can interfere in the work environment, enabling their professional satisfaction (Cura & Rodrigues, 1999). With this, we can relate the professional satisfaction exercised by nurses with the autonomy that the activity provides, as these professionals have the knowledge to perform their function in the best way, ensuring quality of life for the elderly and, consequently, allowing satisfaction with the care provided.

The category "professional achievement and quality of care for institutionalized elderly" enabled the discussion on the positive and negative points faced by the entrepreneur, evidenced by reports on the quality of care/rehabilitation, dignity of patients, satisfaction, contributing to the quality of life, victims of abuse, difficulties in the relationship with the family, the loss and financial independence of the elderly.

Reports of ill-treatment of the elderly are still common, sometimes by the family member, which is why Lsifte administrators have the challenge of guaranteeing the residents qualified care, leaving their family members at ease and guaranteeing the nursing team safety in their actions (Santos, Silva, Barlem, & Lopes, 2008). The professionals who work in these institutions dedicated to the care of the elderly need to be technically and emotionally trained, taking on responsibility for meeting these people's basic needs. For this to occur, in addition to technical and scientific qualifications, they need to present qualities to promote efficient care (Castro, Dehrun, & Carreira, 2013).

"The positives are always that it's a differential, we list everything, what the region doesn't have, so we have that will of doing innovation, that determination to do something different." (E1)

In studies, it became evident that the role of nurses in the Lsifte is to improve the quality and well-being of institutionalized elderly people through basic care in physical, psychological and social issues, as well as promoting the integration of the multidisciplinary team and guiding families and guardians. The nurse who recognizes the needs of the elderly can make care more humane, receptive, evaluative and comprehensive, which contributes to quality care for the elderly (Santos et al., 2008).

"[...] other than that, you see the quality of care, the rehabilitation of the elderly when they are institutionalized, this is gratifying, it is the positive side. We have elderly people who entered here without walking, who did not walk, who used a nasoenteral catheter, today they rehabilitated themselves with the help of the professionals, with the multidisciplinary team, here we aim to work as a team." (E1)

The degree of satisfaction with health services is relevant. Some seniors who expressed contentment added that they felt that way for living in that house, which offers a place to sleep, eat, and where "they don't lack for anything". In a study by Lenardt, Michel and Wachholz (2010), a high degree of satisfaction with life, health services, activities performed in their free time and social resources available at the institution was noted. The elderly was satisfied with the attention they received at the institution and said they felt respected.

"The positive side is precisely that, of caring. You give them dignity because they often arrive here very weakened, because the family, it only really gets real about the need for the elderly to need better care when it gets worse." (E2)

The speeches reveal that the absence of the family makes them more vulnerable to situations of violence, translated into the context of statements mainly due to abandonment. Elderly people are victims of various types of violence, from insults and beatings by family members and caregivers (domestic violence) to abuse in public transport and institutions in general (Lenardt, Michel, & Wachholz, 2010). Still, there is a predominance of factors related to loss of contact with family members or abandonment of the elderly as the main factor for institutionalization. Some families claim not to be able to provide support for old age, time to care, talk, give attention, as well as provide financial support. In addition, family members currently have numerous activities,

Thus, professional satisfaction related to the institution, when knowledge about caring for the elderly is obtained, tends to improve the opportunities to provide adequate care. Professionals who have been prepared and received some type of initiation acquire security to perform a more specific care, becoming more prepared for such action, thus aiming at the quality of care for the elderly (Figueiredo, Rabelo, & Veloso, 2014).

"[...] the responsibility is very big, it's a business that you don't have a time and you close, and you leave. It's 24 hours, so you, as a nurse, have 24-hour responsibility in all sectors, whether in the kitchen, cleaning or nursing. The nursing staff is a lot of work, unfortunately, so it's a 24-hour thing, so you must like it and love it a lot. Now answering the second part of your question, what are the positive points, the positive ones, I'll tell you that it's when

you look at their faces and they smile, when you look at them and you see that you've done well, when you feed them properly, give them good hygiene, give them quality, make them a little party and you see joy in them, you spend the whole day with a lot of problems but you stay in this room for half an hour, it all ends." (E3)

Considering this context, it is noted that a care environment is one in which respect, trust, attention, recognition, and acceptance of people with their limitations and difficulties prevail, seeking to offer them support and help. Nursing care is not only aimed at knowledge about care, but mainly at how to carry it out.

The category "unpreparedness for managing one's own business" allowed for the discussion of the negative points faced by the entrepreneur, as evidenced by reports regarding work overload, responsibility, difficulty with management, difficulties with the team, uncommitted team, and difficulty of being an entrepreneur.

The literature points to the fact that nurses' knowledge about the managerial work method is still initial, given its magnitude and complexity. The professional must be interested in reaching, evolving, and regularly improving managerial skills, which can happen through participation in postgraduate courses, continuing education, among other possibilities (Rothbarth, Wolff, & Peres, 2009).

The deficiency in academic preparation for the development and growth of students' entrepreneurial skills, associated with the culture of traditional salaried service and the little encouragement of entrepreneurship support programs, is also seen in the literature (Morais, Haddad, Rossaneis, & Silva, 2013).

"[...] Of the negative points, they are more administrative and there is an overload of work, in addition to being a nurse, you are being the owner of the establishment, everything revolves around you, it is a lot of responsibility, ranging from the responsibility of the assistance with the elderly, even the financial part, you must take care of everything. The management part is very important, so sometimes the difficulty we have on the management part." (E1)

Entrepreneurship, therefore, should be encouraged during nursing education, so that it allows them to think about the dimension of developing creative and transformative attitudes, with autonomy and determination, in the pursuit of excellence in nursing and health care (Carvalho, Vaghetti, Dias, & Rocha, 2016).

The nurse needs to acquire negotiation skills, as this skill is necessary for the management of the business itself, and with regard to the coverage of care provided by Lsifte, including the negotiation of values, the service provision contracts entered into by for-profit entities allow free negotiation, and the minimum services to be offered and other legislation in this regard must also be observed (National Council for the Rights of the Elderly [CNDI], 2017).

The category "unpreparedness on legal requirements and financial resources for own business" it enabled the discussion through the negative points reported by nurses in which issues related to bureaucracy were raised in the opening of the business, requirement of health surveillance and other legislation, difficulties with specific furniture for the elderly, financial difficulty, onerous taxes, and default. This is a discussion that complements the previous one, but it is quite specific, as knowledge of the ministerial decrees on the subject is essential.

Long stay institutions for the elderly have characteristics of a residence, a collective home for people aged over 60 years, housing residents with different health characteristics, in conditions of chronic and disabling diseases that require greater care (Salche, Portella, & Scortegagna, 2015).

"[...] we had a lot of difficulty in adapting because the properties are not prepared for the elderly." (E3)

"The negative points are the Health Surveillance, Public Ministry, labor laws, dealing with employees and their families [...], it is very difficult to undertake in this country, there is a lot of tax." (E8)

Brazilian laws ensure greater rights for the elderly, their families and the community, and characterize the Lsifte, defined according to Anvisa Resolution, as "governmental and non-governmental institutions of a residential nature, intended to be collective homes for elderly people, with or without family support, in a condition of freedom, dignity and citizenship". As they are institutions for the elderly, it is important to understand the demand for care (Roquete, Batista, & Arantes, 2017).

The RDC No. 283/2005 defines regulatory standards for the functioning of long-stay institutions and conceptualizes that such institutions are social entities dedicated to providing services to the elderly, contemplating care for individuals regardless of the degree of dependence, which requires greater assistance from the team in all self-care activities for the daily life (Carvalho, 2014).

According to article 48 of Law nº 10741 of 2003, of the Elderly Statute, the must enter into a formal service provision contract with the elderly person or legal guardian, specifying the type of service, rights and obligations of the entity, with the description of all the

items that the entity offers, as well as the service delivery team (Estatuto do Idoso, 2003).

Federal Law No. 6.437, of August 20, 1977, provides that non-compliance with any of the laws in force or with RDC 283, which standardizes the rules, is subject to penalty in accordance with arts. 1 and 2 (Anvisa, 1977).

Art.1- Violations of federal health legislation, except for those expressly provided for in special rules, are those set out in this law.

Art.2- Without prejudice to the applicable civil or criminal sanctions, sanitary infractions will be punished, alternatively or cumulatively, with the penalties of: I- warning; II - fine; III- product seizure; IV- product destruction; V- product ban; VI- suspension of product sales and/or manufacturing; VII- partial or total prohibition of the establishment.

Knowing about the requirements of the legislation, nurses find it difficult to regulate it within an institution, as they are unaware of such laws, generating future misunderstandings with regulatory bodies.

"The negatives are that there is a lot of bureaucracy. When we're going to open, we don't have much support for opening businesses, especially services for the elderly, so when we go to the responsible agencies, get informed and search, then we have to have this active search, but it's a little bit difficult because depending on the regulation, it's one agency that has to wait for the other, it gets discouraged, it's a time-consuming process, and apart from the documentation, the administrative part, when you start a business, you're not just a nurse, you have to do everything the part, then the administrative part becomes a bigger challenge, which is part of the documentation, business license, part of licenses [...]" (E1)

The cost of an institution is greatly affected by its legal nature and the provision of services. The largest portion of expenses in Lsifte is allocated to payroll, which corresponds to 52.5% of the total. Of the remainder, 14.1% are for food; 9.4% to payments of fixed expenses, such as water, telephone and gas; and 18.8% paid for rent, small repairs, fuel, house maintenance and/or purchase of office supplies. Medications, on the other hand, are responsible for a relatively low share of expenses, as they are almost always the responsibility of family members or donations (Camarano & Camarano, 2010).

As for funding sources, they can come from monthly fees ranging from 3,500 to 8000 reais, and may also rely on other funding sources, especially if they have a philanthropic nature, such as government funding, donations, beneficiary contributions, agreements, events and other sources. (Freire, Mendonça & Costa, 2012)

"[...] now the negative points are always the absurd taxes, in addition to taxes, sometimes you take an employee to work and he is not concerned about the quality of life of the elderly, he is concerned about what he will earn and the that he will take advantage and sometimes forget that he has a human being, I have already dismissed many employees because the elderly person said that he was abused, sometimes not physically abused, but verbally. [...] the health surveillance, sometimes, comes a health surveillance worker, who is not concerned with the quality of life of the elderly, he is concerned with the protocol, it does not matter if the elderly is doing well or not, it matters the protocol, and if you are private then, that's when things get complicated [...]" (E4)

"[...] the financial issue, unfortunately, things get more expensive every month, the values change, and we cannot change the monthly fee, so the financial issue has always been very difficult, in terms of not taking of their quality, so you end up taking it out of your own pocket, so you don't mess with the quality you keep for them, so I think there's a little bit of incentive, because even if it's private, we're providing a service, because if the people go see the SUS law, right? The government would have to provide this foundation, provide this foundation, it would have to have public houses there, with qualities to welcome the elderly, because this is part of public health, unfortunately this project within public health, it is very small." (E3)

Thus, Lsifte needs to organize itself from an economic point of view, getting involved in operations of the entire economic system of the institution. This system is centered on limiting resources, as well as on distributing and ensuring that the needs of social systems are met (Creutzberg, Gonçalves, & Sobottka, 2007).

"[...] we work 100% privately, and sometimes pay even more than other businesses. [...] It's a very big, very big bureaucracy, nothing is made easy and no matter how legal you are, here for example we are 100% legalized by the health surveillance, annually they visit, we are always approved, we don't have no irregularities, but unfortunately we end up having a very high cost with this, because there are many requirements that we have to comply with and unfortunately this does not always bring us any return at that time, whether you have patients or not, you have to be adequate and then if you don't have a patient, you don't have a return, so it's a very difficult field." (E3)

This entire context ends up presenting a scenario of financial difficulties. Therefore, professionals point out as management challenges to comply with what is established for Lsifte, requiring adequate and trained human resources

to carry out health care, leisure, cleaning and feeding activities, adjusting the number of professionals to the degree of dependence and number of elderly people, in addition to having working hours with activities to be developed (Rodrigues, 2018).

According to the Sebrae manual (2020), a business plan is a document in which the objectives of a business are described, following steps so that the purposes are achieved. With this, it allows the minimization of risks and uncertainties, enabling the perception of the need for change in the theoretical plan, so that errors do not happen in the practical execution.

These results show that the large amount of taxes and financial difficulties are challenges that nurses face. However, the biggest challenge for opening a business for seniors is the lack of knowledge about the legislation, causing non-compliance with them, which generates failures in the care of the elderly and compromises the enterprise.

IV. CONCLUSION

Data analysis made it possible to achieve the objectives of the study, regarding self-employment and being an entrepreneur, there is a perception that the market opportunity related to nursing care in long stay institutions for the elderly is real and will increase with the aging of the population. Autonomy makes it possible to make dreams come true, see the difference in care, and when associated with personal experiences, it underlies the process of opening long stay institutions for the elderly by nurses. quality and the bond developed between the institution and its clients.

The challenges in professional fulfillment and quality of care for the elderly, show that professional fulfillment comes from ensuring the quality of care and rehabilitation of the elderly. The dignity of the elderly, the quality of the affective bond between the members of the care team and respect for their individuality through simple actions are essential for entrepreneurs, as the absence of family, the feeling of abandonment and dependence are obstacles to service quality.

Unpreparedness for business management awakens a need to search for a better understanding of human, material, and financial resources, avoiding the workload of employees, ensuring team motivation and gains in institutional performance. The best financial management comes from knowledge of legislation and regulatory bodies, establishing planning strategies, such as the business plan, negotiating the price of the services offered, so that there is no loss or emotional distress in relation to family members. patient, in addition to exploring different possible sources of income for long stay institutions for the elderly.

Finally, it was noticeable that research aimed at the enterprise in long stay institutions for the elderly is of great value, needing to be further explored to have more information on this subject, thus contributing to entrepreneurial professionals in the health area.

REFERENCES

[1] Alexandre, A., Oliveira, J. da S. J., Silva, E. B., Neto, N. G., Costa, L. da, & Rodrigues, K. (2019). Arte e Ciência do Cuidar: Alteridade, Estabelecidos e Outsiders na Autonomia do Enfermeiro como Profissional Liberal. Revista de Pesquisa: Cuidado é Fundamental Online, 11 (2), 370-376. Doi: 10.9789/2175-5361.2019.v11i2.370-376

[2] Andrade, A. de. C., Ben, L. W. D., & Sanna, M. C. (2015). Empreendedorismo na Enfermagem: panorama das empresas no Estado de São Paulo. Revista Brasileira de Enfermagem, 68 (1), 40-44. Doi: 10.1590/0034-7167.2015680106p

[3] Andrade, A. de C., & Sanna, M. C. (2017). Trajetória de enfermeiros empreendedores da década de 1980 na cidade de São Paulo. São Paulo, SP: Scortecci.

[4] Baggio, A. F., & Baggio, D. K. (2015). Empreendedorismo: Conceitos e definições. Revista de Empreendedorismo, Inovação e Tecnologia, 1 (1), 25-38. Doi: 10.18256/2359-3539/reit-imed.v1n1p25-38

[5] Brasil (1977). Lei n. 6437, de 20 de agosto de 1977. Configura infrações à legislação sanitária federal, estabelece as sanções respectivas, e dá outras providências. Recuperado de: http://www.planalto.gov.br/ccivil_03/leis/l6437.html

[6] Brasil (1987). Decreto n. 94.406, de 8 de junho de 1987. Regulamenta a Lei nº 7.498, de 25 de junho de 1986, que dispõe sobre o exercício da enfermagem e dá outras providências. Recuperado de: http://www.cofen.gov.br/decreto-n-9440687_4173.html

[7] Brasil (2003). Lei n. 10.741, de 1º de outubro de 2003. Dispõe sobre o Estatuto do Idoso e dá outras providências. Recuperado de: https://www.gov.br/cidadania/pt-br/acesso-a-informacao/legislacao/lei-no-10-741-de-01-de-outubro-de-2003

[8] Camarano, A. A., & Kanso, S. (2010). As instituições de longa permanência para idosos no Brasil. Revista Brasileira do Estudos de População, 27 (1), 232-235. Doi: 10.1590/S0102-30982010000100014

[9] Campos, C. J. G. (2004). Método de análise de conteúdo: ferramenta para a análise de dados qualitativos no campo da saúde. Revista Brasileira de Enfermagem, 57 (5), 611-614. Doi: 10.1590/S0034-71672004000500019

[10] Carvalho, D. P. de., Vaghetti, H. H., Dias, J. S, & Rocha, L. P. (2016). Características empreendedoras de enfermeiras: um estudo no Sul do Brasil. Revista Baiana de Enfermagem, 30 (4), 1-11. Doi: 10.18471/rbe.v30i4.16803

[11] Carvalho, V. L. de. (2014). Perfil das instituições de longa permanência para idosos situadas em uma capital do

Nordeste. Cadernos Saúde Coletiva, 22 (2), 184-191. Doi: 10.1590/1414-462X201400020012

[12] Castro, V. C. de., Derhun, F. M., & Carreira, L. (2013). Satisfação dos idosos e profissionais de enfermagem com o cuidado prestado em uma instituição asilar. Revista de Pesquisa: Cuidado é Fundamental Online, 5 (4), 493-502. Doi: 10.9789/2175-5361.2013v5n4p493

[13] Conselho Federal de Enfermagem [Cofen]. (2017). Resolução Cofen nº 564/2017: Código de ética dos profissionais de enfermagem. Recuperado de: http://www.cofen.gov.br/resolucao-cofen-no-5642017_59145.html.

[14] Conselho Nacional Dos Direitos Da Pessoa Idosa [CNDI]. (2017). Resolução n. 33, de 24 de maio de 2017: Estabelece diretrizes e parâmetros para aregulamentação do Art. 35 da Lei nº10.741/2003 (Estatuto do Idoso), que dispõesobre o contrato de prestação de serviçosde toda entidade de longa permanência,ou casa-lar, com a pessoa idosa abrigada,substituindo a Resolução CNDI nº12/2008. Recuperado de: https://www.in.gov.br/materia/-/asset_publisher/Kujrw0TZC2Mb/content/id/19219978/do1-2017-08-07-resolucao-n-33-de-24-de-maio-de-2017--19219851

[15] Conselho Nacional De Saúde [CNS]. (2012). Resolução n. 466, de 12 de dezembro de 2012: Diretrizes e normas regulamentadoras de pesquisas envolvendo seres humanos. Recuperado de: https://conselho.saude.gov.br/resolucoes/2012/Reso466.pdf

[16] Costa, M. C. N. de S., & Mercadante, E. F. (2013). O Idoso residente em ILPI (Instituição de Longa Permanência do Idoso) e o que isso representa para o sujeito idoso. Revista Kairós: Gerontologia, 16 (1), 209-222. Doi: 10.23925/2176-901X.2013v16i1p209-222

[17] Creutzberg, M., Gonçalves, L. H. T., & Sobottka, E. A. (2007). A sobrevivência econômica de instituições de longa permanência para idosos empobrecidos. Revista Latino-Americana de Enfermagem, 15 (spe), 748-754. Doi: 10.1590/S0104-11692007000700006

[18] Cura, M. L. A. D., & Rodrigues, A. R. F. (1999). Satisfação profissional do enfermeiro. Revista Latino-Americana de Enfermagem, 7 (4), 21-28. Doi: 10.1590/S0104-11691999000400004

[19] Dornelas, J. (2016). Empreendedorismo: transformando ideias em negócios (6a ed.). São Paulo, SP: Atlas.

[20] Dyniewicz, A. M. (2014). Metodologia da pesquisa em saúde para iniciantes (3a ed.). São Caetano do Sul: Difusão Editora.

[21] Falqueto, J. M. Z., Hoffmann, V. E., & Farias, J. S. (2019). Saturação Teórica em Pesquisas Qualitativas: Relato de uma Experiência de Aplicação em Estudo na Área de Administração. Revista de Ciências da Administração, 52 (20), 40-53. Doi: 10.5007/2175-8077.2018V20n52p40

[22] Figueiredo, T. S., Rabelo, T. L. P., & Veloso, L. C. (2014). A vivência de idosos em instituições de longa permanência. Revista Interdisciplinar, 7 (2), 70-78. Recuperado de: https://revistainterdisciplinar.uninovafapi.edu.br/index.php/revinter/article/download/427/pdf_128

[23] Freire, F. de S., Mendonça, L. H. de., & Costa, A. de J. B. (2012). Sustentabilidade econômica das instituições de longa permanência para idosos. Saúde em Debate, 36 (95), 533-543. Doi: 10.1590/S0103-11042012000400005

[24] Gil, A. C. (2002). Como elaborar projetos de pesquisa (4a ed.). São Paulo, SP: Atlas.

[25] Hermann, A. P., Fentanes, L. R. C., Chamma, R. de C., & Lacerda, M. R. (2011). Autonomia Profissional Do Enfermeiro: Revisão Integrativa. Cogitare Enfermagem, 16 (3), 530-535. Doi: 10.5380/ce.v16i3.24227

[26] Kletemberg, D. F., Siqueira, M. T. D., Mantovani, M. de F., Padilha, M. I., Amante, L. N., & Anders, J. C. (2010). O processo de enfermagem e a lei do exercício profissional. Revista Brasileira de Enfermagem, 63 (1), 26-32. Doi: 10.1590/S0034-71672010000100005

[27] Kraemer, F. Z., Duarte, M. de L. C., & Kaiser, D. E. (2011). Autonomia e trabalho do enfermeiro. Revista Gaúcha de Enfermagem, 32 (3), 487-494. Doi: 10.1590/S1983-14472011000300008

[28] Lenardt, M. H., Michel, T., & Wachholz, P. A. (2010). Autoavaliação da saúde e satisfação com a vida de idosas institucionalizadas. Ciência, Cuidado e Saúde, 9 (2), 246-254. Doi: 10.4025/cienccuidsaude.v9i2.8041

[29] Minayo, M. C., & Gomes, S. F. D. O. C. N. R. (2002). Pesquisa social: teoria, método e criatividade (21a ed.). Petrópolis: Vozes.

[30] Moraes, R. (1999). Análise de conteúdo. Revista Educação, 37 (22), 7-32. Recuperado de: http://cliente.argo.com.br/~mgos/analise_de_conteudo_moraes.html

[31] Morais, J. de., Haddad, M., Rossaneis, M., & Silva, L. da. (2013). Práticas de enfermagem empreendedoras e autônomas. Cogitare Enfermagem, 18 (4). Doi: 10.5380/ce.v18i4.46422

[32] Nicolaci-da-Costa, A. M. (2007). O campo da pesquisa qualitativa e o Método de Explicitação do Discurso Subjacente (MEDS). Psicologia: Reflexão e Crítica, 20 (1), 65-73. Doi: 10.1590/S0102-79722007000100009

[33] Oliveira, D. de P. R. de. (2014). Empreendedorismo: vocação, capacitação e atuação direcionadas para o plano de negócios. São Paulo, SP: Atlas.

[34] Polit, D. F., & Beck, C. T. (2002). Fundamentos de pesquisa em enfermagem (7a ed.). Porto Alegre: Artmed.

[35] Rodrigues, M. A., Santana, R. F., Paula, R. C. C. de., Silva, M. T. N. da., & Santo, F H. do E. (2018). Exercício profissional de enfermagem em instituições de longa permanência para idosos: estudo retrospectivo. Texto & Contexto - Enfermagem, 27 (2), e1700016. Doi: 10.1590/0104-070720180001700016

[36] Roncon, P. F., & Munhoz, S. (2009). Estudantes de enfermagem têm perfil empreendedor?. Revista Brasileira de Enfermagem, 62 (5), 695-700. Doi: 10.1590/S0034-71672009000500007

[37] Roquete, F. F., Batista, C. C. R. F., & Arantes, R. C. (2017). Demandas assistenciais e gerenciais das instituições de longa permanência para idosos: uma revisão integrativa (2004-2014). Revista Brasileira de Geriatria e Gerontologia, 20 (2), 286-299. Doi: 10.1590/1981-22562017020.160053

[38] Rothbarth, S., Wolff, L. D. G., & Peres, A. M. (2009). O desenvolvimento de competências gerenciais do enfermeiro na perspectiva de docentes de disciplinas de Administração aplicada à Enfermagem. Texto & Contexto - Enfermagem, 18 (2), 321-329. Doi: 10.1590/S0104-07072009000200016

[39] Salcher, E. B. G., Portella, M. R., & Scortegagna, H. de M. (2015). Cenários de instituições de longa permanência para idosos: retratos da realidade vivenciada por equipe multiprofissional. Revista Brasileira de Geriatria e Gerontologia, 18 (2), 259-272. Doi: 10.1590/1809-9823.2015.14073

[40] Santos, S. S. C., Silva, B. T. da., Barlem, E. L. D., & Lopes, R. da S. (2008). O papel do enfermeiro na instituição de longa permanência para idosos. Journal of Nursing UFPE on line, 2 (3), 291-299. Doi: 10.5205/reuol.351-11415-1-LE.0203200812

[41] Serviço Brasileiro de Apoio às Micro e Pequenas Empresas (2020). Tudo o que você precisa saber para criar o seu plano de negócio. Recuperado de: https://www.sebrae.com.br/sites/PortalSebrae/artigos/como-elaborar-um-plano-de-negocio,37d2438af1c92410VgnVCM100000b272010aRCRD

[42] Silva, A. H., & Fossá, M. I. T. (2015). Análise de conteúdo: exemplo de aplicação da técnica para análise de dados qualitativos. Qualitas Revista Eletrônica, 16 (1), 1-14. Doi: 10.18391/qualitas.v16i1.2113

[43] Silva, B. T., Barlem, E. L. D., Lunardi, V. L., & Santos, S. S. C. (2008). Educação permanente: instrumento de trabalho do enfermeiro na instituição de longa permanência. Cuidado E Saúde, 7 (2), 256-261. Doi: 10.4025/cienccuidsaude.v7i2.501

[44] Silva, I. de S., Xavier, P. B., & Almeida, J. L. S. (2020). Business entrepreneurship in Nursing: challenges, potentialities and perspectives. Research, Society and Development, 9 (8), e912986348. Doi: 10.33448/rsd-v9i8.6348

[45] Siqueira, V. T. A., & Kurcgant, P. (2012). Satisfação no trabalho: indicador de qualidade no gerenciamento de recursos humanos em enfermagem. Revista da Escola de Enfermagem da USP, 46 (1), 151-157. Doi: 10.1590/S0080-62342012000100021

[46] Zampier, M. A., & Takahashi, A. R. W. (2011). Competências empreendedoras e processos de aprendizagem empreendedora: modelo conceitual de pesquisa. Cadernos EBAPE.BR, 9 (spe1), 564-585. Doi: 10.1590/S1679-39512011000600007

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.29

Performance Analysis of a 3.2 kWp Photovoltaic System with Microinverter for Distributed Generation

Raylla Silveira Souto[1], Lya Serpa Claudio dos Santos[2], Elissandro Monteiro do Sacramento[3], Lutero Carmo de Lima[4]

[1]Centro de Ciências e Tecnologia Universidade Estadual do Ceara´ Fortaleza, CE, Brazil
Email: raylla.ssilveira@hotmail.com
[2]Centro de Ciências e Tecnologia Universidade Estadual do Ceara´ Fortaleza, CE, Brazil
Email: serpa.santos@aluno.uece.br
[3]Instituto Federal de, Educação Ciência e Tecnologia-IFCE Fortaleza, CE, Brazil
Email : elissandro.monteiro@ifce.edu.br
[4]Centro de Ciências e Tecnologia Universidade Estadual do Ceara´ Fortaleza, CE, Brazil
Email : lutero.lima@uece.br

Received: 08 Apr 2022,

Received in revised form: 03 May 2022,

Accepted: 10 May 2022,

Available online: 29 May 2022

Keywords*— *Distributed Generation, Microinverter, Performance Analysis, Photovoltaic Solar System.

***Abstract*—** *Faced with the increase in electricity consumption and in the tariffs of the kWh consumed, as well as the insertion of renewable sources in the world energy matrix, several countries seek to encourage industrial, commercial and residential consumers to invest in distributed generation systems. In Brazil, ANEEL Resolution No. 482 of 2012 and later updated by No. 687 of 2015, aims to establish distributed mini and microgeneration from renewable sources such as photovoltaic solar energy. Distributed generation is advantageous both for local utilities, as it provides a reduction in grid loading, minimization of losses and diversification of the national energy matrix, among others, and for the consumer who, through the provided compensation system, will be able to inject the surplus energy generated into the electricity grid of the local energy concessionaire and, with that, it will earn a bonus on your electricity bill at the end of the month. Considering that Brazil is mostly located in the intertropical region, for exemple, the Northeast region, where the sun is present most of the year. Thus, this study aims to present an evaluation of the local solar resource and the performance indexes related to a photovoltaic system connected to the 3.2 kWp grid with microinverter in a low voltage residence in Fortaleza-CE.*

I. INTRODUCTION

Electricity generation in Brazil is highly dependent on hydroelectric plants and, facing the worst water crisis of the past 91 years, the lower levels of rain reduced the water reservoirs to critical levels and aggravated the situation of the country during the fight against the COVID-19 pandemic. This fact made the Brazilian government increase the generating capacity of thermoelectric plants, which increased the electricity bills for Brazilian people due to the fact that the kilowatt-hour (kWh) generated by the thermoelectric plants is more expensive compared to hydroelectric [1].

According to the Instituto de Pesquisa Econômica Aplicada (Applied Economic Research Institute), the increase of industrialization, population density, urbanization, and mass consumption of industrialized

products demand that companies, governments, and consumers, in general, invest in renewable energy sources with low environmental impact aiming to meet the current energetic needs that do not impact future generations' capacities [2].

Besides those problems, the debates about climate change became the topic of conferences and forums around the world, since it is necessary to discuss the future of development considering the urgency of adopting strategies focused on electricity generation that does not impact the environment. In this scope, renewable energy sources are an option to change the worldwide energetic matrix and a way to avoid scarcity of resources such as oil and derivatives [3].

According to [4], one of the possibilities found to reduce the costs of electricity in Brazil is the exploration of photovoltaic systems, aiming to generate energy through a renewable and sustainable source. Brazil is mostly-located in the intertropical region and has a great potential to explore solar energy all year. The Northeast part of the country, for example, receives high levels of sunlight most period of the year and attracts investments for the sector. According to [5], the use of solar energy brings long-term benefits to the country, enabling the development of remote regions where the costs of electrification with the conventional grid are excessively high compared with the financial return of the investment.

Distributed generation (DG) is, by definition, the electricity generation produced near the consumer(s), regardless of its potency, technology resources, and energy source. It is worth highlighting that, until 2012, DG did not have much promotion in Brazil compared to other countries. Aiming to regularize and encourage the implementation of these systems, the government created the Regulatory Standard 482/2012 (RN 482/2012), lately updated by RN n° 687 in 2015. The referred resolution allows any electricity generator unit to distribute to the energy providers through their grids and created the modalities microgeneration (with an installed power of ≤ 75 kW) and distributed microgeneration (installed power > 75 kW ≤ 3 MW for water sources or ≤ 5 MW for other renewable energy sources), in which consumers receive credits with the energy provider of the region to use when necessary [6], [7].

On the world stage, solar photovoltaic power generation increased 22% in 2019, representing 131 TWh, becoming the second increase in renewable energy resources behind wind power. In Brazil, photovoltaic plants represent 1,68% of the energetic matrix but it is important to highlight that the plants whose constructions were and are yet to be initiated are, respectively, 5,68% and 43,50% of the power bestowed, showing, thus, a tendency of growth on the application of solar photovoltaic energy [8], [9].

It is worth highlighting that, before the installation and the correct functioning of the DG with solar photovoltaic energy, it is necessary to evaluate the factors that might directly affect the power generation, such as shadowing, inclination, misdirection or poor location, maintenance of the cables and inverter, among others. In this sense, it is essential to analyze the main factors liked to the project and performance of a grid connected photovoltaic power system (On Grid), in order to avoid possible losses and, therefore, preserve the system. Therefore, this study aims to show the performance of a 3,2 kWp grid connected photovoltaic system with a micro-inverter installed in a house in Fortaleza, Ceará, Brazil.

II. THE GRID CONNECTED PV SYSTEM

The grid connected photovoltaic system analyzed in this study is connected to the grid of the local energy provider ENEL-Ceará. The single-family house consumer belongs to the low tension (LT) single-phase (220 V) tariff group. The distributed microgeneration solar photovoltaic system follows ANEEL's RN n° 482/2012 and RN n° 687/2015 standards as well as ENEL's Technical Standard (TS). The system operation started on March 2021 and its coordinates are latitude: -3.719076 S/longitude: -38.563698 W (decimal degrees).

According to the technical requirements for the connection of micro and mini on grid generations, it is necessary to estimate the total installed power considering the potency of all the pieces of equipment at the Consumer Unit (CU), the total installed power of the house was 6.738 kW. Thus, the proposed topology for the photovoltaic system was 08 photovoltaic solar modules with a total array area of 17,43 m^2, a calculated unit power (kWp) of 5,54 m^2, and a maximum nominal power of 3,2 kWp installed on the roof of the building.

The photovoltaic solar module selected for the GCPVS was DAH HCP78X9 POLI 400 W made of polycrystalline silicon pointing to the North at a 10º azimuth angle. The two microinverters are the MI-1500 model by HOYMILES with a 25-year lifespan and maximum rated efficiency from 96,7 to 97, 2% according to the manufacturer. The installation was in a covered space, allowing the sheltering of the conversion installation as well as the protection of the system from weathering and unauthorized access.

III. PERFORMANCE PARAMETERS

The evaluation of a grid connected photovoltaic system usually follows the Standard IEC 61724. The evaluated parameters were: energy output, yield (reference, array, and final), energy losses of the array and of the system, system efficiencies (array efficiency, system efficiency, and inverter efficiency), performance ratio, and capacity factor [10]-[12].

Energy output

The energy output is the amount of alternating potency generated by the system for a certain amount of time. The total, daily, and monthly hourly energy produced might be determined respectively by:

$$E_{CA,h} = \sum_{t=1}^{60} E_{CA,t} \quad (1)$$

$$E_{CA,d} = \sum_{h=1}^{24} E_{CA,h} \quad (2)$$

$$E_{CA,m} = \sum_{d=1}^{N} E_{CA,d} \quad (3)$$

In which $E_{AC,t}$ is the total AC energy at t time (in minutes), E_{ACh} is the hourly total AC energy (in hours), $E_{AC,d}$ is the daily total AC energy, $E_{AC,m}$ is the monthly total AC energy, and N is the number of days on the month.

$$Y_F = \left(\frac{E_{CC}}{P_{pV,nom}}\right) . \left(\frac{kWh}{kWp\ .dia}\right) \quad (5)$$

System yield

There are three types of system yields, which are: reference yield (Y_R), PV array yield (Y_{PV}), and final yield (Y_F). They represent the energy generated, in kWh, for each kWp of installed power. The unit to represent the yields is kWh/kWp.day or in hours/day. When expressed in hours/day, it represents the time the system should operate in its nominal power to generate the same amount of energy in the same given period of time. The yields indicate the real operation of the photovoltaic modules and the photovoltaic array in relation to its nominal power. The PV array yield (Y_{PV}) is given by equation 10, in which E_{DC} is the total energy (in kWh) produced by the photovoltaic array [13].

$$Y_{pV} = \left(\frac{E_{CC}}{E_{CC,nom}}\right) . \left(\frac{kWh}{kWp\ .dia}\right) \quad (4)$$

The final yield Y_F is given by equation 5, in which E_{AC} represents the total AC energy and the nominal power of the photovoltaic modules is $P_{PV.\ nom}$.

The reference yield Y_R is the total irradiation on the level or the global horizontal irradiation (H_T) on the level divided by the reference irradiation (H_R) in standard temperature and pressure conditions are equal to 1 kWh/m^2. This is a theoretical energy measurement available in a specific place during a specific period of time (MORAIS, 2017). The reference performance can be calculated by equation 6:

$$Y_R = \left(\frac{H_T}{H_R}\right) . \left(\frac{kWh}{kWp\ .dia}\right) \quad (6)$$

According to equations 4, 5, and 6, we will reach values that theoretically express a mathematical relation between the productivities, it is possible to affirm that:

$$Y_R \geq Y_{FV} \geq Y_F \quad (7)$$

System energy losses

The capture losses of the photovoltaic array (L_{PV}) represent the losses due to the operation that highlight the incapacity of the photovoltaic array in fully using the available irradiation [13]. The calculation of the PV array capture loss is the difference between the reference production of the photovoltaic panels. It is given by equation 8:

$$L_{pV} = Y_R - Y_{pV} \left(kWh/kWp\right) \quad (8)$$

The losses of the photovoltaic system (L_S) are due to the losses on the conversion of direct current output (E_{DC}) to alternating current (E_{AC}) by the inverter, it is the subtraction of the PV array yield by the final yield. It is also necessary to consider the losses by the Joule effect. Equation 9 below shows it:

$$L_S = Y_{pV} - Y_F \left(kWh/kWp\right) \quad (9)$$

The total PV system losses (L_T) are the sum of the capture loss of the PV array (L_{PV}) with the PV system losses (L_S), given by equation 10 below:

$$L_T = L_{pV} + L_S \left(kWh/kWp\right) \quad (10)$$

System efficiencies

There are three classifications for the photovoltaic system efficiency: photovoltaic array efficiency, system efficiency, and inverter efficiency. Depending on the available data and the level of desired resolution, these efficiencies might be determined on an instant, hourly, daily, monthly and annual basis, expressed in percentages [13].

The PV array efficiency is the output of DC energy while the system efficiency is a function of the output of AC energy. The PV array efficiency (η_{PV}) represents the average efficiency of the energy conversion of the photovoltaic array, which is the ratio between the daily production of DC energy and the product of total daily irradiation on the level and the area of the PV array [14]. The system efficiency is given by equation 12 and the inverter efficiency by equation 13. Considering A_{PV} the total area of the photovoltaic array in m^2 and P_{PV} the potency of the PV array:

$$\eta_{pV} = \frac{100 \, x \, P_{pV} \, x \, Y_{pV}}{Y_R \, x \, A_{pV}} \qquad (11)$$

$$\eta_{SYS} = \frac{100 \, x \, E_{CA}}{H_T \, x \, A_{pV}} \qquad (12)$$

$$\eta_{INV} = \frac{100 \, x \, E_{CA}}{E_{CC}} (\%) \qquad (13)$$

Performance ratio

According to [13], performance ratio (P_R) is a quality measure of a photovoltaic system that is regardless of its localization and, in many occasions, is described as a quality factor. Expressed in percentage, it shows the relationship between the real and theoretical outputs of the GCPVS. Thus, it shows the amount of energy really available to input on the grid after the deduction of the losses and energy consumed for this operation.

The closer to 100% the P_R is, the lower the system losses. However, it is not possible to reach 100% P_R in reality since there are inevitable losses that happen during the performance of a PV system. With the P_R, it is possible to compare the energy output of your own photovoltaic system with other photovoltaic systems in any geographic localization. The performance ratio, seen in equation 9, is the final ratio between the final yield of the photovoltaic system (Y_F) and the reference yield (Y_R), expressed in percentage, as seen in equation 14 below [14]:

$$P_R = \frac{Y_F}{Y_R} \, x \, 100\% \qquad (14)$$

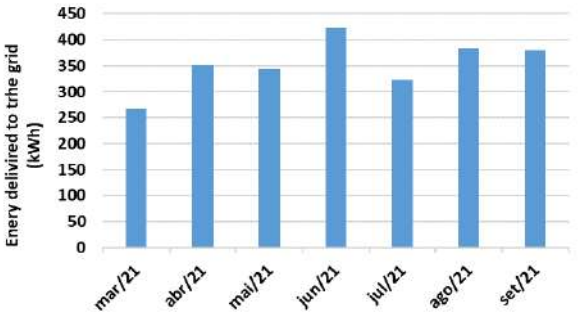
Capacity factor

The capacity factor (FC) is, by definition, the relation between the real annual AC total power productivity and the amount of power the PF array would produce if it operated with a total power ($P_{FV,\,nom}$) for 24 hours a day for a period of a year, according to equation 15.

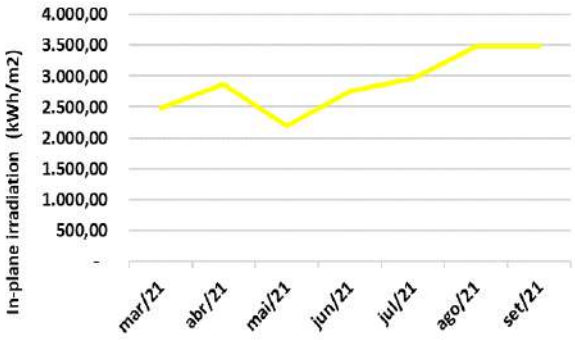
$$FC = \frac{E_{CA}}{P_{pV,nom} \, x \, 8760} (\%) \qquad (15)$$

IV. RESULTS AND DISCUSSION

According to the graphic on Fig. 1 (a), the total power produced from March to September 2021 was 2,47 MWh, with a monthly average of 353,09 kWh. According to the report of the national energy balance (EPE, 2021), the average consumption in the residential category in the Northeast in 2021 was 128 kWh/month. Thus, the GCPVS in this study delivers, on average, energy equivalent to 2,76 houses per month. The total radiation during the period was 20.247,22 kWh/m2, with a monthly average of 2892,46 kWh/m2. The highest amount of energy produced was in November/2021 (433,25 kWh) and the lowest was in March/2021 (267, 27kWh). The lowest level of solar irradiation was in September (3.485, 33 kWh/m2), during the dry rainless season. March/2021 was the month with the lowest irradiation levels (2.196,13 kWh/m2), as seen in Fig. 1 (b).



(a) Energy produced by the GCPVS.



(b) Irradiation on the horizontal level.

Fig. 1: Energy produced by the photovoltaic system and irradiation on the horizontal level.

It is worth highlighting that the monitoring of the photovoltaic system is realized by electronic equipment that sends information about the photovoltaic system to a digital platform. A frequent inverter captures the data and sends it online, in real-time, to the manufacturer's website. Thus, the user can follow and monitor on daily basis information such as the performance as well as the daily, monthly and annual economy. It is also possible to verify with live data eventual failures on the performance, which allows fixing in a timely manner.

Thus, by comparing the monthly energy consumption in the building and also the electricity bills, we collected the costs from March to September 2020 and 2021. Table 1 shows the monthly consumptions in kWh/month (according to the amounts shown in the electricity bill) and the respective cost in Reais. The GCPVS operates since March 2021 and, when compared to March 2020 before its installation, it was possible to verify a reduction in the electricity consumption. This happened due to the reduction in the excess power imputed on the grid of the energy provider which resulted in the credit compensation described on the RN 482/2012 showing, therefore, the benefits of adopting the distributed energy generation system using renewable energy sources.

Table.1: Comparison between the 2020-2021 electricity bills.

2020	Monthly consumption (kwh)	Electricity bill	2021	Monthly consumption (kwh)	Electricity bill	Difference on the consumption with the pvs
Mar	378	R$ 339,30	Mar	158	R$ 127,89	58,2%
Apr	485	R$ 421,28	Apr	313	R$ 172,41	35,46%
May	384	R$ 343,91	May	337	R$ 227,19	12,24%
Jun	437	R$ 384,61	Jun	307	R$ 108,85	29,75%
Jul	358	R$ 323,94	Jul	296	R$ 142,63	17,32%
Aug	345	R$ 313,96	Aug	285	R$ 125,38	17,39%
Sep	315	R$ 290,92	Sep	275	R$ 120,38	12,7%

Comparing the period from March to September/2021, the seven months after the installation of the GCPVS, it was possible to notice an economy of R$ 1.393,19. Therefore, in seven months, the GCPVS allowed a reduction in energy consumption and, consequently, a reduction in the electricity bill. it is essential to highlight that there are many other benefits linked to the use of distributed energy using renewable sources, such as the reduction of greenhouse gas emissions; reduction of the expansion of huge generation installations; reduction of the use of non-renewable energy sources; an increase of supply reliability; reduction on the transmission and distribution losses; contribution to local development; faster answer to an increase of the demand; cost reduction with the energy provider; and appreciation of the building or business.

The monthly average yields are in Fig. 2, which highlights the reference yield (Y_R), PV array yield (Y_{PV}), and final yield (Y_F). It is possible to observe that the lowest values were in May 4,03 kWh/kWp/day; 3,60 kWh/kWp/day, and 3,48 kWh/kWp/day, respectively. On the other hand, the highest values were in September, 6,60 kWh/kWp/day; 4,10 kWh/kWp/day, and 3,96 kWh/kWp/day, respectively. The monthly average of the seven-month period were 5,38 kWh/kWp/day; 3,74 kWh/kWp/day, and 3,61 kWh/kWp/day, respectively. According to [14], the lowest yield rates occurred during the rainy season in the Northeast, between February and May. While the rates between June and January are superior to the rainy season due to the dry climatic conditions and the solar irradiation on the level.

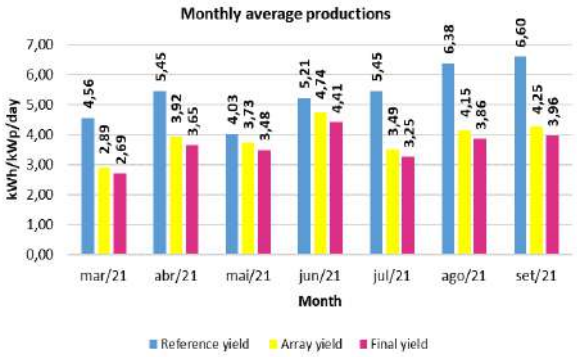


Fig. 2: Monthly average YR, YFV, and YF yields.

Comparing this study with [14] that registered its lowest level in April with 4,5 kWh/kWp/day, 3,9

kWh/kWp/day, and 3,7 kWh/kWp/day, respectively, the differences are 0,47 kWh/kWp/day; 0,3 kWh/kWp/day, and 0,22 kWh/kWp/day, respectively. On the other hand, the highest YR rate was in October with 6,5 kWh/kWp/day, a difference of 0,1 kWh/kWp/day; while the YPV and YF rates in September were 5,8 kWh/kWp/day and 5,5 kWh/kWp/day, a difference of 1,7 kWh/kWp/day and 1,89 kWh/kWp/day, respectively. It was possible to infer that the difference is linked to the azimuth orientation, in which this study shows a 10º while [14] has a 0º azimuth.

The monthly average efficiencies estimated for the photovoltaic system are in Fig. 3. The average inverter efficiency was 98% from March to September/2021, close to the highest theoric level described by the manufacturer. The monthly average rates for the system and the array were 12,71% and 12,43%, respectively. The highest system and array efficiencies were in May with a 16% rate.

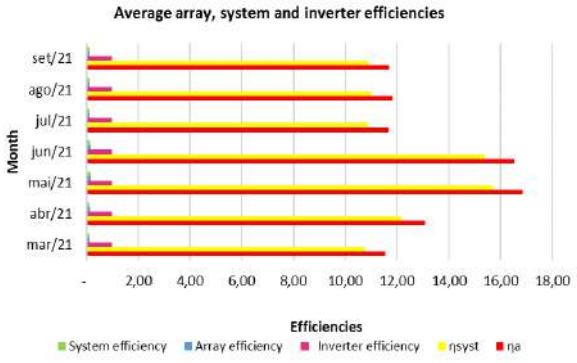


Fig. 3: Monthly average efficiencies.

In the study by [14], the monthly average array, system, and inverter efficiencies were 13,3%, 12,6%, and 94,6%, respectively. The highest matrix, system, and inverter efficiencies were 14,8% (in August), 13,9% (in August), and 95,3% (in July), respectively. Thus, it is possible to notice a slight percentual difference between the studies. The authors link this factor to shadowing that caused a reduction in the matrix, system, and, possibly, the inverter efficiencies. The performance ratio (PR) showed variation between 59,11% in March/2021 to 86,35% in May/2021 and an annual average of 68,19%. The performance ratio (PR) measures the global effect of the losses over the nominal power of the GCPVS due to factors such as inefficiency of the inverters and losses on the conversion from DC to AC, soiling of the panels, and failure of the components of the system, and lack of electric energy from the energy provider (ENEL) which avoids the binding of the GCPVS. Lastly, the capacity factor (CF) varied between 11,23% (March/2021) and 18,39% (June/2021), with an average of 15,06%, this factor aimed to measure the average percentage in which the GCPVS operated at full capacity, as shown in Fig. 4 [13].

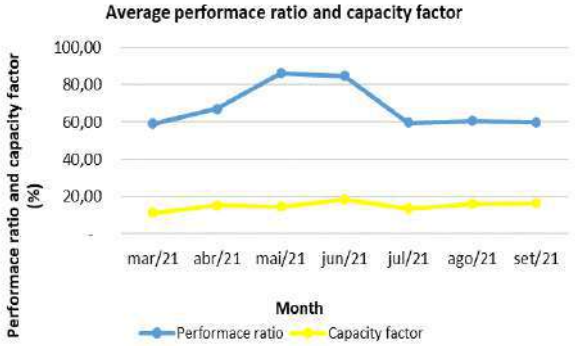


Fig. 4: Monthly averages CF and PR.

Fig. 5 shows the relative losses of the studied GCPVS. The month with the highest loss was September/2021 with 2,64 kWh/kWp/day and the lowest was in May/2021with 0,55 kWh/kWp/day. In all the months of the study, the array loss (that represents the losses due to the operation that highlights the incapacity of the photovoltaic array in fully using the available irradiation) surpassed the system loss (losses that occurred due to the conversion of direct current output to alternating current by the inverter also considering the losses caused by joule effect). It is also necessary to consider that the GCPVS is oriented to a 10º azimuth and this condition might increase the losses on the photovoltaic panels due to the failure of direct radiation capture, according to the relative solar movement. According to [15], there is an optimization of the annual energy production of GCPVS with a fixed array when it points to the geographic north (azimuth 0) and has an inclination similar to the installation site.

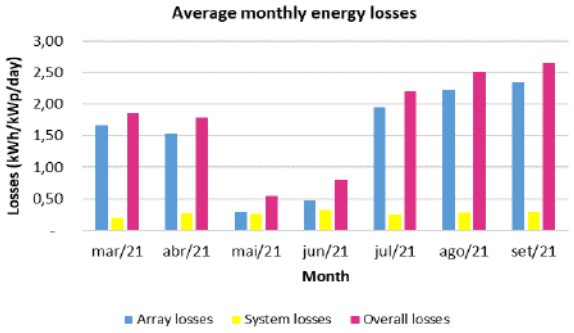


Fig. 5: the relative losses of the GCPVS

V. CONCLUSION

This study showed the analysis of a distributed generation system of a house located in Fortaleza/CE that

used the local solar resources aiming to reduce the costs of the electricity bill by using the credit compensation system included on the RN 482/2015. Thus, the collection of the installed loads and the evaluation of the local irradiation on the horizontal level indicators sent by FUCEME/CE which contains the climate conditions of the Brazilian Northeast region. The project of the 3,2 kWp GCPVS and the evaluation of its performance indicators were analyzed in a way that standardized the localization as a basic variable, such as solar irradiance, maintenance, temperature, and shadowing, among others.

According to the analysis, the GCPVS delivered to the grid a monthly output of 353,09 kWh (March/2021 to September/2021), an amount over the average consumption in the Northeast region of Brazil 128 kWh/month and equal to the consumption of 2,76 construction/month. Besides that, the monthly average radiation of the analyzed period was 2892,46 kWh/m^2. We also analyzed the electricity bills of the building from March and September in 2020 (without the GCPVS) and 2021 (after the installation) in a period of seven months the system provided an economy of R$ 1.393,19, since the spare energy was input into the grid of the local provider and, by the credits compensation, it was possible to have a discount on the electricity bills.

Besides that, we calculated the estimates of the average efficiency of the system and of the array considering the data on the microinverter. Thus, the average system efficiency was 12,71% and the average array efficiency for the same period was 12,43% for the period from March to September 2021. We also calculated the estimated performance ratio and the capacity variation, the performance ratio had an annual average of 68,19% while the capacity factor was 15,06%. The relative losses of the GCPVS showed a higher loss in September/2021 with an amount of 2,64 kWh/kWp/day and a lower amount in May/2021 with 0,55 kWh/kWp/day.

REFERENCES

[1] AGÊNCIA BRASIL. Brasil em pauta discute os desafios da crise hídrica no país. (2021). [(in portuguese)]. Available in: https://agenciabrasil.ebc.com.br/geral/noticia/2021-09/brasil-em-pauta-discute-os-desafios-da-crise-hidrica-no-pais. Accessed in: 18.04.2022.

[2] INSTITUTO DE PESQUISA ECONÔMICA APLICADA (IPEA). Sustentabilidade ambiental no Brasil: biodiversidade, economia bem-estar humano. Brasília: IPEA. (2010). [(in portuguese)]. Available in: https://www.ipea.gov.br/portal/images/stories/PDFs/livros/livros/livro07_sustentabilidadeambienta.pdf.. Accessed in: 18.04.2022: 18. 04. 2022.

[3] de Oliveira, A. M., Mario, M. C., & Pacheco, M. T. T. (2021). Fontes renováveis de energia elétrica: evolução da oferta de energia fotovoltaica no Brasil até 2050. Brazilian Applied Science Review, 5(1), 257-272.

[4] Neto, F. L. (2021). Soluções integradas para as crises hídrica e energética no Brasil. Parcerias Estratégicas, 25(50), 159-174.

[5] Pereira, E. B., Martins, F. R., Gonçalves, A. R., Costa, R. S., Lima, F. D., Rüther, R., ... & Souza, J. D. (2017). Atlas brasileiro de energia solar. São josé dos campos: Inpe, 1.

[6] _____. Resolução Normativa n° 687, de 24 de novembro de 2015. [(in portuguese)]. Available in: http://www.abgd.com.br/portal/doc/201905310147-01-49a661_ef3989b8166d4ef28b6478bba20f92dc.pdf. . Accessed in:: 20. 04. 2022.

[7] _____. Resolução Normativa n° 482, de 17 de abril de 2012. [(in portuguese)]. Available in: https://www.cemig.com.br/wpcontent/uploads/2020/08/REN-482_2012.pdf. Accessed in: 20.04.2022.

[8] AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA (ANEEL). Unidades consumidoras com geração distribuída. (2022). [(in portuguese)]. Available in: http://www2.aneel.gov.br/scg/gd/GD_Fonte.asp. Accessed in: 20.04. 2022.

[9] de Melo, A. R., Varella, F. K. D. O. M., Vale, M. R. B. G., & Silva, A. K. F. (2020, December). Desenvolvimento e aplicaçao de um sistema supervisório baseado em IoT em uma usina solar fotovoltaica. In Congresso Brasileiro de Automática-CBA (Vol. 2, No. 1).

[10] Dobaria, B., Pandya, M., & Aware, M. (2016). Analytical assessment of 5.05 kWp grid tied photovoltaic plant performance on the system level in a composite climate of western India. Energy, 111, 47-51.

[11] Sidi, C. E. B. E., Ndiaye, M. L., El Bah, M., Mbodji, A., Ndiaye, A., & Ndiaye, P. A. (2016). Performance analysis of the first large-scale (15 MWp) grid-connected photovoltaic plant in Mauritania. Energy Conversion and Management, 119, 411-421.

[12] Ozden, T., Akinoglu, B. G., & Turan, R. (2017). Long term outdoor performances of three different on-grid PV arrays in central Anatolia–An extended analysis. Renewable energy, 101, 182-195.

[13] Morais, F. D. L. (2017). Análise de desempenho de um sistema fotovoltaico de 5, 2 Kwp conectado à rede instalado na UECE. [(in portuguese)].

[14] de Lima, L. C., de Araújo Ferreira, L., & de Lima Morais, F. H. B. (2017). Performance analysis of a grid connected photovoltaic system in northeastern Brazil. Energy for Sustainable Development, 37, 79-85.

[15] PINHO, J. T.; GALDINO, M. A. (Org.), Manual de Engenharia para Sistemas Fotovoltaicos. Ed. Revisada e Atualizada, Rio de Janeiro. (2014). Available in: https://www.portal-energia.com/downloads/livro-manual-de-engenharia-sistemas-fotovoltaicos-2014.pdf. Accessed in: 20. mar. 2022.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.30

Professional Integration between Public Health and Social Assistance Systems: Challenges and Possibilities

Adriana Lima dos Santos[1], Lucia Marisy Souza Ribeirode Oliveira[2]

[1]Ms. em Ciências da saúdee Biológicas
Email:acanudos2019@gmail.com
[2]Dra. Desenvolvimento Sócioambiental
Email:lucia.oliveira@univasf.edu.br

Received: 16 Apr 2022,

Received in revised form: 13 May 2022,

Accepted: 18 May 2022,

Available online: 29 May 2022

***Keywords*— intersectoriality, social assistance, professional intervention, public health systems.**

***Palavras-chave*— intersetorialidade, assistência social, intervenção profissional, sistemas públicos de saúde.**

***Palabras clave*— intersectorialidad, asistencia social, intervención profesional, sistemas de salud pública.**

***Mots clés*— intersectorialité, Assistance sociale, intervention professionnelle, systèmes de santé publique.**

***Abstract*—** *In Brazil, social public policies were inscribed in the Federal Constitution of 1988, under the aegis of social rights. Because they are of universal and egalitarian scope, they provide the exercise of citizenship to Brazilians and, in this context, are the Unified Health System (SUS) and the Unified Social Assistance System (SUAS). This study aims to understand the inter-professional integration between these two public policies, whose qualitative approach took the Municipal Health and Social Assistance Departments of the municipality of Senhor do Bonfim - Bahia as the locus of research. The results point to the obstacles that health professionals face in the municipality to provide quality care to the population, however, there is an understanding on their part of the importance of improving the management of these public policies, from the perspective of intersectoriality and integrality of care. and social protection to the population that uses these services.*

***Resumo*—** *No Brasil, as políticas públicas sociais foram inscritas na Constituição Federal de 1988, sob a égide dos direitos sociais. Por serem de alcance universal e igualitário, proporcionam o exercício da cidadania aos brasileiros e, nesse contexto, encontram-se o Sistema Único de Saúde (SUS) e o Sistema Único de Assistência Social (SUAS). Este estudo tem por objetivo compreender a integração inter profissional entre essas duas políticas públicas, cuja abordagem qualitativa tomou como lócus de pesquisa as Secretarias Municipais de Saúde e de Assistência Social do município de Senhor do Bonfim - Bahia. Os resultados apontam os entraves que os profissionais da saúde enfrentam no município para prestarem um atendimento de qualidade à população, entretanto, há por parte dos mesmos a compreensão da importância de se aperfeiçoar a gestão dessas políticas públicas, na perspectiva da intersetorialidade e integralidade do cuidado e da proteção social à população usuária desses serviços.*

***Resumen*—** *En Brasil, las políticas públicas sociales fueron inscritas en la Constitución Federal de 1988, bajo la égida de los derechos sociales. Por ser de alcance universal e igualitario, facilitan el ejercicio de la ciudadanía a los brasileños y, en ese contexto, son el Sistema Único de Salud (SUS) y el Sistema Único de Asistencia Social (SUAS). Este estudio*

tiene como objetivo comprender la integración interprofesional entre estas dos políticas públicas, cuyo enfoque cualitativo tomó como lugar de investigación las Secretarías Municipales de Salud y Asistencia Social del municipio de Senhor do Bonfim - Bahia. Los resultados apuntan a los obstáculos que enfrentan los profesionales de la salud en el municipio para brindar una atención de calidad a la población, sin embargo, existe una comprensión por su parte de la importancia de mejorar la gestión de estas políticas públicas, desde la perspectiva de la intersectorialidad e integralidad de las atención y protección social a la población usuaria de estos servicios.

Résumé— *Au Brésil, les politiques publiques sociales ont été inscrites dans la Constitution fédérale de 1988, sous l'égide des droits sociaux. Comme ils ont une portée universelle et égalitaire, ils facilitent l'exercice de la citoyenneté pour les Brésiliens et, dans ce contexte, il s'agit du Système Unifié de Santé (SUS) et du Système Unifié d'Assistance Sociale (SUAS). Cette étude vise à comprendre l'intégration interprofessionnelle entre ces deux politiques publiques, dont l'approche qualitative a pris comme lieu d'investigation les Secrétaires Municipaux de la Santé et de l'Assistance Sociale de la commune de Senhor do Bonfim - Bahia. Les résultats pointent les obstacles auxquels sont confrontés les professionnels de la santé dans la municipalité pour apporter une attention chaleureuse à la population, sans embargo, il y a une compréhension de leur part de l'importance d'améliorer la gestion de ces politiques publiques, du point de vue de l'intersectorialité et l'intégralité de l'attention et de la protection sociale à la population utilisatrice de ces services.*

I. INTRODUCTION

The first forms of social protection in Brazil were developed through Christian charity andphilanthropy, characterized by the non-intervention of the State in assisting those in need. It was in the 20th century that the Brazilian State began to assume an effective role with regard to social protection, mainly from the determinations issued by the Federal Constitution (FC) of 1988, creating actions to reduce vulnerabilities. The State, therefore, began to intervene to guarantee some minimum services for the survival of those who needed it most (SPOSATI, 2009).

It can be said that the need for social protection is related to economic aspects, through inequalities designed in a given society, political, from the interests of this group of individuals and how these interests influence social relations; and, finally, cultural, especially when there is a cultural construction of segregation in access to spaces, experiences and opportunities, influenced by economic factors (BRASIL, 2009; MONNERAT, 2011).

Social protection is intended for the population living in a situation of social vulnerability, due to their socioeconomic condition; of political factors; the weakening of affective bonds, among other factors. Social protection is fundamental in the face of the precariousness experienced by users of public policies, among them, the policy of social assistance and health. This reflection is based on the understanding that social protection is a challenge for the contemporary world, considering that in order to offer such services, professionals need to enter the reality of the individual, being purposeful and intervening to enable exactly the protection that this person needs. precise, and may find obstacles in the individual's own attitudes; of your family members; friends and community; there is also the challenge of understanding, in a reliable way, what is actually happening in the general context, in order to offer the most adequate protection/care.

Protection is a fundamental social right and the responsibility of the State, to guarantee and meet the minimum needs experienced by the population, in this way, it is important to deepen knowledge about protection, public policies, intersectoriality, about professional performance and how they are implemented. the challenges today.

Public policies must be implemented based on the intersectoriality guideline, in a decentralized and participatory way, as recommended by the Citizen Constitution of 1988, however, it is observed that there is a limitation in the daily life of professional action in health and assistance policies social welfare, which weakens its

effectiveness in terms of providing good service to the population. (BRAZIL, 2012)

The discussion on professional action brings up the debate on intersectoriality and its possibilities to generate a different way of thinking and acting in the face of the demands that are necessary regarding the execution of public policies on Health and Social Assistance. It is important to identify that one of the principles of the Unified Social Assistance System (SUAS) is the intersectoral articulation with the Unified Health System (SUS), which organizes the Public Health Policy, which must be carried out through the network of services in a complementary and with integrated execution with other public policies (BRASIL, 2012).

From the perspective of intersectoral action sohighlighted by the regulations that guide the execution of public social security policies, an interdisciplinary practice is shown to be extremely relevant as a support mechanism for the effectiveness of joint intervention between the various professions involved in these sectors, and should be carried out through the analysis of the interdisciplinary process, whose application of intersectoriality in the field of public policies and the possibility of jointly aggregating technical knowledge, proves to be crucial, given that specialist professionals in a given sector began to participate in collective actions and socialize common objectives, and there is still an increase in studies on this topic.

This article was divided into four parts: the first was a literature review distributed in topics, covering public policies and social protection in Brazil; overview of public health systems (SUS) and social assistance (SUAS); territory as a space for the integrated execution of public policies; reflections on intersectoriality and public facilities; and reference and interdisciplinarity teams. Then, the materials and methods used in the study were discussed; the results and discussions were subdivided in accordance with the data collection instrument. And finally, final remarks.

Given the conjuncture that involves the implementation of public policies today, regarding the relationship between the sectors and also the service to users in an articulated and integral way, greater efficiency was sought in the resolution of the demands in this study, whose objective was to understand the points from a point of view of inter-professional integration in practice scenarios within the scope of the Unified Social Assistance System - SUAS and the Unified Health System - SUS, in the municipality of Senhor do Bonfim - Bahia.

REVIEWING PUBLIC POLICIES AND SOCIAL PROTECTION IN BRAZIL

Social protection supposes an approximation with people's daily lives, where the presence of risks and social vulnerabilities confronts people's capacity; of families; segments and social classes to overcome them". (ANDRADE, 2010).

When discussing public policies and social protection, it is necessary to take a historical view of the country, and remember that there is a Brazil before and after the 1988 Constitution, which brought about the realization of the achievements of the struggles of social movements, with Social Security being the biggest of them.

According to Monnerat and Souza (2011), from a normative point of view, the concept of social security is understood as "an integrated set of actions initiated by public authorities and society, aimed at ensuring rights related to health, social security and social security". to social assistance" (BRASIL, 2002, art. 194). The inclusion of social security, health and assistance as part of Social Security introduced the notion of universal social rights as part of the condition of citizenship, previously restricted only to Social Security beneficiaries. (BRAZIL, 1988).

Prior to the aforementioned FC, the public health system provided assistance only to workers linked to Social Security, approximately 30 million people with access to hospital services, with philanthropic entities providing care to other citizens (FRATINI, 2008).

We can highlight and understand that public policies exist to guarantee and implement the social rights that are guaranteed in the Federal Constitution, and that these are operationalized through services, programs, projects and decision-making by federated entities, union, states and municipalities, with the direct and/or indirect participation of public or private bodies that aim to ensure a certain citizenship right for various groups in society or for a certain social, cultural, ethnic or economic segment.

Starting from the context described above, there is a need to understand how health and social assistance policies are operationalized to guarantee Basic and Special protection/attention to Brazilians and, asstated by Silva and Tavares cited by Junqueira (2000), bring intersectoriality to the center of the debate, whose practice requires broad negotiation, reaching a cross-sectoral dimension from the possibilities of creating perspectives and establishing new values.

In the SUAS proposal, the reciprocity of the actions of the basic and special social protection network, with centrality in the family, is a fundamental condition,

being determined the establishment of flow, reference and backup between the modalities and complexities of care, as well as, the definition of gateways to the system. Thus, the new public-private relationship was regulated with a view to defining basic and special protection services; the quality and cost of services; as well as building standards andcriteria.

The Basic Operational Norm of the Single Social Assistance System - NOB SUAS (2012), in its first article, provides that the social assistance policy, whose functions are social protection, social assistance surveillance and the defense of rights, is organized in the form of a non-contributory, decentralized and participatory public system, called the Single Social Assistance System - SUAS.

PUBLIC SYSTEMS SUS AND ITS

One of the largest and most complex public health systems in the world is the SUS, whose creation provided universality without discrimination to the public health system, becoming a right of all Brazilians from pregnancy and for life, with a focus on health. with quality of life, aiming at prevention and health promotion, with the management of actions carried out in a solidary way between the three entities of the Federation, encompassing primary, medium and high complexity care (BRASIL, 2019).

The SUS was born through pressure from social movements that understood that health is a right for all, transferring management power to the municipalities, thus promoting greater access to health for the population, as well as greater equity and rationalization in the distribution of resources.

The aforementioned decentralization process has expanded the SUS' contact with the reality of the population's needs, putting managers ahead of challenges to organize a regionalized and hierarchical network of health actions and services, seeking to improve management (BRASIL, 2006).

The SUS is organized according to the following guidelines: decentralization, with a single direction in each sphere of government; comprehensive care, with priority given to preventive activities, without prejudice to care services; community participation; regionalized and hierarchical network, thus constituting a single system (BRASIL, 2006).

While the municipal health system has different levels of complexity, it is common for health establishments or bodies in one municipality to serve users referred by another, which requires negotiation between municipal managers. (BRAZIL, 2006).

Primary care/primary care in the SUS according to ordinance 2,488 that approves it, the revision of its guidelines is guided by the principles of universality, accessibility, bonding, continuity of care, comprehensive care, accountability, humanization , equity and social participation. Primary Care considers the subject in its uniqueness and socio-cultural insertion, seeking to produce comprehensive care (BRASIL, 2011).

With a participatory management model, SUAS articulates the efforts and resources of the three levels of government, organizing actions into two types of social protection. The first is Basic Social Protection, aimed at preventing social and personal risks by offering programs, projects, services and benefits to individuals and families in situations of social vulnerability. The second is Special Social Protection, aimed at families and individuals who are already at risk and who have had their rights violated due to abandonment, mistreatment, sexual abuse, drug use, among others. (BRAZIL, 2012).

The SUAS also offers Assistance Benefits, provided to specific audiences in an integrated way with the services, contributing to overcoming situations of vulnerability and also managing the linking of social assistance entities and organizations to the system, keeping the National Registry of Entities and Social Assistance Organizations - CNEAS (BRAZIL, 2019).

The National Social Assistance Policy - PNAS, has the functions of social protection, social assistance surveillance and the defense of rights, organized in the form of a non-contributory, decentralized and participatory public system, called SUAS. To understand what is directly linked to social assistance, as well as its organization, it is necessary and fundamental to understand the categories territory, social vulnerability and social risk. (BRAZIL, 2011; BRAZIL, 2012).

Programs, projects, services and benefits must be developed in the most vulnerable regions, by public units, Social Assistance Reference Centers (CRAS); Specialized Reference Centers for Social Assistance (CREAS); the Specialized Reference Centers for the Homeless; and in a complementary way, by the Private Social Assistance Network, among others, with the family as the focus of attention (BRASIL, 2012).

Quinonero et. al (2013), argue that the “Integrality of social protection”, if materialized by the guarantee and supply of provisions in their entirety, through an articulated set of services, programs, projects and benefits [...] and the principle of “Intersectoriality” that is present in the search for integration and articulation

of the social assistance network with other sectoral policies and bodies, such as those of the Rights Guarantee System. In this way, the actions developed by the PNAS must be permeated by the set of social public policies, because the meaning of social protection goes beyond the possibility of a single social policy and requires the establishment of a set of public policies that guarantee rights and respond to different and complex basic needs (PEREIRA cited by CFESS, 2011).

When analyzing the two public systems, it is understood that protection/primary care is the pillar of their services, which demand that they have a clear and integrated organization. According to the parameters for the performance of social workers "(...) Basic Social Protection is understood to be preventive actions that reinforce coexistence, socialization, reception and insertion and have a more generic character and primarily focused on the family" (CFESS, 2011).

TERRITORY AS A SPACE FOR INTEGRAL EXECUTION OF PUBLIC POLICIES

The territorial perspective brought by both SUS and SUAS represents a relevant paradigmatic change, considering that public actions in the area of social assistance and health must be territorially planned, with a view to overcoming their fragmentation, reaching universality of coverage, the possibility of planning.

And also the importance of monitoring the service network and carrying out surveillance to better identify the problems present in the territories with the highest incidence of vulnerability (BRASIL, 2008).

For Sposati (2008), the territory is dynamic, because, in addition to the natural topography, it constitutes a "social topography", resulting from the relationships between those who live in it and their relationships with those who live in other territories. Therefore, territory is not ghetto, separation, but mobility. Therefore, discussing measures of a territory is a much more complex matter than defining its area, as it implies considering the set of forces and dynamics that operate in it.

The creation and functioning of the SUS at the municipal level makes it possible for municipalities to be highly responsible for the health of all residents in their territory, configuring a new way of looking at the space where people live; to build possibilities so that their living ones do not have to leave their place to seek care through public policies; and above all to live off philanthropy and politics. (BRAZIL, 2006).

Thus, the promotion of intersectoral articulation in the territory covered is understood as collective action that is shared and integrated with the objectives and possibilities of other areas, with the aim of guaranteeing the integrality of the service to social segments in situations of vulnerability and social risk (BRAZIL, 2009).

Kastrup (2011) explains that inhabiting a territory is a process that involves "wasting time", which implies wandering and also assiduity, resulting in a direct and intimate experience with matter.

> "[...] I inhabit the territory where I feel at home, I have skills and I perform movements that seem spontaneous. [...] Skillful handling is an act in flow, a deal with things and situations, an activity and a practice. However, it is necessary to pay attention to the fact that both the invention of problems and the solution of problems are present in the same space of possibilities" (KASTRUP, 2011).

For Schneider apud Pereira et al. (2011), "the territory becomes a reference unit, a level of operation and aggregation adequate to operate the planning of governmental actions and public policies that promote changes and multiple transformations in the social space".

REFLECTIONS ON THE INTERSECTORIALITY BETWEEN PUBLIC EQUIPMENT

Intersectoral articulation promotes dialogue between public policies with their sectors and existing equipment in the territory, enabling greater access for families to sectoral services; enhances the objectives of intersectoral agendas within the municipality, contributing to the definition of priority for access to public services by families, especially those in situations of greater social vulnerability and health issues that can be aggravated.

Monnerat and Souza (2014), emphasize that in the search for more effective results, the health area through the transversality of actions in the social field and its intervention very directed to specific issues, still what prevails in the field of collective health, including there The definition of the World Health Organization (WHO) is the idea of intersectoral action as the articulation of several sectors to achieve better health results, such as, for example, improving infant mortality rates, hypertension, malnutrition and others.

For Rodrigues and Cruz (2015), intersectoriality is constituted by contrasting the sectoral situation on which social policies are supported. In this way, it seeks integrated actions by sectors from various segments that meet the social demands of the population in their entirety. From this perspective, working intersectorally promotes the strengthening of the capacities of public policies to guarantee results in an integral way with families and individuals and their rights in the set of municipal services to be demanded for health, social assistance and education for example.

In the case of CRAS, which is intersectoral in nature, it also functions as a gateway to services, programs and projects of basic social protection, given that it articulates and interacts with other internal and external public services, and focuses on the family and the problems that reach their teams and need solutions (UNICEF, 2021).

Understanding that expanding intersectoriality improves services, since allthose involved come to understand different perspectives of the problems and become more capable of formulating more complete, sustainable and, therefore, more effective solutions, is an urgency in the public service. Having a comprehensive view of the family, carrying out systematic articulation between the services, makes it possible to expand the coverage of the service in the areas of coverage provided for the equipment.

In this way, the concepts of reference and counter-reference in health, despite constituting one of the bases of the desired change for the sector, are still at an elementary stage, both in relation to their possible theoretical meanings, and in the sense of reference. and counter-reference in integrality in health, and the effectiveness and dissemination of experiences, successful or not (FRATINI, 2008).

In short, reference teams are those constituting effective civil servants responsible for organizing and offering basic and special social protection services, programs, projects and benefits and contribute to resolving or minimizing the lack of definition of responsibilities; therapeutic bond; and integrality in health care and social assistance, offering dignified, respectful, quality, welcoming and bonding treatment (NOB-RH/SUAS: annotated and commented, 2011).

It is important to emphasize that the composition of the reference teams is made up of professional categories of higher education, guided by codes of ethics and, therefore, they add this dimension to the services and benefits to the management of SUAS, also establishing that the ethical principles of the respective professions must be considered when designing, implementing and implementing specific standards, routines and protocols, to standardize and regulate professional performance by type of social assistance service (BRASIL, 2011).

INTERDICIPLINARITY IN THE GUARANTEE OF PROTECTION

For Oliveira and Moreira (2017), citing Leff, “interdisciplinarity, therefore, must be understood not only as an integrative method, but as a transforming alternative to the current paradigms of knowledge. In the same direction, Fazenda (2002) points out that interdisciplinarity is a collective attitude towards the issue of knowledge; a project in which cause and intention coincide; a doing that arises from an act of will and that, therefore, requires an immersion in everyday work. In this way, interdisciplinarity is characterized by the intensity of exchanges between specialists and the integration of disciplines in the same project.

Teamwork requires coexistence among professionals, sharing decisions, where each member has his/her role and seeks alternatives for certain questions or situations, where the main mark is responsibility and respect for colleagues, always aiming at the quality of services provided.

II. MATERIALS AND METHODS

To approach the problem, the qualitative research method was used, understanding that the only quantitative nature would limit the study and the subjectivities of the participating subjects. The research was carried out in the public facilities of the Municipal Health and Social Assistance Departments, administratively linked to the Municipality of Senhor do Bonfim, State of Bahia, through a semi-structured interview, in the workplace and at an agreed time with the professionals involved, for this, the prior authorization of the person in charge of the institution where the interviewee is assigned. Even for those interviews carried

out in the online format, the scheduling was for working hours or when the interviewee was in the best condition for it.

The sample was intentional formed by 20 professionals. contemplating the units/equipment in the rural and urban areas of the municipality, linked to the two public policies in question, but taking into account the following inclusion criteria: voluntary participation in the research; reading and signing the informed consent form; higher education training; and professional action in the services, programs, projects and benefits of the health policy and/or social assistance of the municipality for at least one year and accepted to participate in the study by signing the Free and Informed Consent Term (ICF).

The field research was carried out through the application of a semi-structured interview, with open and closed questions, guided by a script and direct observation. The data analysis of the present work was of a descriptive nature through the use of the content analysis technique.

III. RESULTS AND DISCUSSIONS

The sociodemographic characteristics of the participants are presented in the data presented above. A dominant characteristic of the social assistance and health professionals surveyed is that they divide their time in more than one work space, including in other municipalities in the region.

A positive factor diagnosed is that the vast majority of workers have an effective bond with the municipality, which provides an increase in their reference to social and health care.

As for the age of the participants, most fit the profile between 30 and 45 years old and their training varies a lot: They are social workers; Psychologists; Nurses, Lawyers; Degree in Education, who holds a coordination position. The greatest predominance of the social service area was Social Workers, in a total of twelve, all of them with postgraduate courses. Of the effective servers, four are on probation, with one and two years of service. Of these, four work at the Municipal Health Department and sixteen at the Municipal Social Assistance Department.

When asked if they considered necessary actions carried out in their daily work, the totality answered affirmatively, which means an understanding of the need for greater quality at work, as explained in these lines:

> *"I am very happy to assist many people in difficult situations in my work. Helping people in times of pain is very rewarding. I just wish I had better working conditions and better pay. In times of a pandemic, our feeling is increasingly distressing, mainly because I work in a unit that deals directly with death. (professional 17).*

> *"Well, actions are necessary, because today mental health is being increasingly recognized and valued and people are looking for help, they recognize the problem and in fact seek help. Demand is high in the municipality so it is essential work. And how do I feel about performing, I feel good in an area that I like, the Clinical area. I feel pleasure in being able to be helping people in a more direct way and listening, helping, guiding and intervening with the techniques in psychology so I feel good."*
> *(professional 04).*

> *"I can say that while I fulfill myself as a professional in the social area, I see it as a dynamic*

of great responsibility because it involves not only the sustainability of the individual, but above all guaranteeing and protecting their social, civil and political rights". (Professional 13)

"Having contact with the people is very good. I like to provide social assistance, but we still have a lot to learn, we still have a lot to train, to develop, so, contrary to what people think, I don't think it's a bankrupt institution. In Social Assistance, it is difficult to break some historical issues, but our effort is also in the sense of providing, checking information, getting information about rights and duties. I believe the work is good" (Professional 09).

When asked about what they could contribute to improving service to the public, questions and possibilities related to: greater and better quantity of equipment, such as cell phones, computers, better working conditions, adequate workload, increase in reference teams in equipment were mentioned. , expansion of users' rights, service flow, establishing reference and counter-reference and others.

The issue of improving working conditions, the structure of the service both in the health area and in social assistance, is presented in the speeches of the professionals, mainly emphasizing the importance of meeting the demands brought by users, improving the structure and increasing the number of professionals. that make up the teams. In the following statements, the expectations and feelings of the health professionals participants are evident:

"Improve the physical structure for the CAPS service, ensuring accessibility, safety (avoiding stairs and ramps), ventilation and lighting, healthy conditions to welcome and treat people who need to be in the unit to work or be attended to. Equipping, computerizing the data record to enable the management of services, studies and research. Currently, the service is operating in a building without architectural conditions (infiltrations in the ceiling, dangerous stairs and ramps), scrapped equipment (air conditioning, computers, tables, chairs, files) that make it impossible to offer services with better quality and health" (professional 08)).

How? improve the service, well, precisely because the demand is high and the workload is only 20 hours, so I see that a small workload is still not enough to meet all

the demands. If the workload was longer, even to better divide the time of care for each patient, or if we had more professionals, psychologists, working in the municipality, in the health area, for all the demand that exists in the municipality, I think I already answered a little of what can be modified to improve. I believe it would actually be more in that sense. (professional04)

In addition to strengthening the bond, it could distribute a healthy snack to the children accompanied by CriançaFeliz. Create channels directly with the program's priority audience; that the demands brought by the visitor were reviewed or forwarded without having to go through the bureaucratic process. (Professional 15).

As for improving service to the public, several suggestions were identified by the interviewees, the most evident being the improvement of the structure and more adequate working instruments; implementation of internal and network service flow; distinction of emergency and prevention services, or improve those that consequently belong to basic and special protection of social assistance, as well as those of primary and specialized care, of urgency and emergency of Health. Implementation of management protocols that exist theoretically but do not work in practice, and something well requested was the expansion of teams and/or increase in paid working hours for those who are due.

"I wouldn't put it directly to myself because actually if it were to increase my workload I'm not interested, but in the sense of hiring other professionals to improve this work because that would be very positive for the entire population. The more professionals, the less waiting list for the population. And also, increase the number of daily appointments, to reduce the wait, not to mention that professionals need to have a healthy environment at work to ensure their mental and emotional health (Professional 4).

Regarding the issue of workload, it was clear in the research that it is an obstacle for both public policies, mainly with regard to service throughout the territory covered by the municipality. When asked about future expectations in relation to work, the answers were very different, as can be seen in their speeches:

"Without many expectations on the part of management, but always believing that I will still achieve through my actions a future achievement (personal and professional) and in

the lives of users" (Professional 07)

"[...] have appropriate training for both supervisors and visitors" (professional 15).

"By identifying with the issues that involve the demands of users and by contributing to the formulation of actions that enable autonomy and strengthening of bonds and construction of new knowledge and practices". (Professional 08)

"I feel frustrated, because we work as if we were bridges in guaranteeing rights, but we can't promise anything to anyone, that we'll get it, and sometimes I think that makes me very frustrated, and also when things lock when we want to see change. Today I'm a little like that, very unmotivated. (professional 19).

Achieve the largest possible number of user registrations in order to interrupt the cycle of poverty and misery. And develop excellent work. (Professional 13).

Still, regarding professional identity, when starting a discussion, it is important to recognize that in the construction of identity, the territory is the main component. Regardless of the perspective, whether social or professional, recognizing oneself permeates people's daily lives and living conditions, being essential for the transformation process (SACHINI and RIBEIRO, 2021).

It was still possible to observe that the vast majority likes the work, and intends to continue in the role they perform. Seventeen respondents stated that they do not intend to change their activity and only three intend to seek other job possibilities.

Regarding the intention to continue the activities they currently carry out, the interviewees who do not intend to continue in the public health service, justify their discomfort with the way in which the management conducts the activities. Those who intend to remain, even if they are dissatisfied, believe that changes can happen, hence their resilience and belief in the public health service, thus manifesting themselves:

"By identifying with the issues that involve the demands of users and by contributing to the formulation of actions that enable autonomy and strengthening of bonds and construction of new knowledge and practices" (Professional 08).

"I love being a social worker, being useful through my professional intervention" (Professional 17).

"For obvious reasons, to mature within the area I chose for my life". (Professional 13).

Regarding the professional qualification of the interviewees, all participated in training and even after the beginning of the pandemic, they started training courses and participation in seminars, congresses, workshops, among others in their specific area of activity, on their own, without the institution offering any help. However, the NOB/SUS states that it is necessary to "develop actions for the qualification of primary care professionals through

permanent education strategies and the provision of specialization courses and multi-professional residency". (BRAZIL, 2006). Therefore, professional qualification is substantial for an innovative work practice and within the parameters provided for in the Operational Norm of Human Resources - NOB/RH, the training of Social Assistance workers must be permanent, it is worth noting that the vast majority of training took place remotely, with costs below what would be conventional.

Research carried out by the National Institute of Educational Studies and Research Anísio Teixeira (Inep), shows that Brazil already has more students enrolled in online courses than in face-to-face courses. This growth is related to the pandemic of the new coronavirus, which drastically influenced the increase in students enrolled in online courses, a teaching modality that had already been on the rise in recent years.

The Ministry of Citizenship and Health provides access to courses through websites that offer several courses for free and with certification. However, qualification also depends on the personal will of each professional, but it is important that the institution seeks a way to encourage and guarantee the participation of workers in the continuing education process.

In the survey of answers about the activities that the interviewees could possibly carry out with professionals from the Department of Health and Social Assistance, it appears that the home visit is in first place and team meetings in second, with the most evident options being what refers to a daily practice between the two areas, provided for in the regulations and guidelines of the services, programs and projects of the two public policies. Next comes a case study and, in the third, use of a common file with other professionals, and fourth, group work.

With regard to the activities chosen, it can be said that these themes had as their main objective to act as a work tool to ensure that the demands that come to the health and social assistance services of the municipality of Senhor do Bonfim are met.

Social work essential to PAIF/CRAS, for example, is based on welcoming; social study; home visit; guidance and referrals; family groups; family accompaniment; community activities; socio-educational campaigns; information; communication and advocacy; promotion of access to personal documentation; mobilization and strengthening of social support networks; development of family and community life; mobilization for citizenship; knowledge of the territory; socioeconomic registration; preparation of reports and/or charts; notification of the occurrence of vulnerability situations; social risk and active search.

Such elements were identified in the reports made by the interviewees, which is in line with the work base guided by the norms of professional practice, but still in an incipient way with regard to the work between professionals in the two areas jointly and frequently, being more accomplished when the result of a provocation.

In order to analyze and reflect on the perceptions of the interviewees about the actions that require complementary and integrated action between public policies, an analysis of the concept/perception about intersectoriality, integrality and interdisciplinarity was carried out.

> *"The work, the intersectoral action is what we can do with a really connected network, an intersectoral and interdisciplinary intervention, so the climate in which others and all of them are involved in the monitoring process, due to the intersectoral work. It is characterized by that, where we can go and establish a network of action, which effectively monitors that person" (Professional 09).*

> *"Intersectoral work is when you articulate several policies, several sectors, several actors for the same common objective" (Professional 19).*

> *"Intersectoral action is the learning process where management needs to be determined and integrated to*

produce results and respond efficiently to solutions to problems encountered" (Professional 13).

In order forintersectoriality to occur, it is necessary that the sectors dialogue with each other, get to know each other and build ways of working together (BRAZIL. 2012).

The answers related to the understanding of intersectoral work or action demonstrate that they are in line with the literature review carried out. of will and deliberation of the management and also of the professionals involved.

"I think that with all sectors, but with whom it is more evident and what I see is the articulation with social assistance that we have many weaknesses and that health cannot, the basic health unit cannot provide account of the lack of education. It's very important because they manage to open the doors so that we can really do health education at school and everything else is another sector that I think is quite fundamental, which I don't even know how to describe. But it would be the appointments sector in the health area, a sector where people sometimes identify the need for a more urgent demand and we somehow do not get faster feedback; we can't do it as fast as we should. Articulation between the sectors of the network in general, but when you say intersectoral, you only refer to the issue of sectors within health or, in general, the articulations, for example, with the school. There are many pregnant women in adolescence whose information is fundamental for us, educate in health and guide family planning" (Professional 05).

Intersectoriality is materialized through the creation of communication spaces, the increase in negotiation capacity and the availability to work with conflicts. Its effectiveness depends on an investment by municipalities in promoting local intersectoriality, as well. the ability to establish and coordinate flows of demands and information between the organizations and social actors involved.

Municipal Law nº 1423/2017, which established the municipal SUAS in Senhor do Bonfim, provides in its article 7, sole paragraph, that it is up to the Municipal Secretary of Social Assistance to maintain a system of regulation of work processes, with the definition of quality standards , flows and interfaces between services, promotion and inter-institutional and inter-sectoral articulation. (Senhor do Bonfim, 2017).

The articulation between sectors and knowledge, aiming in a common way, to respond in an integrated way, is what most clearly characterizes intersectoriality. It is a new way of working, governing and building public policies, which makes it possible to overcome the fragmentation of knowledge and social structures, to produce more significant effects on the lives of the population, effectively responding to complex social problems (BRASIL, 2012). .

For Leite, Lopes, Ruas (2015), practices built across professional boundaries are only possible when one is able to think beyond disciplinary boundaries, thus,

intersectoral actions and interdisciplinary teams will only be able to be concrete when interdisciplinarity is in the educational organization itself.

In relation to what can contribute for the interdisciplinary practice to be a constant in the health and social assistance services of Senhor do Bonfim, a very direct relationship is identified with computerization, creation of integrated systems between the two municipal secretariats, although in the electronic systems already exist E-SUS, for example, where all services are launched, as well as in assistance there is already a simplified electronic medical record, but stillthere are no tools for data to be cross-referenced and used efficiently by teams. Sometimes there is no equipment with internet. The seriousness is that it is not known for which services, programs and projects, the patient assisted by the teams has already had access, hence the relevance of interdisciplinary practice.

Another factor mentioned by the interviewees in relation to the interdisciplinary practice in the services is related to a better organization of the services, of the technicians/professionals having determined and "authorized" time to exercise the practice in this way. The understanding that those who occupy leadership positions (managers, directors, coordinators) need to have to enable actions, have autonomy and technical knowledge of how the service should be, because interdisciplinarity is a practice provided for by the norms that organize services such as PAIF of social assistance and the health FHS, but the quantity of care is often prioritized, the numbers, and not the quality, the integral look at the user/patient who demands care/service, and which often happens in a fragmented way, thus losing its effectiveness and efficiency, with more clinical, welfare, immediate actions.

Seeing the problem of social issues and their resolution, reminds us of the principle of articulation between public policies so recommended by the Citizen Constitution, which lack the revision of regulations, since there are municipalities that are with new managements, new people occupying management positions, who need knowledge of their area and that of others.

The interdisciplinarity at SUAS characterizes a collective political project that aggregates and directs diverse interests in the understanding of social assistance as a right, and as a public policy consolidated in the unified system, towards a broad and universal system of social protection, with democratization of income and wealth, and socialization of participation (SILVEIRA, 2011).

Despite the limits and challenges highlighted in this study for the integrated practice between SUS and SUAS in the municipality in question, the results are related to the identification of bottlenecks that make communication difficult and consequently professional intervention in the perspective of interdisciplinary action between professionals, and, above all, , the integrated action between the two public policies in the municipality of Senhor do Bonfim - Bahia. The study preliminarily pointed out some of the obstacles to the integration between the two public policies, which hinders the expansion, quality and resolution of service and monitoring of users, namely: high demand and quantity of professionals/insufficient workload to suppress demand ; lack of time to carry out interdisciplinary activities; lack of integrated planning; low or inadequate form of organization of actions in the territory covered by health and social assistance services in accordance with the principles and guidelines established by the TC of 1988, which guarantees intersectoriality. Still the lack of understanding of the coordinations/leaderships that are in front of the equipment regarding the real attributions of the professionals and the objective of the service, program, project and benefit. There is, however, a conservative, clientelistic and sometimes welfare ideology, with a partisan political bias, still seeing public policy as a government action and not as a duty of the state.

The possibilities and ways to improve professional performance are directly related to the way of acting, the daily practice of professionals and the understanding of leaders (managers, coordinators, directors), regarding the prerogatives of each service, program, project and benefits; respect and guarantee of permanent and continuing education of all actors, and not only of the reference teams, but of the management of public policy and the instance of social control, even because, despite the fact that there are a number of professionals with an effective bond in the In the municipality, the management positions are freely appointed, which tends to change with each new administration, requiring a reorganization of work in the direction of intersectoriality and integrality of care and social protection.

In order to improve service to users by health and social assistance services, in the logic of intersectorality advocated by the regulations of the two public policies, it is essential to build a process of continuous and effective dialogue between managers for the elaboration of an integrated protocol and/or flowchart. service for the municipality, in order to facilitate communication between sectors and the relationship with the target audience. It is worth remembering that there are already protocols and flows defined by the state and national bodies on the subject, but it is necessary that they

are in accordance with the local reality, prepared with the participation of professionals who are at the forefront.

It is also essential to carry out a diagnosis of the reality regarding interventions that require articulation, interdisciplinary practice among professionals, and that the management has a technical and administrative look that guarantees the applicability of what is defined in the standards of the services, programs and projects and, above all, that guarantee the integrality of the service to the demands of the users, seeking to act on all aspects of the lives of individuals and families residing in the territories covered by the municipality.

The open questions made it possible to carry out the analysis of subjective information, brought to the light of the interviewees' perceptions about daily practice in real work spaces in the municipality of Senhor do Bonfim, on concepts such as intersectoriality, interdisciplinarity, integrality that brought many elements to be considered. .

Due to the COVID 19 pandemic, new ways of acting and thinking have emerged, the way of dealing with health-disease has been demanding many of the professionals of the two public policies, who throughout this period have not been able to stop their activities because they are activities of extreme relevance. and essential for the population, even seeing co-workers die, fear of taking the infection into their homes and not knowing for sure what the future will be like. At the moment, the main focus is on the virus (prevention and cure), but at the same time social issues are getting worse every day, as a result of the high unemployment rate, the return of hunger and vulnerability. It is noticed that, as a relevant aspect brought by the teams, the lack of professionals to meet the demands is the biggest limiting factor for the quality of the service.

The two policies are part of the tripod of social security, along with social security, but the form of financing is unfair and unequal. There were no ways of mutual accessibility between their operations, even the simplest ones that provide a more integrated operation within the common territories of attention and care, as observed in the analysis and observation of the study.

Assuming that desire and technical knowledge when they go together can make a lot of difference, it is possible to envision the improvement of care provided to users by professionals in the municipality in question, valuing and prioritizing integration actions within the entire territory where the activities are performed shares.

In this context, it is urgent to implement management techniques, with an emphasis on matrix support, creation of forums for SUAS and SUS workers, management committees, and even an intersectoral nucleus for the joint elaboration of proposals to facilitate dialogue between the secretariats and sectors and the organized civil society of the municipality.

Thus, this study is considered a theoretical contribution on the integration of SUS and SUAS, in the municipality of Senhor do Bonfim, encouraging the other municipalities in the region to reflect on their practices and on how integrality has been guaranteed. Finally, there remains the affirmation that a workspace deserves prudence and care, and its workers deserve attention and listening in the direction of the best choice to intervene in reality in an integrated and efficient way.

For the functioning of SUS and SUAS, with regard mainly to human resources, there is NOB-RH\SUAS, however its full implementation is still a challenge, taking into account the precariousness of work in management and operationalization. of this system and the precariousness to which workers are subjected. A challenge that presents itself is the realization of a public tender to balance the quantity of human resources and the adequate working conditions, qualification policies and permanent education, of the workers.

It is also essential to incorporate new information technologies at work, to ensure the intersectoral practice of social policies, thus allowing the positive impacts of the process to be visualized.

REFERENCES

[1] ANDRADE, Renato Almeida de. **A influência dos modos de custeio na ação do prestador privado de serviços socioassistenciais (O caso de cinco municípios da região metropolitana da grande Vitória)** Tese de Doutorado Em Serviço Social. Pontifícia Universidade Católica De São Paulo (Puc - Sp) São Paulo 2010,

[2] ALMEIDA, N. L. T. Descentralização e intersetorialidade: desafios para a consolidação da política pública de educação. In: MONNERAT, G. L.; ALMEIDA, N. L. T.; SOUZA, R. G. (org.). **A intersetorialidade na agenda das políticas sociais. Campinas:** Papel Social, 2014.

[3] ARAGAO, J. W. M.; MENDES NETA, M. A. H. **Metodologia Cientifica**. Salvador: UFBA, Faculdade de Educação, Superintendência de Educação a Distância, 2017.

[4] AZEVEDO, E. de; PELICIONI, M. C. F.; WESTPHAL, M. F. Práticas intersetoriais nas políticas públicas de promoção de saúde. Physis: **Revista de Saúde Coletiva,** v. 22, n. 4, p. 1333-1356,2012.

[5] BARDIN, L. **Análise de Conteúdo**. São Paulo, 2011. Edições 70.

[6] BEHRING, Elaine Rossetti. **Brasil em contra-reforma: desestruturação do Estado e perda de direitos.** 2ª edição. São Paulo: Cortez, 2008.

[7] BRASIL. Ministério do Desenvolvimento Social e Combate

à Fome. Secretaria Nacional de Assistência Social. Política Nacional de Assistência Social. Brasília: MDS, 2004.

[8] BRASIL. Ministério da Saúde. Secretaria-Executiva. Núcleo Técnico da Política Nacional de Humanização. Humaniza SUS: equipe de referência e apoio matricial / **Ministério da Saúde, Secretaria-Executiva, Núcleo Técnico da Política Nacional de Humanização. –** Brasília: Ministério da Saúde, 2004.

[9] BRASIL. Ministério do Desenvolvimento Social e Combate à Fome. **GUIA DE ORIENTAÇÃO TÉCNICA – SUAS N.º1 – PROTEÇÃO SOCIAL BÁSICA DE ASSISTÊNCIA SOCIAL.** Brasília:MDS, 2005.

[10] BRASIL. **Ministério da Saúde. Pacto ela vida, em Defesa do SUS e de Gestão -**Diretrizes Operacionais. Departamento de Apoio à Descentralização/Secretaria Executiva. Brasília: Ministério da Saúde; 2006.

[11] BRASIL. Ministério da Saúde. **Coletânea de Normas para o Controle Social do Sistema Único de Saúde**. 2ª ed. Brasília: Ministério da Saúde; 2006.

[12] BRASIL. NOB-RH/SUAS. **Norma Operacional Básica de Recursos Humanos do SUAS,** 2006.

[13] BRASIL. Secretaria Nacional de Assistência Social. **Politica Nacional de Assistência Social.** Brasília, 2004.

[14] BRASIL. Diário Oficial da União. **Tipificação Nacional de Serviços Socioassistenciais**. Texto da Resolução Nº 109, 2009.

[15] BRASIL. Ministério da Cidadania. **O Acompanhamento de Organizações da Sociedade Civil com atuação no SUAS.** Brasília/DF Janeiro de 2022.

[16] BRASIL. Ministério do Desenvolvimento Social e Combate à Fome. **Norma Operacional Básica do Sistema Único de Assistência Social - Nob/Suas.** 2. ed. Brasília: MDS, 2012.

[17] BRASIL. Constituição **(1988). Constituição da República Federativa do Brasil**: promulgada em 5 de outubro de 1988. Brasília, 2014.

[18] BRASIL. Ministério do Desenvolvimento Social e Combate à Fome**. GESTÃO DO TRABALHO NO ÂMBITO DO SUAS: Uma contribuição Necessária.** -- Brasília, DF:MDS;Secretaria Nacional de Assistência Social. Acesso em 05 de fevereiro de 2022.

[19] BRASIL. Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Política Nacional de Atenção Básica / Ministério da Saúde. **Secretaria de Atenção à Saúde**. Departamento de Atenção Básica. – Brasília: Ministério da Saúde, 2012. 110 p. : il. – (Série E. Legislação em Saúde).

[20] BRASIL. Ministério da Saúde.Secretaria Executiva. Departamento de Apoio à Descentralização.**Coordenação-Geral de Apoio à Gestão Descentralizada.**Diretrizes operacionais dos pactos pela vida, em defesa do SUS e de gestão. 2. ed. Brasília, DF, 2006. 76 p. – (Série A. Normas e Manuais Técnicos).

[21] BRASIL.PORTARIA Nº 2.488, DE 21 DE OUTUBRO DE 2011.Aprova a Política Nacional de Atenção Básica, estabelecendo a revisão de diretrizes e normas para a organização da Atenção Básica, para a Estratégia Saúde da Família (ESF) e o Programa de Agentes Comunitários de Saúde (PACS). Disponível em: https://bvsms.saude.gov.br/bvs/saudelegis/gm/2011/prt2488_21_10_2011.html. Acesso em 01 de janeiro de 2022.

[22] CÂMARA, Rosana Hoffman. **Análise de conteúdo: da teoria à prática em pesquisas sociais aplicadas às organizações.** Gerais: Revista Interinstitucional de Psicologia, v. 6, n. 2, p. 179-191, 2013.

[23] CAMPOS, Gastão Wagner de Sousa; DOMITTI, Ana Carla. **Apoio matricial e equipe de referência: uma metodologia para gestão do trabalho interdisciplinar em saúde.** Cadernos de saúde pública, v. 23, n. 2, p. 399-407, 2007.

[24] CAVALCANTI, P. B.; BATISTA; K. G. S.; SILVA, L. R. **A estratégia da intersetorialidade como mecanismo de articulação nas ações de saúde e assistência social no município de Cajazeiras-PB.**In: SEMINÁRIO INTERNACIONAL SOBRE POLÍTICAS PÚBLICAS, INTERSETORIALIDADE E FAMÍLIAS, 1., 2013, Porto Alegre. Anais [...], Porto Alegre: PUC/RS, 2013.

[25] CHIZZOTTI, A. **Pesquisa qualitativa em ciências humanas e sociais**. 2. Ed. Petrópolis, R.J.: Vozes, 2008.

[26] CRESWELL, John W.; TASHAKKORI, Abbas. **Desenvolvimento de manuscritos de métodos mistos publicáveis.** Journal of Mixed Methods Research , v. 1, n. 2, pág. 107-111, 2007.

[27] CUSTÓDIO, A. V.; SILVA, C. R. C. **A Intersetorialidade nas Políticas Sociais Públicas. In: Mostra de Trabalho Científico,** 1.;Seminário Nacional de Demandas Sociais e Políticas Públicas na Sociedade Contemporânea, 11., 2015, Santa Cruz do Sul. Anais [...], Santa Cruz do Sul: UNISC, 2015. https://online.unisc.br/acadnet/anais/index.php/snpp/article/viewFile/14264/2708.Acesso em: 09 out. 2018.

[28] FRATINI, Juciane Rosa Gaio; SAUPE, Rosita; MASSAROLI, Aline. **Referência e contra referência: contribuição para a integralidade em saúde**. Ciência, cuidado e saúde, v. 7, n. 1, p. 065-072, 2008.

[29] FRATINI, J. R. G.; SAUPE, R.; MASSAROLI, A**. Referência e contra referência: contribuição para a integralidade em saúde. Ciência,** cuidado e saúde, v. 7, n. 1, p. 065-072, 2008.

[30] Gil AC. **Métodos e técnicas de Pesquisa Social**. 5ª ed. São Paulo: Atlas; 1999

[31] GIL, A. C. **Como elaborar projetos de pesquisa.** 4. ed. São Paulo: Atlas, 2002.

[32] KASTRUP, Virgínia. **Aprendizagem, arte e invenção. Psicologia em estudo**, v. 6, 2001.

[33] LAKATOS, E. M.; MARCONI, M..**Fundamentos de metodologia científica**. 5. ed. São Paulo: Atlas 2003.

[34] LUNA, Sérgio Vasconcelos de**. Planejamento de pesquisa: uma introdução**- 2 ed., 1 reimpr. - São Paulo: EDUC, 2011. 116 p.; 18 cm. - (Série Trilhas).

[35] MAGALHÃES, V. B. **Rompendo o Isolamento: Reflexões Sobre História Oral e Entrevistas a Distância.** Universidade de São Paulo (USP), São Paulo, SP,Brasil.

[36] MARTINS, A. S. R. **A intersetorialidade das políticas de saúde e de assistência social no sistema de atenção domiciliar em Franca/SP.** 2015. 176 f. Tese (Doutorado

em Serviço Social) - Faculdade de Ciências Humanas e Sociais, Universidade Estadual Paulista Júlio de Mesquita Filho, Franca, 2015. Disponível em: http://hdl.handle.net/11449/134151. Acesso em: 10 jan.2021.

[37] MINAYO, M. C. S. O **desafio do conhecimento: pesquisa qualitativa em saúde**.12. ed. São Paulo: HUCITEC,2010.

[38] MONNERAT, G. L.; ALMEIDA, N. L. T.; SOUZA, R. G. (orgs.). **A intersetorialidade na agenda das políticas sociais**. Campinas: Papel Social, 2014.

[39] MONNERAT, G. L. SOUZA, R. G. **Espaço Temático: Políticas Sociais e Questões Contemporâneas. DaSeguridade Social à intersetorialidade: reflexões sobre a integração das políticas sociais no Brasil.**Rev. katálysis 14(1), Jun 2011. Disponivel em: https://doi.org/10.1590/S1414-49802011000100005.

[40] MOREIRA, Ruy. **Repensando a Geografia**. In:SANTOS, Milton (Org.). Novos rumos da Geografiabrasileira. São Paulo: Hucitec,1982.

[41] MUNIZ, Egli. Equipes de Referência no SUAS e as Responsabilidades dos trabalhadores. In: **Gestão do Trabalho no Âmbito do SUAS: Uma Contribuição Necessária para Ressignificar as Ofertas e Consolidar o Direito Socioassistencial.** BRASIL, 2011.

[42] OLIVEIRA, L. M. S. R. de; MOREIRA, M. B. **Da disciplinaridade para a interdisciplinaridade: um caminho a ser percorrido pela academia.** Revista de Educação do Vale do São Francisco-REVASF, v. 7, n. 12, p. 38-59, 2017.

[43] PEREIRA, José Roberto et al. **Gestão social dos territórios da cidadania: o zoneamento ecológico-econômico como instrumento de gestão do território noroeste de Minas Gerais.** Cadernos EBAPE. BR, v. 9, n. 3,2011.

[44] PHILIPPI JR., A. et al. **Interdisciplinaridade em Ciências Ambientais**. São Paulo: Signus Editora, 2000.

[45] QUINONERO, Camila Gomes et al. **Princípios e diretrizes da Assistência Social: da LOAS à NOB SUAS.** O Social em questão, v. 16, n. 30, p. 47-70, 2013.

[46] RAICHELIS, Raquel. **Intervenção profissional do assistente social e as condições de trabalho no SUAS.** Serviço Social & Sociedade, n. 104, p. 750-772, 2010.

[47] RODRIGUES, C. R.; CRUZ, N. M. B. da. **Avanços e desafios da intersetorialidade entre as políticas públicas que compõem o tripé da Seguridade Social: um estudo no campo da saúde mental em Divinópolis/MG.** In: SIMPÓSIO MINEIRO DE ASSISTENTES SOCIAIS, 4., 2016, Minas Gerais. Anais [...], Minas Gerais: CRESS- MG, 2016.

[48] SEVERO, S. B.; SEMINOTTI, N. I**ntegralidade e transdisciplinaridade em equipes multiprofissionais na saúde coletiva.Ciência & Saúde Coletiva**, v. 15, p. 1685-1698, 2010.

[49] SILVA, D. A. J. da; TAVARES, M. F. L. Ação **intersetorial: potencialidades e dificuldades do trabalho em equipes da Estratégia Saúde da Família na cidade do Rio de Janeiro.** Saúde em Debate, v. 40, n. 111, p. 193-205, 2016. Disponível em: http://www.scielo.br/pdf/sdeb/v40n111/0103-1104-sdeb-40-111-0193.pdf. Acesso em: 09 nov.2021.

[50] SILVA, Andressa Hennig; FOSSÁ, Maria Ivete Trevisan. **Análise de conteúdo: exemplo de aplicação da técnica para análise de dados qualitativos**. Qualitas revista eletrônica, v. 16, n. 1, 2015.

[51] SILVA JÚNIOR, Evanildo Souza da et al. **Acessibilidade geográfica à atenção primária à saúde em distrito sanitário do município de Salvador, Bahia**. Revista Brasileira de Saúde Materno Infantil, v. 10, p. s49-s60, 2010.

[52] SPOSATI, Aldaiza. **Descaminhos da seguridade social e desproteção social no Brasil.** Ciência & Saúde Coletiva, v. 23, 2018.

[53] SPOSATI, A. A gestão da assistência social na cidade de São Paulo (2001-04). **Revista de Administração Pública-RAP**, v. 39, n. 3, p. 505-571, 2005.

[54] SPOSATI, A. O primeiro ano do Sistema Único de Assistência Social. **Revista Serviço Social e Sociedade,** São Paulo, n. 87, p. 96-122, 2006.

[55] SPOSATI M. M. da C. Et. al. **Orientações Técnicas: Centro de Referência de Assistência Social – CRAS/ Ministério do Desenvolvimento Social e Combate à Fome.** – 1. ed. – Brasília: Ministério do Desenvolvimento Social e Combate à Fome, 2009

[56] SOUZA, Gilberto Gomes. S729p **Percepção dos profissionais de saúde sobre educação permanente na área** - Petrolina, 2017. xiv, 103 f.: il.: 29 cm.Gil, Antônio Carlos, 1946- Como elaborar projetos de pesquisa/Antônio Carlos Gil. -4. ed. - São Paulo : Atlas, 2002

[57] TEIXEIRA, Carmem Fontes; PAIM, Jairnilson Silva; VILAS BÔAS, Ana Luiza. SUS, **modelos assistenciais e vigilância da saúde.** Fundamentos da vigilância sanitária, p. 49-60, 2000.

[58] VAITSMAN, J., Andrade, G.R.B & Farias, L.F. **Proteção social no Brasil: o que mudou na assistência social após a Constituição de 1988.** Ciência & Saúde Coletiva, 14(3):731-741, 2009

[59] ZWICK, Elisa et al. **Administração pública tupiniquim: reflexões a partir da Teoria N e da Teoria P de Guerreiro Ramos**. Cadernos Ebape. BR, v. 10, 2012.

[60] Universidade Federal do Vale do São Francisco. Gabinete da Reitoria. Sistema Integrado de Bibliotecas. **Manual de normalização de trabalhos acadêmicos da UNIVASF/ UNIVASF. – 4**. ed. . – Petrolina, 2019. 115 f.

[61] SCHMIDT, Beatriz; PALAZZI, Ambra; PICCININI, Cesar Augusto. **Entrevistas online: potencialidades e desafios para coleta de dados no contexto da pandemia de COVID- 19**. Revista Família, Ciclos de Vida e Saúde no Contexto Social, v. 8, n. 4, p. 960-966, 2020.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.31

Chemical Composition and Bioactivity of Essential Oils of Croton blanchetianus Bailland and Sida cordifolia L. on Callosobruchus maculatus (Fabr., 1775)

Michele Sousa Travassos Torres[1], Rita de Cássia Rodrigues Gonçalves Gervásio[2], José Alves de Siqueira Filho[3] Yury Jansen Soares Siqueira Torres[4]

[1]PhD Student from the Doctoral Graduate Program in Agroecology and Territorial Development, Universidade Federal do Vale do Rio São Francisco (UNIVASF) – Brazil
E-mail: mstravassos@hotmail.com
[2]PhD Professora, Doctoral Graduate Program in Agroecology and Territorial Development, Universidade Federal do Vale do Rio São Francisco
[3]PhD Professor, Doctoral Graduate Program in Agroecology and Territorial Development, Universidade Federal do Vale do Rio São Francisco
[4]Mestrado em Química Analítica, Universidade Federal do Maranhão (UFMA) - Brazil

Received: 11 Apr 2022,

Received in revised form: 01 May 2022,

Accepted: 06 May 2022,

Available online: 29 May 2022

***Keywords*— aromatic plants, hydrodistillation, Yield, pest insects, stored grains.**

***Abstract*—** *This study aimed to evaluate the yield and chemical composition of essential oils from Croton blanchetianus and Sida cordifolia, in addition to investigating the insecticidal potential of these oils on adults of the bean weevil, Callosobruchus maculatus. To obtain the oils, the hydrodistillation method was adopted, using a Clevenger apparatus. The identification and quantification of chemical constituents was performed by means of gas chromatography coupled to mass spectrometry (GC-MS). For each oil, fumigation bioassays were performed on adults of C. Macullatus in six concentrations, 0; 0,30; 0,48; 0,60 e 0,70 (µL/750 mL) for C. Blanchetianus. As for the essential oil of S. cordifolia, the concentrations applied were 0, 3, 6, 9, 12 and 15 (µg/750 mL). The bioassays were carried out under constant conditions of temperature (25 ± 2ºC) and relative humidity (60% ± 10%). In the fumigation tests, different concentrations of the oils were applied to strips of filter paper (2x3 cm) attached to the bottom of the lid of a glass container (750mL), which contained 10 grams of cowpea and 15 unsexed adult insects. Insect mortality was evaluated 48 hours after the treatments were applied. Data were submitted to analysis of variance and regression analysis. When possible, lethal doses were calculated for 50 and 95% of the test population (LD50 and LD95). The yield of essential oil from C. blanchtianus was 0.50%, higher than that obtained for S.cordifolia, which was 0.03%. For the species C. blanchetianus, 20 components were identified, with the monoterpene eucalyptol being the major compound (32.89%). For S.cordifolia, 12 components were identified, with sesquiterpene spathulenol being the major compound (31.76%). In fumigation bioassays, considerable insecticidal activity of C. blanchetianus essential oil was observed on C. maculatus adults, with relatively low lethal doses. As for the essential oil of S.cordifolia, the*

doses used in the study caused a maximum of 5.3% mortality, and it was not possible to determine the LD50 and 90 for the essential oil of this species.

I. INTRODUCTION

Grain loss due to insect pest infestation during storage can reach 50 to 60% in extreme situations (KUMAR et al., 2017; LUO *et al*., 2020) which is one of the major obstacles to improve food quality and achieve food security (BOXALL, 2001). Among the insects that damage cowpea under storage conditions, the woodworm *Callosobruchus maculatus* stands out. It causes a quantitative and qualitative damage to grains and seeds (SHAAYA *et al*., 1997; RAJKUMAR *et al*., 2019).

The management of stored grain insect pests is usually carried out with chemical pesticides (WAQAS *et al*., 2018). However, its abuse leads to ecological, environmental and health risks (WERRIE *et al*., 2021). In addition, it promotes the development of tough insect populations resistant to active ingredients (SISAY *et al*., 2019; RUSIN e GOSPODAREK, 2018). Therefore, the discovery of a relatively safe new natural products effective against new insect, that contributes to a sustainable management of the agroecosystem, has become increasingly frequent.

Herbal products are potentially important sources of botanical pesticides. In such context, essential oils (EO) are presented as a promising alternative. They have insecticide activity, great bioavailability, and a great cost-effective relation (CAMPOLO e ORLANDO, 2018). Besides, they are efficient for insect control and the application does not require special care. Generalym they are safe and do not cause damage to human health and environment. (ISMAN, 2020; Zimmermann, 2021).

The methods for obtaining essential oils vary according to the part of the plant that is used. These methods can be by steam distillation, hydrodistillation or pressing (SIMÕES e SPITZER, 2004). These processes result in an aromatic concentrate, considered as a source of active substances, of extremely powerful and precise action (BUTNARIU, 2018). These aromatic compounds contain 85–99% of low molecular weight volatile components, including terpenoids, terpenes, and other aromatic and aliphatic constituents. (GONZÁLEZ-MAS *et al*., 2019).

Essential oils are highly complex natural liquids, aromatic, volatile, hydrophobic and oily, consisting of several compounds synthesized by aromatic plants as secondary metabolites. (SWAMY, 2016). Terpenes are the most abundant compounds in essential oils (CAZELLA *et al*., 2019), Terpenes are the most abundant compounds in essential oils. They are generally toxic to physiological and biochemical processes in insects (PASSREITER *et al*., *2004; ROH et al., 2020)*, such as thymol, which can be found in essential oils of several plant species, including *Thymus vulgaris*, and has considerable toxicity against *Spodoptera litura* (Lepdoptera: Noctuidae) (MARCHESE *et al*., 2016).

Rodrigues *et al*. (2019) analysing the chemical composition of the essential oil *C. blanchetianus* from Euphorbiaceae family, verifyed that 49.5% of the constituents were terpenoids, with 39.2% being monoterpenes and 10.3% sesquiterpenes. Pinheiro (2016) when analysing the chemical composition of *Sida rhombifolia* essential oil (Malvaceae), found 19.9% of monoterpene compounds. Investigating the chemical composition and insecticidal potential of essential oils from plant species is an important and necessary activity in order to obtain new compounds that can be used in pest management.

Intending to identify control methods of insect pests alternative to chemical control, we determined the yield, chemical composition of *C. blanchetianus* (Euphorbiaceae) and *S. cordifolia* (Malvaceae) essential oils and its possible. Com o objetivo de identificar métodos de controle de insetos-praga alternativos ao controle químico, determinamos o rendimento, a composição química dos óleos essenciais de *C. blanchetianus* (Euphorbiaceae) e *S. cordifolia* (Malvaceae) and its possible insecticide effect by means of biofumigation tests on the cowpea weevil (*C. maculatus*).

II. MATERIAL AND METHODS

2.1 Insect breeding

The creation of *C. maculatus* was carried out on Vale do São Francisco's Federal University (UNIVASF) Laboratory of Beekeeping and Meliponiculture, Agricultural Sciences *Campus*. The insects were kept in 2.0 L glass containers, covered with a thin "tulle" containing cowpea (*V. unguiculata*) grains. Adult insects were kept in the grains for eight days after copulation and oviposition. After this infestation period, the insects were removed, and the system was left with only the eggs to obtain the first generation. The same procedure was performed to obtain the next generations. The insects were kept in an air-conditioned chamber, at a 25°C ± 2°C temperature, relative humidity of 60% ± 10%, and photophase of 12h.

2.2 Plant Material

The plant species *C. blanchetianus* and *S. cordifolia* used in this study were identified by the team of professionals from the Reference Center for the Recovery of Degraded Areas in Caatinga, at the Vale do São Francisco's Federal University (Centro de Referência para Recuperação de Áreas Degradadas da Caatinga, of Universidade Federal do Vale do São Francisco - CRAD/UNIVASF). Three samples of ach plant were deposited on the Herbarium Vale do São Francisco (HVASF), and the exsiccates of *C. blanchetianus* and *S. cordifolia* were registered with the numbers 24.231 and 24.232, respectively. The material for extracting the EOs consisted on fresh leaves of *C. blanchetianus* (latitude -9.26707946 and longitude -40.43271789) and *S. cordifolia*. (latitude -9.26678400 and longitude -40.43245554), which were collected in March 2021, at 9:00 am, on Santana's farm - Petrolina-PE city, Northeast region of Brazil.

2.3 Essential oil's extraction and performance

For the EOs extractions, it was weighed in triplicate, 100g of fresh leaves, which were transferred to a volumetric balloon of 2 Liters, with subsequent addition of 1.5 L of water. This balloon was connected to a Clevenger apparatus for hydrodistillation according to the method recommended by the European Pharmacopoeia (1983). At the process' end, the essential oil was measured directly in the extraction burette. Gravimetric analysis to obtain the oil yield (%, w/w) was performed, based on the fresh weight, according to the following equation: RO% = (Mo*100) / Bm. Where: RO%, Mo e Bm, are the essential oil yield, extracted essential oil mass and plant biomass, respectively. Após a extração, os óleos foram armazenados em frasco âmbar e conservados a 4°C até o uso.

2.4 GC-MS Essential Oil Analysis

The chemical analysis of the essential oil was performed using the SHimadzu QP 2020 equipment, which consists of a GC-2010 Gaseous Chromatograph, connected to a quadrupole mass spectrometry analyser. The column used was an RTX 5MS (crosslinked 5% phenyl methyl siloxane) with 30 m × 0,25 mm internal diameter (DI), film thickness of 0,25 μm. The carrier gas was helium, with a column flow of 1,82 ml.min-1. The amount of samples injected was 1 μL with a split of 5:1. The oven temperature was initially 50°C, increased at a rate of 3°C. min-1 to 280°C. The quadrupole mass spectrometer was swept along the range 37 to 660 u (atomic mass unit) with an Electronic Impact voltage of 70 eV. The main components of the EOs were identified based on mass spectra compared with data from the Mass Library database NIST14.

2.5 Evaluation of insecticide activity

The evaluation of the insecticidal activity of EOs on *C. macullatus* was performed through biological assays with insects in adulthood, using the methodology of biofumigation in glass jars. Fifteen adult non-sexed insects were introduced into glass jars (750mL) containing 10g of cowpea. To perform the biofumigation tests in order to determine the lethal concentrations for the essential oil of *C. blanchetianus*, concentrations of 0; 1,38; 1,90; 2,63; 3,62; 5,0 (μg/750mL) were used. For the essential oil of *S. cordifolia*, only a preliminary test was performed involving the following oil concentrations 0;3;6;9;12 and 15 (μg/750 mL).

The application of the essential oil was performed by introducing a strip of filter paper (2x3 cm) inside the container lid being impregnated with different volumes of essential oil with the aid of a micropipette. To avoid direct contact of the essential oil with insects, the paper strip was suspended on a thin fabric, "tule" type, positioned at the top of the bottle. For the control treatment, strips of paper impregnated with distilled water were used, using the volume corresponding to the highest dose of the essential oil. After applying the treatments, the vials were closed in order to avoid the outflow of gases. Subsequently, the insects were kept in a climatic chamber, with 25º ± 2ºC, relative humidity of 60% ± 10% and photophase of 12h. The evaluation of mortality was performed 48 hours after the installation of the experiment, recording the number of dead insects.

2.6 Statistical Analysis

The data were submitted to analysis of variance and regression study with the help of the Sisvar software. (FERREIRA, 2014). Lethal Doses (LD) were calculated by PROBIT (FINNEY, 1971), analysis using the R software.

III. RESULTS AND DISCUSSION

3.1 Essential oil extraction and yield

At the beginning of the distillation of the leaves of *C. blanchetianus* it was possible to observe two phases, an aqueous (aromatic water) and an organic (essential oil) of yellowish colour. In addition, it was possible to feel the presence of a characteristic aroma, the same detected in the field, at the time of collection of this plant material. After two hours of distillation, it was observed that the extraction of the oil was practically irrelevant. For species S. cordifolia, the biphasic mixture (aromatic water and essential oil) was only observed from the first hour of distillation. The essential oil presented a transparent colour preserving the aroma of fresh leaves collected in the field.

Table 1 shows the average yield of essential oils of *C. blanchetianus* and *S. cordifolia*, which reached values of 0.50 % and 0.03%, respectively.

Table 1. Average yield of essential oil obtained from leaves of C. blanchetianus e S. cordifolia.

	C. blanchetianus	*S. cordifolia*
Mass of leaves (g)	100	100
Oil mass (g)	0,50	0,03
Yield (%)	0,50	0,03

The yield of essential oil from fresh leaves of *C. blanchetianus* has already been determined in some studies, which demonstrated by the results that this species has a high content of volatile oil in its leaves. Angélico (2011), obteve um rendimento de 0,72%, já Melo (2011), relatou 0,70%. Angelico (2011), obtained a yield of 0.72%, Melo (2011), reported 0.70%. Pereira (2017), described an income of 0.40%. This study demonstrated an income close to the works cited here for *C. blanchetianus*. Regarding the species of the genus Sida, of the Malvaceae family, it is observed that they have a low content of volatile oils, since Pinheiro (2016) using the aerial parts of *S. rhombifolia*, obtained a yield of only 0.005%. Nunes (2006) using fresh leaves of *S. cordifolia*, obtained a yield of 0.06%, higher than the result of this study, as shown in Table 1. The respective variation in yield during oil extraction may be related to environmental factors such as climate, soil, altitude, wind, rain, as well as the time of collection.

3.2 GC-MS analysis of essential oil

The analysis by CG-MS of the essential oils of *C. blanchetianus* and *S. cordifolia* generated 20 peaks in both samples, where it was possible to identify by comparing the mass spectrum with the database of the Mass Library NIST14, 20 components in the first (Figure 1) and 12 in the second (Figure 3).

3.2.1 *C. blanchetianus* Essential oil

After comparing with the GC-MS database and known retention indices, it was possible to identify twenty EO compounds of *C. blanchetianus*, mostly monoterpenes, totalling 63.59% of their total composition (Table 2). The major constituents were monoterpene hydrocarbons 1,8-cineol (32.89%) and α-pinene (12.98%), in addition to sesquiterpene spathutulenol (13.87%), and its sum corresponded to a total of 59.74%. *C. blanchetianus*, like most species of the genus *Croton*, synthesise essential oils, which chemical composition is abundant in mono, sesquiterpenoids and phenylpropanoids (PALMEIRA-JUNIOR et al., 2006).

Ribeiro *et al*., (2018) performed the chemical analysis of the essential oils and obtained from the leaves (three species of the genus Croton collected at different times of the day, including *Croton blanchetianus Baill*) identified spatulenol as the majority constituent at 8 and 12 noon, and anethol at 8 pm. The same authors observed that for this species, spatulenol (second most abundant constituent of this study), is absent at 8pm. Oliveira (2008) identified in the chemical composition of the essential oil of *C. blanchetianus*, α-pinene (10.5%) as the majority compound, followed by β-pinene (1.4%) and β-myrcene (1.9%), while Rodrigues et al., (2019), observed 1,8 cineol (16.9%) as the main compound, followed by β-caryophyllene (15.9%) and germacrene D (14.5%).

The analysis of the chemical constituents of the essential oil's fresh leaves of *C. blanchetianus*, according to the data of the present study and previous reports, showed a variation in the majority compound, and only in the work of Rodrigues et al., (2019) similarities were found with the components referenced here. The authors also identified 1,8-cineol as the most abundant constituent. This compound is a monoterpene naturally identified in several aromatic plants of the genera *Eucalyptus*, *Croton*, *Hyptis*, *Pectis*, *Rosamarinus* e *Salvia* (ARAÚJO, 2003; VILELA, 2009). In this study, 1,8-cineol and α-Pinene as were considered major monoterpenes in *C. blanchetianus*, Ebadollahi essential oil (2020). It was also identified in the *Eucalyptus'* essential oil, recognized for its insecticide action, the 1.8-cineol (51.6%) and α-Pinene (15.8%).

These differences in the chemical composition of essential oils are linked to the physiology of the entire plant. The constituents and their amounts depend mainly on the enzymes responsible for catalyzing the production of volatile compounds in an organ. Stage of development and abiotic stresses such as soil salinity, moisture and temperature. (SANGWAN *et al*., 2001).

Table 2. Constituents of C. blanchetianus'essential oil leaves.

COMPOUNDS	SI*	RT (min.)**	%
α-Thujene	96	6.384	1.35
α-Pinene	97	7.073	12.98
Sabinene	96	8.445	2.03
Nopinene	97	8.541	1.65
Myrcene	92	9.142	1.45
Phellandrene	97	9.611	1.10
Cymene	96	10.435	2.08
Eucaliptol	90	10.751	32.89
Terpinene	97	11.859	1.21
Terpinolene	96	13.110	1.21
4-Terpineol	95	17.043	2.56
α-Terpineol	96	17.677	3.08
Elemene	91	24.154	2.31
β-Elemene	93	26.499	1.12
Caryophyllene	95	27.637	7.14
Humulene	96	29.003	1.39
D-Germacrene	94	30.143	1.66
B-Germacrene	93	30.793	4.58
Spathulenol	94	34.045	13.87
Caryophyllene oxide	90	34.170	4.34
Monoterpenes (%)			63.59
Sesquiterpenes (%)			36.41
Total Componentes:			20

(*) Similarity Index based on NIST14 Mass Library mass spectra.

(**) Retention time.

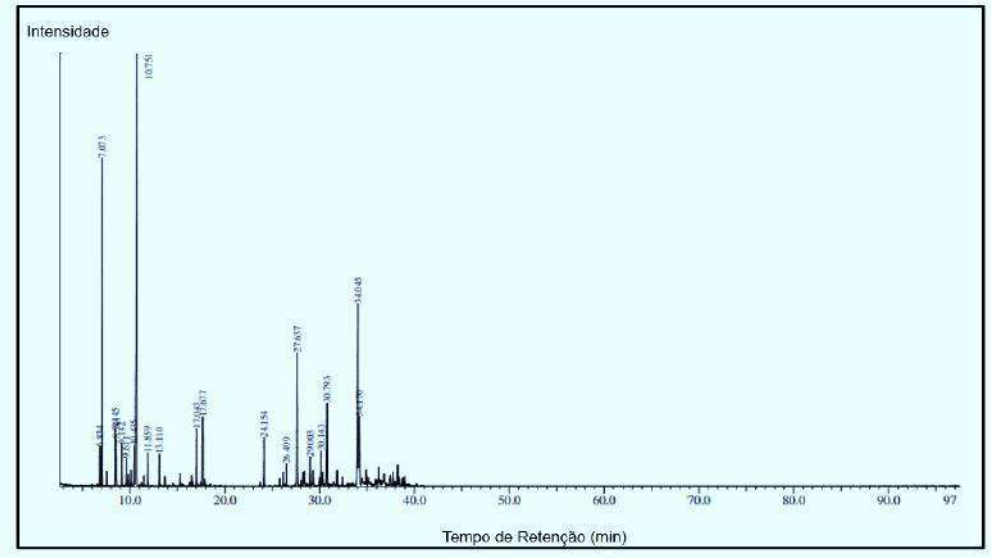
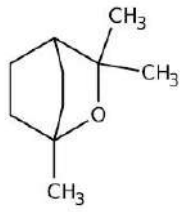
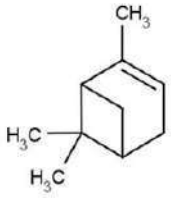


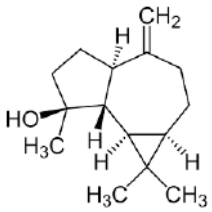
Fig.1. Chromatographic profile of the essential oil of C. blanchetianus' leaves.



1,8-Cineol



α-Pinene



Spathulenol

Fig.2. Constituintes majoritários identificados no óleo essencial de C. Blanchetianus.

3.2.2 *S. cordifolia's* essential oil

For the essential oil *S. cordifolia* (Malvaceae), the Chemical analysis allowed the identification of 12 compounds by CG-MS, all of them sesquiterpenes, totaling 83.81% of its constitution (Table 4). The major compounds were spathulenol (31.76%) and caryophyllene oxide (24.88%), and its sum corresponded to a total of 56.64% (Figure 4). On the other hand, some authors identified monoterpenes compounds in plant species on *Malvaceae's* family, such as Pinheiro (2016), who analising the *Sida rhombifolia's* essential oil, found out the linalol (15.1%), α-terpinol (2.6%), geraniol (1.7%) e o α-Pinene (0.5%). Oliveira (2021), in turn, analising the Chemical composition of *Malva Sylvestris'* essential oil, identified the monoterpene eugenol (14,9%). The constituents of the EOs' monoterpenes group, such as 1-8-cineol, carvacrol e eugenol, are the ones with high pesticidal properties Against stored product pests (AJAYI, 2014). So, the absence or low amount of terpenoids might result in low insecticidal activity.

Table 3. Constituintes do óleo essencial de folhas de S. Cordifolia.

COMPOUNDS	SI*	TR (min.)**	%
β-Elemene	94	26.498	3.40
Caryophyllene	95	27.599	5.79
Humulene	95	28.997	1.73
Aromadrendene	94	29.287	1.07
Humulene Epoxide	91	32.926	1.20
Spathulenol	94	34.010	31.76
Caryophylene Oxide	92	34.160	24.88
Ledol	95	34.474	1.59
Viridiflorol	95	34.900	3.67
Humulene Oxide II	90	35.120	3.35
α-Cadinol	90	36.827	2.04
Dioctyl Phtalate	93	44.309	3.33
Monoterpenes (%)			-
Sesquiterpenes (%)			83,81
Total Components:			12

(*) Similarity Index based on NIST14 Mass Library mass spectra.

(**) Retention time.

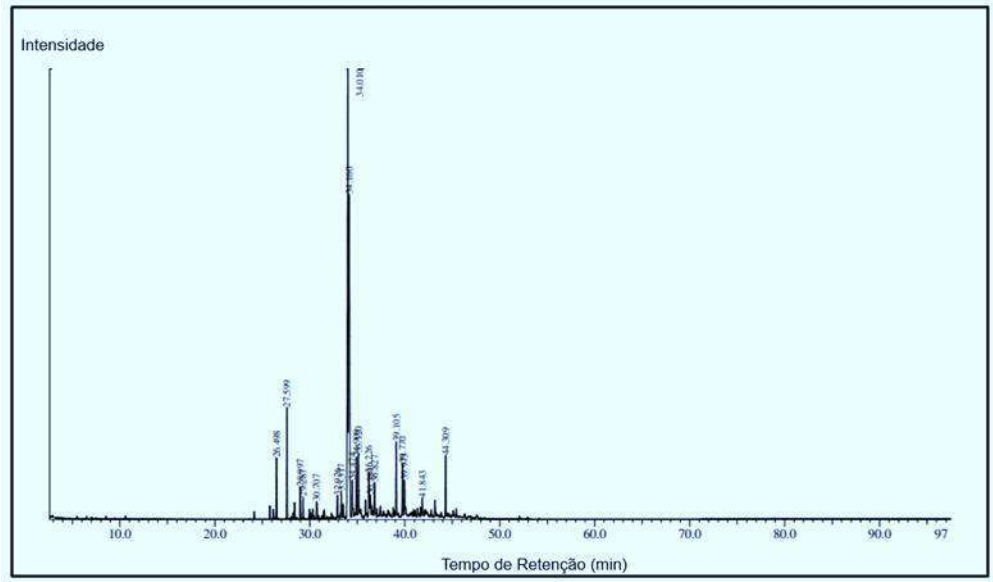
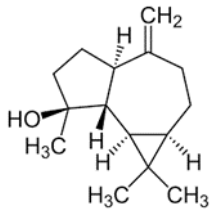
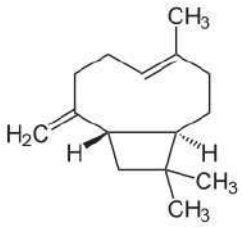


Fig.3. Chromatographic profile of essential oil from S. cordifolia leaves.



Spathulenol



Caryophyllene Oxide

Fig.4. Major constituents identified in the essential oil of S. Cordifolia.

3.3. Insecticidal Activity

While the *C. blanchetianu's* essential oil showed greater bioactivity apresentou maior bioatividade on *C. maculatus* (CL50 = 2,44µL/750 mL e CL90 = 3,41µL/750 mL, respectively) (Table 4), *S. cordifolia* essential oil showed low actividade Against the insect, causig low mortality, which reached at the maximum of 5,3% at the highest dose used (15µL/750 mL). So, it was not possible to determine the LC50 and LC 90 in this case.

Table 4. Estimates of DL50 e DL90 (µg/750 cm^3) of Croton blanchetianus' essential oil on Callosobruchus maculatus.

Essential oil	Angular Coefficient (± EP)	DL_{50} (IC)[a]	DL_{90} (IC)	χ^2 [b]	p-value
C. blanchetianus	8,73 ± 2,02	2,44 (2,24 - 2,65)	3,41 (3,08 – 4,01)	21,08	0,9999

[a] IC: Confidence interval at 95% probability.

[b] χ^2 : calculated chi-square value.

The mortality effect of the EO *C. blanchetianus* on *C. maculatus* was significative and was increasingly shown to increase the dose, which demonstrates the potential of this product for the control of *C. maculatus*, when applied via fumigation on the insect. Corroborating the results of the present study, Silva *et. al*, (2020) observed in contact toxicity tests, the insecticidal action of the *C. blanchetianus's* essential oil on *C. maculatus* (CL50 = 7,14

µL/20g of cowpeas and CL90 = 14,85 µL/20g cowpeas respectively). Besides, the authors also demonstrated that the action of *C. blanchetianus* essential oil on oviposition and *C. maculatus* born alive is dose-dependent. The lowest and highest concentration caused an average reduction in the amount of 16.7% eggs and 95.52%, respectively, in addition to reduce the emergence of insects, which reached values of 15,75%. This result potentializes the efficiency of the EO from this specie on the *C. maculatus* since it shows insecticidal action by contact and fumigation. According to Silva et al., (2020) the EL from this specie shows Insecticidal activity for a long storage period, however, because it is biodegradable, its insecticidal activity decreases over time.

Other species of the genus *Croton* also have insecticidal activity, such as *C. conduplicatus* and *C. sonderianus* species, which, according to Oliveira et al. (2019), reduces oviposition and feeding punctures of the vegetable leaf miner, Liriomyza sativae, in melon.

Many studies have demonstrated the insecticide effect of the essential oils on *C. Macularia*, acting in different ways. This demonstrates the abundance of plant species producing compounds with biocidal properties. The *Lippia citrodora Kunth*., *Rosmarinus officinalis L., Mentha piperita L. and Juniperus Sabina L*. essential oils show excellent fumigation action against *C. maculatus*, while the essential oil of wormwood from Judaea (*Artemisia judaica L*.) reduces the fecundity and emergence of adults. The *Wedelia trilobata L*.'s Essential oil, rich of α-pinene, also shows high potential for effectiveness in controlling *C. maculatus* (MAHMOUDVAND *et al.*, 2011; ABD-ELHADY, 2012; SATONGROD *et al*., 2021)

Essential oils, through the diversity of constituents, have multiple mechanisms of action, connecting to different target sites at biochemical and physiological levels in insects. (TRIPATHI ARUN, 2016). Terpenoid compounds obtained from EOs reveal various insecticidal activities against pests of stored products, flies, cockroaches, and mosquitoes (TRIPATHI ARUN, 2016). From the main constituents of essential oils that have insecticidal properties against pests of stored products, monoterpenes 1,8-cineol and carvacrol are the most toxic, with a high insecticidal activity against *C. maculatus*. The compounds β-pinene and α-pinene also have activity on these insects. However, with a lower toxicity (AJAYI, 2014). The 1,8-cineol is used as a fumigant for *C. maculatus* adults (AGGARWAL *et al*., 2001), and acetylcholinesterase enzyme inhibitor (RYAN and BRYAN, 1988).

Some studies propose that acetylcholinesterase (AChE) might be a potential target of insecticidal activity since the respective enzyme exerts a critical action in the regulation of nerve transmissions. (LIU J, 2021). It has already been demonstrated that insecticides induce mortality in pests by stopping AChE (BHAVYA et al., 2018). The monoterpenes 1,8-cineol and α-pinene (two of the major constituents of the essential oil of *C. blanchetianus* in this study), have previously been described as having inhibitory activity of AChE (DOHI et al., 2009). The monoterpenoids of numerous plant species' essential oils are, in fact, the main responsible for insecticidal activity (TONG and COATS, 2010), identified as fumigants and contact toxic for many insect pests. (RICE and COATS, 1994).

Some essential oils' constituents, especially the majority ones, are able to exert insecticidal action alone. However, this biocidal effect is potentiated by the joint action of the numerous constituents present, which end up promoting synergism. Rosemary essential oil has a potent insecticidal action, in which 1,8-cineole and camphor are two of its main constituents. Tak and Isman (2015) demonstrated that part of the Insecticidal action of rosemary essential oil is due to the synergism of 1,8-cineol and camphor, in which the first substance alone is more toxic than the second when applied topically. However, together, they cause a more significant insecticidal action, due to 1,8-cineol interaction with the lipid layer of the insect cuticle, causing increased solubility of camphor, potentiating its penetration and, consequently, a more lethal toxic effect.

It is observed that plant EOs, due to their less aggressive components, are able to replace conventional insecticides, because of their minimal harmful effects on the environment and human health. (GONZALEZ-MAS *et al*., 2019).

Considering the numerous reports of the insecticidal action of the monoterpenes 1,8-cineol and α-pinene, it is believed that these constituents are the main actors in the fumigant insecticidal action of the EO of *C. blanchetianus* against *C. maculatus*. Besides, it is noticed that the maximum effect occurs due to the synergism of all elements, including the sesquiterpene spatulenol. The α-pinene e and the spatulenol have already been listed as potent insecticidal agents (SILVA et al., 2012; ANDRADE, 2016; LAWAL et al., 2018). Therefore, the *C. blanchetianus*' EOs due to its chemical composition, can become an alternative to chemical pesticides, because it is effective in controlling *C. maculatus.*

About the fumigant effect of the *S. cordifolia* essential oil, this study found no significant differences for the concentrations tested when compared to the control

treatment. The oil extracted from the leaves of these species caused low mortality of insects, reaching the maximum value of 5.3% in the highest dosage used (15µL/750 mL). The chemical analysis of *S. cordifolia*'s essential oil did not identify any monoterpenoids. These constituents have biocidal activity and are usually found in large proportions in essential oils of aromatic plants with insecticidal activity. Therefore, it is believed that this fact can explain the results found in this study in relation to the species *C. blanchetianus* and *S. cordifolia*.

IV. CONCLUSION

The main volatile compounds of the essential oil obtained from the leaves of *C. blanchetianus* collected in Petrolina-PE city are the monoterpenes 1,8-cineol and α-pinene, in addition to the sesquiterpene spatulenol. For the *S. cordifolia*'s essential oil, at the same city, the major components are spatulenol and caryophyllene oxide. The yields of essential oils from fresh leaves of *C. blanchetianus* and *S. cordifolia* were 0.50% and 0.03%, respectively.

From the essential oils evaluated, the essential oil of *C. blanchetianus* has fumigation toxicity, promoting high mortality in *C. maculatus choleopteran* adults, with relatively low lethal concentrations when compared to other analogue studies. The strong insecticidal activity of the essential oil *C. blanchetianus* may be, mainly, due to the monoterpenes 1,8-cineol e α-pinene and also to the synergistic interactions of mono and sesquiterpenes. The essential oil *S. cordifolia*, without the identification of any monoterpene constituent, promoted low mortality, with weak insecticidal potential

Our results emphasise the potential of *C. blanchetianus* as a source of essential oil for application in the control of *C. maculatus* in stored grains, and it may become a viable management option to replace synthetic insecticides.

REFERENCES

[1] Abd-Elhady, H.(2012). Insecticidal Activity and Chemical Composition of Essential Oil from *Artemisia Judaica* L. Against *Callosobruchus Maculatus* (F.) (Coleoptera: Bruchidae). Journal of Plant Protection Research. 52. 10.2478/v10045-012-0057-9.

[2] Aggarwal, K.K., Tripathi, A.K., Prajapati, V., Kumar, S. (2001). Toxicity of 1,8-cineole towards three species of stored product coleopterans. Insect Science and Its Application 21, 155–160.

[3] Ajayi, O. & Appel, A. & Fadamiro, H. (2014). Fumigation Toxicity of Essential Oil Monoterpenes to *Callosobruchus maculatus* (Coleoptera: Chrysomelidae: Bruchinae). Journal of Insects. 2014. 10.1155/2014/917212.

[4] Andrade,F.C. (2016). Composição Química e atividade inseticida de óleos essenciais de espécies de Myrtaceae contra *Plutella xylostella* e *Rhyzopertha dominica* – Tese de Doutorado em Agroquímica – Universidade Federal de Viçosa. Viçosa, MG.

[5] Angélico, E.C. (2011). Avaliação das atividades antibacteriana e antioxidante de *Croton* Heliotropiifolius Kunte e *Croton blanchetianus* Baill. Dissertação de Mestrado, Universidade Federal de Campina Grande, Patos, Paraíba, Brasil.

[6] Araújo, E.C.C.; Silveira, E.R.; Lima, M.A.S.; Neto, M.A.; de Andrade, I.L.; LIMA, M.A.A. et al. (2003). Insecticidal activity and chemical composition of volatile oils from Hyptis martiusii Benth. J. Agric. Food Chem 51: 3760–3762. PMID: 12797740.

[7] Bhavya, M. L.; Chandu, A. G. S., and Devi, S. S. (2018). *Ocimum tenuiflorum* oil, a potential insecticide against rice weevil with anti-acetylcholinesterase activity. Ind. Crop. Prod. 126, 434–439. doi: 10.1016/j.indcrop.2018.10.043.

[8] Boxall, R.A. (2001). Post-harvest losses to insects: A world overview. International Biodeterioration & Biodegradation. 48, 137-152.

[9] Butnariu, M.; Sarac, I. (2018). Essential Oils from Plants. Journal of Biotechnology and Biomedical Science - 1(4):35-43.

[10] Cazella, L. N., Glamoclija, J., Soković, M., Gonçalves, J. E., Linde, G. A., Colauto, N. B., et al. (2019). Antimicrobial activity of essential oil of Baccharis dracunculifolia DC (Asteraceae) aerial parts at flowering period. Front. Plant Sci. 10:27.

[11] Dohi, S.;Terasaki, M. e Makino, M. (2009). Atividade inibidora da acetilcolinesterase e composição química de óleos essenciais comerciais. J. Agric. Química Alimentar. 57, 4313-4318. doi: 10.1021/jf804013j.

[12] Ebadollahi, A.; Ziaee, M.; Palla, F.C. (2020). Essential Oils Extracted from Different Species of the Lamiaceae Plant Family as Prospective Bioagents against Several Detrimental Pests. Molecules, v. 25, n. 7, p. 1556, 28 mar. 2020. 23.

[13] European Pharmacopoeia. (1983). Part 1. Maisonneuve SA, Sainte. Ruffine, p. V.4.5.8.

[14] Ferreira, D. F. (2014). Sisvar: a Guide for its Bootstrap procedures in multiple comparisons. Ciênc. agrotec. vol.38, n.2, pp. 109-112.

[15] Finney, D.J. (1971). Probit Analysis. 3rd Edition, Cambridge University Press, Cambridge.

[16] González-Mas, M.C.; José, L.; Rambla, J. L.; López-Gresa, M.P.; M. Blázquez, A.; Granell, A. (2019).Volatile Compounds in Citrus Essential Oils: A Comprehensive Review. Frontiers in Plant Science. February. Vol.10.Article 12.

[17] Isman, M. B. (2020).Botanical Insecticides in the Twenty-First Century—Fulfilling Their Promise? Annual Review Of Entomology, v. 65, n. 1, p. 233-249, 7 jan. 2020. Annual Reviews.

[18] Kumar, S., Bhanjana, G., Sharma, A., Dilbaghi, N., Sidhu, M. C., and Kim, K. H. (2017). Development of Nanoformulation Approaches for the Control of Weeds. Sci. Total Environ. 586, 1272–1278. doi:10.1016/j.scitotenv.2017.02.138.

[19] Lawal, O. A.; Ogunwande, I. A.; Gbetoyon, F. S.; Kasali, A. A.; Opoku, A. R. (2018).Chemical Composition and Insecticidal Activity of Essential Oils of Four Varieties of *Codiaeum variegatum*(L.) from Nigeria. Journal Of Essential Oil Bearing Plants, v. 21, n. 3, p. 840-847, 4 maio 2018.

[20] Liu, J.; Hua, J.; Qu, B.; Guo, X.; Wang,Y.; Shao, M.; Luo, S. (2021). Insecticidal Terpenes From the Essential Oils of Artemisia nakaii and Their Inhibitory Effects on Acetylcholinesterase. Front Plant Sci. Aug 12;12:720816. doi: 10.3389/fpls.2021.720816. PMID: 34456959; PMCID: PMC8397410.

[21] Luo, Y., Huang, D., Li, D., and Wu, L. (2020). On Farm Storage, Storage Losses and the Effects of Loss Reduction in China. Resour. Conservation Recycling 162, 105062. doi:10.1016/j.resconrec.2020.105062.

[22] Mahmoudvand, M., H. Abbasipour, M.H. Hosseinpour, F. Rastegar & M. Basij. (2011).Using some plant essential oils as natural fumigants against adults of *Callosobruchus maculatus* (f.) (Coleoptera: Bruchidae). Mun. Entomol. Zool. 6: 150-154.

[23] Marchese A., Orhan I. E., Daglia M., Barbieri R., Di Lorenzo A., Nabavi S. F., et al. (2016). Antibacterial and antifungal activities of thymol: a brief review of the literature. Food Chem. 210, 402–414. 10.1016.

[24] Melo, G. F. A. (2011). Estudo da Composição Química e da Atividade Antibacteriana in vitro e em alimento do óleo essencial de *Croton blanchetianus* Baill. 94 f. Dissertação de Mestrado, Universidade Federal da Paraíba, João Pessoa, Paraíba, Brasil.

[25] Nunes, X.P.; Maia, G.L.A.; Almeida, J.R.G.S.; Pereira, F.O.; Lima, E.O. (2006). Antimicrobial activity of the essential oil of *Sida cordifolia* L., Brazilian Journal of Pharmacognosy, vol. 16, p. 642-644.

[26] Oliveira, A. P. R. (2008). Efeito do Óleo Essencial do *Croton sonderianus* Muell.Arg. sobre o Trato Gastrointestinal. Dissertação (Mestrado em Ciências fisiológicas) - Universidade Estadual do Ceará, Fortaleza. 135p.

[27] Oliveira, J. M. (2021). CONSTITUINTES QUÍMICOS E ATIVIDADES BIOLÓGICAS DE ÓLEOS ESSENCIAIS DAS ESPÉCIES Malva *sylvestris* e *Pelargonium graveolens*: UMA REVISÃO. Uningá Review Journal, v. 36, p. eURJ3728, jul. 2021. ISSN 2178-2571.

[28] Palmeira-Junior, S. F.; Alves, F. S. M.; Vieira, L. F. A.; Conversa, L. M.; Lemos, R. P. L. (2006).Constituintes químicos das folhas de *Croton sellowii* (Euphorbiaceae). Revista Brasileira de Farmacognosia, n° 3, 397-402.

[29] Oliveira, S. J. de. (2019).Antibiose e antixenose à mosca-minadora *Liriomyza sativae* (Diptera: Agromyzidae) em germoplasma de meloeiro. 2019. 42f. Monografia (Graduação em Agronomia) - Universidade Federal do Ceará, Fortaleza.

[30] Passreiter, C. M., Wilson, J., Andersen, R., and Isman, M. B. (2004). Metabolism of thymol and trans-anethole in larvae of Spodoptera litura and Trichoplusia ni (Lepidoptera: Noctuidae). J. Agric. Food Chem. 52, 2549–2551.

[31] Pereira, B. P. V. (2017). Estudo dos Constituintes Químicos do Óleo Essencial de *Croton blanchetianus* Baill presentes no povoado olho d'água no município de Paraníba - PI. 51 f. Monografia de Graduação, Instituto Federal de Educação, Ciência e Tecnologia do Piauí, Paraníba, Piauí, Brasil.

[32] Pinheiro, A. A. V. (2016). Contribuição para o conhecimento fitoquímico de *Sida rhombifolia* L. (Malvaceae) e avaliação da atividade antimicrobiana do seu óleo essencial. 2016.116f Dissertação (Mestrado em Produtos Naturais e Sintéticos Bioativos) - Universidade Federal da Paraíba, João Pessoa.

[33] Rajkumar, Vallavan & Gunasekaran, Chinnappan & Christy, Kanitha & Jayaraman, Dharmaraj & Chinnaraj, Panneerselvam & Paul C, Amita. (2019). Toxicity, antifeedant and biochemical efficacy of *Mentha piperita* L. essential oil and their major constituents against stored grain pest. Pesticide Biochemistry and Physiology. Volume 156, May 2019, Pages 138-144.

[34] Ribeiro, S. M.; Bonilla, O. H.; Lucena, E. M. P. (2018). Influência da sazonalidade e do ciclo circadiano no rendimento e composição química dos óleos essenciais de *Croton* spp. da Caatinga. Iheringia, Série Botânica, v. 73, n. 1, p. 31-38, 30 maio 2018. Editora Letra1.

[35] Rice, P. J. and Coats, J. R. (1994). Insecticidal properties of several monoterpenoids to the house fly (Diptera :Muscidae), red flour beetle (Coleoptera :Tenebrionidae) and southern maize rootworm (Coleoptera: Chrysomelidae). Journal of Economic Entomology, 87:1172-1179.

[36] Rodrigues, O.G.; Falcão, B.R.; Barbosa, B.C.; Pereira, A.V. & Aquino, V.V. (2019). In vitro biological activity of the Croton blanchetianus (Baill) essential oil against Rhipicephalus (Boophilus) microplus (Acari: Ixodidae). Journal of Applied Biology & Biotechnology.

[37] Roh, G. H., Zhou, X., Wang, Y., Cermak, S. C., Kenar, J. A., Lehmann, A., et al. (2020). Spatial repellency, antifeedant activity and toxicity of three medium chain fatty acids and their methyl esters of coconut fatty acid against stable flies. Pest Manag. Sci. 76, 405–414.

[38] Rusin, M.; Gospodarek, J. (2018). The effect of water extracts from Origanum vulgare L. on feeding of Leptinotarsa decemlineata Say. J. Agric. Eng. 2018, 63, 122–127.

[39] Ryan, M.F.; Bryan, O. (1988). Plant-insect coevolution and inhibition of acetylcholinesterase. Journal of Chemical Ecology 14, 1965–1975.

[40] Sangwan, N.S.; Arora, B.; Sangwan, R.S. (2001). Modulação espectral da síntese de óleo essencial em *Pelargonium graveolens* LJ Herbs. Especiarias. Med. Plantas. (no prelo).

[41] Satongrod, B. & Wanna, R. & Khaengkhan, P. & Chumpawadee, T. (2021). Fumigant toxicity and bioactivity of Wedelia trilobata essential oil against *cowpea weevil* (*Callosobruchus maculatus*). 14. 1591-1604.

[42] Shaaya, E.; Kostjukovski, M.; Eilberg, J.; Sukprakarn, C. (1997). Plant Oils as Fumigants and Contact Insecticides for the Control of Stored-product Insects. J. Stored Prod. Res. 1997, 33, 7–15.

[43] Silva, A. B.; da, Oliveira, C. R. F.; de, Matos, C. H. C.; Santos, P. É. M. dos; Lira, C. R. I. de M. (2020). BIOATIVIDADE DO ÓLEO ESSENCIAL DE *Croton blanchetianus Baill* (Euphorbiaceae) SOBRE *Callosobruchus maculatus* Fabricius, 1775 (Coleoptera: Chrysomelidae). Nativa, 8(4), 450-455.

[44] Silva, A.C.R. et al., D.S. (2012). Biological Activities of α-Pinene and β-Pinene Enantiomers Molecules, v.17, p.6305-6316.

[45] Simões, C.M.O.; Spitzer, V. Óleos voláteis. In: Simões, C.M.O.; Schenkel, E.P.; Gosmann, G.; Mello, J.C.P.; Mentz, L.A.; Petrovick, (2004).Farmacognosia: da planta ao medicamento. 5.ed. Porto Alegre: UFRGS, 2004, p. 467-95.

[46] Sisay, B.; Tefera, T.; Wakgari, M.; Ayalew, G.; Mendesil, E. (2019). The Efficacy of Selected Synthetic Insecticides and Botanicals against Fall Armyworm, Spodoptera frugiperda, in Maize. Insects, v. 10, n. 2, p. 45, 1 fev. 2019.

[47] Swamy M.K, Akhtar M.S, Sinniah U.R. (2016). Antimicrobial properties of plant essential oils against human pathogens and their mode of action: an updated review. Evid Based Comp Altern Med. 2016:21.

[48] Tak, J. H.; Isman, M. B. (2015). Enhanced cuticular penetration as the mechanism for synergy of insecticidal constituents of rosemary essential oil in *Trichoplusia ni*. Scientific Reports, v. 5, p. 12690.

[49] Tong, F.; Coats, J. R. (2010). Effects of monoterpenoid insecticides on [3H]-TBOB binding in house fly GABA receptor and 36Cl- uptake in American cockroach ventral nerve cord. Pesticide Bio Rice, P. J. and Coats, J. R. Insecticidal properties of several monoterpenoids to the house fly (Diptera: Muscidae), red flour beetle (Coleoptera: Tenebrionidae) and southern maize rootworm (Coleoptera: Chrysomelidae). Journal of Economic Entomology, 87:1172-1179.

[50] Tripathi, A. K.; Mishra, S. (2016). Plant monoterpenoids (prospective pesticides). In: ECOFRIENDLY pest management for food security. Amsterdam: Academic Press. p. 507-524.

[51] Vilela, G.R.; Almeida, G.S.; D'Arce, M.A.B.R.; Moraes, M.H.D.; Brito, J.O.; da Silva, M.F.G.F. *et al*. (2009).Activity of essential oil and its major compound, 1,8-cineole, from *Eucalyptus globulus* Labill., against the storage fungi Aspergillus flavus Link and *Aspergillus parasiticus* Speare. J. Stored Prod. Res 45: 108–111.

[52] Waqas, W.; Muhammad,Y.; Mirza, A.Q.; Muhammad, U. G., Abdullah, M. A.; Geoffrey, O. B.; Yong, J.K. (2018). Resistance to commonly used insecticides and phosphine fumigant in red palm weevil, Rhynchophorus ferrugineus (Olivier) in Pakistan. PLOS ONE. July 19, 2018.

[53] Werrie, P.; Burgeon, C.; Goff, G.J.L.; Hance, T.; Fauconnier, M. (2021). Biopesticide Trunk Injection Into Apple Trees: A Proof of Concept for the Systemic Movement of Mint and Cinnamon Essential Oils. Frontiers in Plant Sience. Abril, 2021.Volume 12. Article 650132.

[54] Zimmermann, R.C.; Aragão, C.E.D.C.; Araújo, P.J.P.D.; Benatto, A.; Chaaban, A.; Martins, C.E.N.; Amaral, W.D.; Cipriano, R.R.; Zawadneak, M.A.C. (2021). Insecticide activity and toxicity of essential oils against two stored-product insects. Crop Prot. 144, 05575.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.32

Study on the use of chitosan as a collector in chalcopyrite flotation

Oseias Costa Rego[1], André Cesar Zingano[1], Erwin Tochtrop Junior[2], Angelo Ricardo Balduino[2], Rafael Teixeira Rodrigues[2]

[1]Department of Mining Engineering, Metallurgy and Materials, Federal University of Rio Grande of Sul, Brazil
Email: oseiasoseias00@gmail.com
[1]Department of Mining Engineering, Metallurgy and Materials, Federal University of Rio Grande of Sul, Brazil
Email: andrezin@ufrgs.br
[2]Department of Mining Engineering, Palmas Lutheran University Centre, Brazil
Email : tochtrop@ceulp.edu.br
[2]Department of Environmental Sciences, Tocantins Federal Institute of Education, Science and Technology, Brazil
Email : angelo@ifto.edu.br
[2]Department of Mining Engineering, Metallurgy and Materials, Federal University of Rio Grande of Sul, Brazil
Email: rafael.teixeira@ufrgs.br

Received: 30 Apr 2022,

Received in revised form: 14 May 2022,

Accepted: 22 May 2022,

Available online: 29 May 2022

***Keywords*— Chalcopyrite flotation. Chitosan. Xanthate.**

***Abstract*—** *Chalcopyrite is an important ore to obtain copper where in Brazil we have several mines located in all regions. The process of ore separation known as flotation is an efficient process that allows the use of bubbles and a foaming material that with the help of collectors are able to conduct the chalcopyrite as well as other ores for separation through appropriate equipment. Currently in this process are used PH modifiers and collectors that allow the separation of this ore with the use of the pneumatic flotation method. The Chitosan is a biotechnological material produced from the exoskeleton of some arthropod animals that can be used as collector in the flotation process. In this work the performance of the Chitosan was analyzed in relation to a very common collector, the Xanthate, and with this it was verified how in media with different concentrations and levels of PH we can verify the efficiency of the Chitosan in the flotation of the Chalcopyrite. The material used in the microflotation tests was the tailings proceeding from copper mining in São Félix do Xingu-PA, lent by the laboratory of Mining Engineering of CEULP/ULBRA, the tests were made in bench with the use of the modified Hallimond tube. The results showed that there was a considerable recovery where in the solution the most indicated pH is pH 9 for maximum recovery.*

I. INTRODUCTION

Minerals are of paramount importance for the continuity of the evolution of mankind, every day it becomes essential to think about the development of new ways to treat these materials, due to the growth of the world population that demands an increasingly high consumption of technologies and because these resources in nature are scarce and non-renewable.

As minerals are not a renewable source of raw material, it is necessary that these materials receive appropriate treatment for better use and economic viability. In addition, environmental aspects are an important factor in mining, as it is one of the activities

developed by man that produces relevant impacts on nature.

Annually, about 400 million metric tons of mineral are crushed and ground into particles, typically less than 100 µm in diameter, subsequently, in some cases, are subjected to a process called froth flotation, a procedure that isolates the valuable components (YANG; PELTON; RAEGEN; MONTGOMERY; DALNOKI-VERESS, 2011).

The replacement of chemicals by biotechnological materials in ore processing enables the mitigation of environmental impacts, such as chemical bioaccumulation in micro and macro organisms, besides producing effluents with great toxic potential for soil and water bodies.

In this perspective the need of components and biodegradable materials is appearing, where its discard would have less impacts to the environment, having the same functionality of other inorganic compounds, elaborated on organic matrices that form bioproducts and biomaterials as in the case of the Chitosan.

The chitosan is a biopolymer non-toxic, biodegradable, biocompatible and produced by natural renewable sources, whose properties are being explored in industrial and technological applications for almost seventy years, some of the main areas of application of the chitosan is among many the water treatment in the form of flocculants for clarification, removal of metallic ions.

Flotation is employed in the separation of fine mineral particles of iron, copper, molybdenum, nickel, lead, zinc, gold, platinum, phosphate or potassium and related gangue particles such as silica, silicates (argillominerals), carbonates, magnetite, or iron sulfides, among others, thus making this technique one of the most useful in the industry and mineral processing (YIANATO, 2003) (CLARK *et al*, 2005).

The process of ore concentration and classification by flotation is one of the most comprehensive and important in the processes of ore processing, especially metal ores, its great success of the flotation method in the mineral industry is due to its, separation accuracy, wide use and great ability to collect fines in addition to enabling large-scale production.

Studies of the use of nanoparticles in flotation have shown that hydrophobic nanoparticles can obtain advantages as collectors in the flotation process with higher efficiency than conventional collectors (YANG *et al*., 2013). For example, the coverage of polystyrene collector should contain only 10% nanoparticles on the surfaces with the use of glass beads which can promote high flotation efficiency, while the conventional molecular collector requires 25% or more coverage for good recovery (ABARCA *et al*., 2015).

Considering these advantages of nanoparticles as collectors in the flotation process, researchers have exerted substantial efforts to clarify the feasibility of nanoparticles as collectors in a less polluting and effective strategy through still experimental and theoretical approaches (HAJATI *et al*., 2016).

Approximately 2 billion tons of ores are beneficiated and concentrated using the flotation method per year, including almost all copper, lead, zinc, nickel and molybdenum produced in the world.

The xanthate salt is used as the main collecting reagent of the most widely used in flotation operations for both simple metallic minerals and sulphide minerals. However due to its toxicity to aquatic living beings, its effluents must be treated after the end of the process and before discharge into rivers.

The xanthate as industrial waste presents, mainly, high toxicity when found in aqueous media (GARCÍA-LEIVA *et al*, 2017). The greatest risk of toxicity is related to its derivative carbon disulfide (CS2). Which could cause a potential pollutant to the environment, which is why it constitutes the interest to study possible alternatives of organic and biodegradable materials for the replacement of xanthate as an ore collector and one of the main wastewater effluents in sulfide mining.

Mining wastewater from the flotation process collected in tailings dams or tailing ponds can contain both residual xanthate and dissolved metals and non-metals, including some types of acid mine drainage.

When they come into contact with the external environment, they can cause pollution of surface water and groundwater, since xanthate is highly toxic when found in an aqueous medium.

However this research had for objective to verify the potential of the Chitosan as collector in ultrafines of chalcopyrite ore in the flotation process to verify the viability of the addition of this biodegradable material in comparison to the Xanthate, as potential collector and as generator of effluent of minor environmental impact.

II. MATERIAL AND METHODS

The experimental procedures were carried out in the Mining Engineering Laboratory of the Palmas Lutheran University Centre (CEULP/ULBRA). The mineral sample used in the flotation tests came from Garimpo of Matuto, a copper mine in the municipality of São Félix of Xingu-PA.

For the accomplishment of the research it was necessary the execution of some steps such as: comminution, particle size classification in sequence the flotation with concentration variation and pH variations, as demonstrated in Figure 9 presents a flowchart of the steps performed.

2.1 - Sample Processing

During the processing of the chalcopyrite samples, primary and secondary processes of crushing, grinding and granulometric classification were used. The preparation of the samples had as objective to comminute the same so that it possesses appropriate granulometry to suffer the process of pneumatic flotation in precise degree for industrial performance, besides counting on the use of the collector Xantato and of the foaming Lauril, having as modifier of PH, solutions of NaOH and H2SO4. This process was developed on a laboratory scale using small equipment.

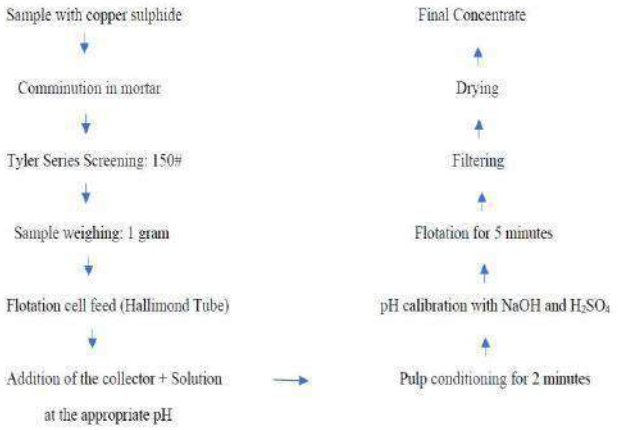


Fig. 1: Process Flowchart

2.2 – Sample Preparation

The sample in question was obtained in its raw state and went through a crushing process, which was performed by a mechanical process based on blows with a common hammer.

In the search for material in appropriate granulometry for the flotation process, it was necessary to fragment the chalcopyrite-based material so that the particles could undergo the flotation process.

Fig. 2: Sulphide copper massif containing chalcopyrite

For this, a common hammer was used on an iron table appropriate for the type of impact generated by the breakage of the material. This process was done at the CEULP-ULBRA Mineral Processing Laboratory.

Fig. 3: Iron table and hammer used for chipping

Figure 3 shows the place where the material was fragmented, a kind of concrete tank with a grid consisting of iron plates approximately 10cm wide, spaced 1.5 mm apart, where the finer material falls into a container and the thicker material is retained on top.

The grinding was performed manually with the use of a porcelain mortar and laboratory pistil, up to 0.075 mm, a particle size appropriate for the flotation process to which the samples will be subjected later.

The choice of particles of 0.075 mm was aimed to verify if the chitosan would reach ultrafine materials.

The material based on crushed chalcopyrite was placed in mortar of the adequate numbering laboratory type so

that it can be manually reduced to smaller particles by mechanical force.

Fig. 4: Grinding of copper chalcopyrite ore in mortar and pestle

After milling, the material was sieved with openings in millimeters (sieves of 2.0, 1.0, 0.6, 0.3, 0.15, 0.075 and <0.075).

The sieving was performed by a set of sieves and manually agitated in the laboratory as shown in the figure below.

Sieves with aperture up to 150# were used with agitation performed manually and the material was sorted by laboratory size 8x2 sieves along with manual agitation.

The sieving process makes use of a set of laboratory sieves that together with a sieve shaker allows to classify the grains in a standardized and uniform way to the point of producing appropriate particles for flotation being these particles equal or smaller than 0.075 mm which is the appropriate granulometry for flotation.

Fig. 5: Sieve set

With the sieving it was possible to classify the samples having a material that with micrometric particles can adhere to the bubble and with the necessary adjustments has the capacity to float.

2.3 – Flotation Test

After the process of sieving the samples the material obtained was weighed on precision scales using 1g of chalcopyrite-based material taken to the Hallimond tube to be flotted with the Xanthate-based collector in tests with 0.3, 0.6, 0.9, and 1.2 ml of solid Xanthate dissolved in distilled water. In the flotation process the pH was changed in 9, 10 and 11 to verify the ideal pH. The flotation process was developed in a specialized equipment called Modified Hallimond Tube.

In the process was used a foaming agent of the Lauryl type that was placed the measure of a drop in each test. After the development of three samples for each one of the concentrations of Xanthate in each one of the pH alterations (9, 10 and 11) we obtained the averages of flotation in each battery of samples, thus accounting for four averages of twelve samples, which were dried in an oven and then weighed. In a second moment the process was repeated having now as collector the Chitosan in concentrations of 1.2, 2.4, 3.6 and 4.8 ml in the same levels of pH (9,10,11), with the addition 1g of NaOH, where the comparison of the processes and of the results obtained with Xanthate and of the results with the Chitosan was made to verify the performances in each process.

In the flotation process were weighed in precision balance 1g of material already processed.

Fig. 6: Precision Balance

The use of the precision balance consists in the exact verification of the initial content having in sight the content of the floated material at the end of the process.

Subsequently the material was placed in a Modified Hallimond Tube of the laboratory type where the flotation process was performed.

Fig. 7: Modified Hallimond tube of the laboratory type

To develop the flotation process in the Hallimond Tube it was necessary the use of foaming agents of the type Lauryl or Sodium Ether Sulphate 27%) besides pH modifiers that with the gauging of a digital peagameter we reached the desired pH's of 9, 10, and 11. Still in the Hallimond Tube we added in distinct stages the collectors based on Xanthate and Chitosan. The development of the flotation was made during 5 min where part of the flotation material was collected with the help of a glass beaker, as shown in the figure 8.

Fig. 8: Flotation being carried out in the modified Hallimond tube

During the flotation process the floated material was collected and put in filters to be drained in a way not to lose any part of the floated material. After the preparation of the samples and the obtaining of the results of the floated material 24 samples of flotation of the chalcopyrite material were produced, being 12 results with the use of Xanthate and 12 results with the use of Chitosan. The samples taken from the Modified Hallimond Tube were filtered on filter paper.

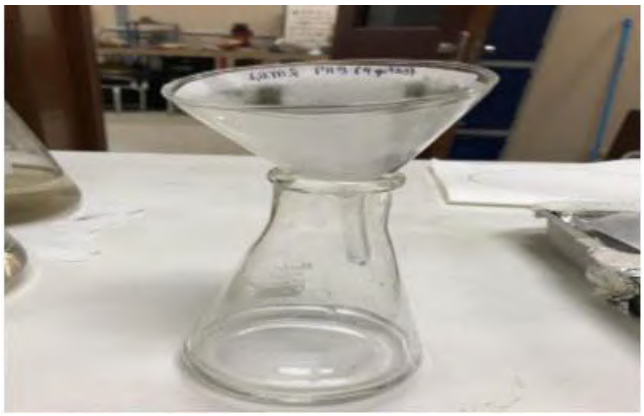


Fig. 9: Material being filtered through filter paper

After filtering the samples of float material they were classified according to the collector dosages and pH levels. After classification, the samples were taken to an oven at 100°C for drying, as shown in figure 10.

Fig. 10: Samples after removal from the oven

Once the samples were dry, they were weighed and thus the masses of the float material were computed with the use of the different collectors in this case Xanthate and Chitosan.

III. RESULTS AND DISCUSSION

3.1 – The Drag Test

Results of the flotation tests (drag) made with copper ore using only foaming reagent where firstly distilled

water was placed in the Hallimond tube, after that we added 1g of material 0.0211g, and left conditioning the pulp for 2 minutes with the aid of magnetic stirrer. After that we turned on the compressor to start the flotation that lasted 5 minutes. After that we removed the floated material to the filter paper and put it to dry in oven at 100°C for 24 hours.

The calculation of the drag values obtained in the test is done as follows:

$$\text{Drag (\%)} = \frac{Float\ Mass}{(Floating\ mass) + (Sinking\ mass)} \text{ x } 100 \quad Eq.\ 1$$

Table.1: Results obtained

After that we get the following results:

TESTS	FILTER WEIGHT (g)	TOTAL WEIGHT (g)	FLOAT MATERIAL (g)	RECOVERY (%)
1	0,820	1,119	0,299	29,9
2	0,836	1,234	0,398	39,8
3	0,849	1,413	0,564	56,4
4	0,829	1,214	0,385	38,5
5	0,830	1,314	0,484	48,4
6	0,839	1,395	0,556	55,6
7	0,841	1,254	0,413	41,3
8	0,827	1,249	0,422	42,2
9	0,824	1,351	0,527	52,7
10	0,836	1,295	0,459	45,9
11	0,832	1,287	0,455	45,5
12	0,835	1,256	0,421	42,1
AVERAGE			0,439	43,9

Therefore, with the obtaining of this average related to the drag, it was possible to disregard the material that is naturally levigated in the process and thus have the parameters for better verification of the performance of the chitosan collector, without the interference of the drag.

The subtraction of the average values of the drag is important because it brings the full verification of the potential of the collector and exposes only the values acquired by flotation with the use of collectors without the contribution of the materials that are dragged by the flow.

3.2 – Flotation with the Xanthate Collector

To compare the chitosan with the xanthate in the performance as collector it was necessary that initially we can verify the performance of the same in the process of flotation of chalcopyrite being made in the same proportion and with the instrumental means such as it was made with the Chitosan.

Once developed in the modified Halimond tube we obtained the following results with the variation of concentration and pH, according to figure 11.

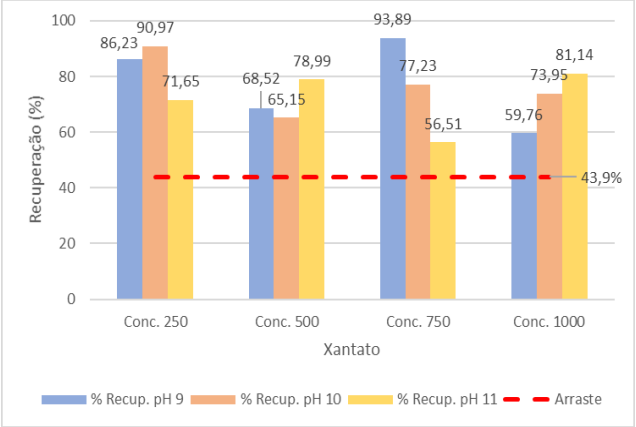


Fig. 11: Recovery

It was verified that in conditions where the concentration of xanthate was equal to 750 mg with an aqueous medium where the pH in 9 we had an optimal recovery of 93.89% of the floated chalcopyrite. According to Nogueira, Osti, Pereira and Lopes (2017) in their experiment in bench test it was possible to verify similar recovery with the use of Xanthate.

Also according to Nogueira, Osti, Pereira and Lopes (2017) With the results of the bench flotation it was possible to state that the best set of reagents used was the test with the use of Xanthate that allowed to constitute a floated material (oversize) with differentiated recoveries from the sunk (undersize). Besides, it was the one that obtained higher recoveries of Zn, Pb and Ag.

3.3 – Flotation with the Chitosan Collector

In the flotation test using chitosan as collector having variations of concentration and pH we can verify its performance as shown in figure 12.

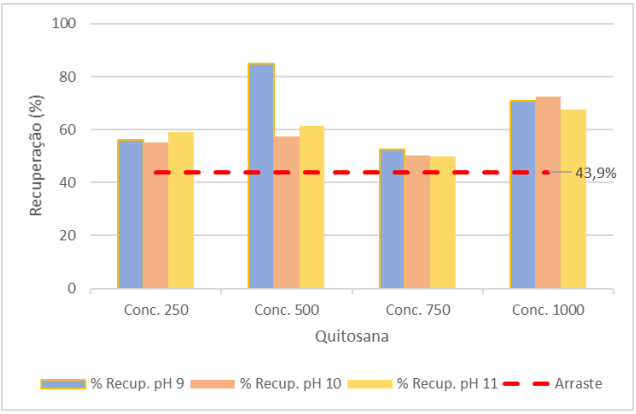


Fig. 12: Flotation test using chitosan

The use of the chitosan as only collector glimpses the collecting capacity of this material where with the use of a PH altered to 10 the best result is reached with about 72.34% of the material to be floated. With this we can verify the potentiality of this material in the recovery of

fines in the flotation of chalcopyrite because alone it reached 72.34% of the material of interest.

3.4 - Chitosan x Xanthate

It was verified that with the pH 9 and with concentration of 500 mg of chitosan, it was possible to obtain the maximum concentration 84.86 mg of chalcopyrite recovered. What is a lower value than that obtained by Xanthate (93.89%), but should be considered that the benefits in the use of biocolector are high, such as low cost in its production, the environmental gain due to the reduction of tons of pollutants due to its biodegradation properties, biocompatibility and non-toxicity as explained (SILVA *et al*., 2016).

In verification of the performance and behaviour of the xanthate in comparison with the chitosan it could be concluded that the chitosan has inferior performance to the xanthate as a chalcopyrite collector in flotation, because its capacity as a chalcopyrite collector was functional, but inferior to the xanthate, as shown in figure 13.

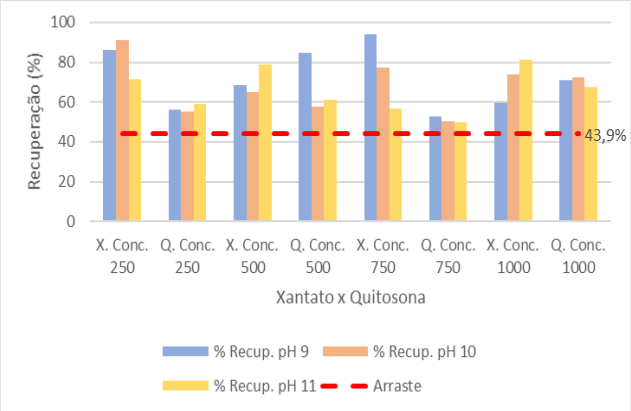


Fig. 13: Performance and behaviour of xanthate compared to chitosan

IV. CONCLUSION

The results obtained in this study, the processing and discussion of the data allow establishing the following conclusions:

The microflotation tests with the xanthate collector presented higher value of flotability of the copper ore, always higher than 55%. The highest values of recovery with the xanthate were: 81.14 % with pH 11 and concentration 1.2 mg, 90.97% with pH 10 and concentration 0.3 mg and 93.89% with pH 9 and concentration 0.9 mg. In relation to the collector with chitosan the highest values of flotability were equal to 67.53%, 72.34% and 84.86% for the tests performed at pH 11, 10 and 9. The results of this work confirm that the chitosan possesses efficiency in the process of recovery in the flotability of the chalcopyrite, however it possesses minor performance that the Xanthate in relation to the recovery, all the way in environmental aspects becomes a sustainable alternative in the process of reduction of environmental impacts what occurs of contrary form with the Xanthate.

REFERENCES

[1] Abarca, C., Lee, S., Pelton, R.H., (2015). Towards high throughput screening of nanoparticle flotation collectors. J. Colloid Interface Sci. 460, 97–104.

[2] Clark, M.E., Brake, I., Huls, B. J., Yu, M. (2005) Creating value through application of flotation science and technology. Minerals Engineering, v.19, pp. 758-765.

[3] Leiva, G., et al. (2017). Degradation DE xanthate degradation in effluents by hydrogen peroxide oxidation, fenton and photofenton processes. XXVII Encontro Nacional de Tratamento de Minérios e Metalurgia Extrativa, Belém - Pa, p. 2-7, 23 oct. Annual.

[4] Hajati, A., Shafaei, S.Z., Oaparast, M., Farrokhpay, S., Aslani, S., (2016). Novelapplication of talc nanoparticles as collector in flotation. RSC Adv. 6, 98096–98103.

[5] Nogueira, F. C., Osti, J., Pereira, C. A., Lopes, M. M., (2017). Evaluation od the recovery of metals silver, lead and zinc presente in zinc hidrometallurgical processing tailings. Holos, Federal Institute of Education, Science and Technology of Rio Grande of Norte (IFRN). [S.L.], v. 6, p. 188, 5 Dec. http://dx.doi.org/10.15628/holos.2017.6393.

[6] Silva, R. K. (Ed.). n/a *et al.* (2016). Chitosan as a natural adsorbent of metal ions and dyes: a review. In: 22° CBECIMAT – Congresso Brasileiro de Engenharia e Ciência dos Materiais. Natal RN v. 22, p. 7-7.

[7] Yang, S., Pelton, R,, (2011). Nanoparticle flotation collectors II: the role of nanoparticle hydrophobicity. Langmuir 27, 11409–11415.

[8] Yang, S., Pelton, R., Abarca, Z., Dai, Z., Montgomery, M., Xu, M., Bos, J.A., (2013). Towards nanoparticle flotation collectors for pentlandite separation. Int. J. Miner. Process. 123, 137–144.

[9] Yianatos, J.B. (2013). Design, Modelling and Control of Flotation Equipment. Proceedings: XXII International Mineral Processing Congress. Cape Town, South Africa; 2003.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.33

Autonomic Heart Rate Regulation During Maximum Incremental Treadmill Test: A Study Case

Felipe Farnesi Ribeiro Borges[1], Robson da Silva Medeiros[2], Fanny Gonçalves de Lima[2], Daniel Martins lúcio[2], Frederico Balbino Lizardo[3], Romeu Paulo Martins Silva[5], Silvio Soares dos Santos[4], Elmiro Santos Resende[2], Adriano Alves Pereira[1], Thiago Montes Fidale[1,5]

[1]Post-graduation Program in Biomedical Engineering, Federal University of Uberlândia, Uberlândia, MG, Brazil.
[2]Laboratory of Experimental Medicine, Federal University of Uberlândia, Uberlândia, MG, Brazil.
[3]Laboratory of Kinesiological Electromyography, Institute of Biomedical Sciences, Federal University of Uberlândia, Uberlândia, MG, Brazil.
4Faculty of Physical Education Federal University of Uberlândia Uberlândia, Brazil.
[5]Academic Unit of Biotechnology, Federal University of Catalan, Goias, Brazil.
*Corresponding Author: Felipe Farnesi Ribeiro Borges. Federal University of Uberlandia, MG, Brazil / Program of Postgraduate in Biomedical Engineering – PPGEB/UFU. Av. João Naves de Ávila 2121, Bloco 3N, Sala 3N115 - Campus Santa Mônica - 38400-902 Uberlândia (MG) Brasil. Telefone: + 55 34 3239 4761. Email: felipe.farnesi18@gmail.com

Received: 18 Apr 2022,
Received in revised form: 10 May 2022,
Accepted: 16 May 2022,
Available online: 31 May 2022

***Keywords*— HRV, ANS, Street Running, PNS Index, SNS Index**

***Abstract*— Background:** *Street running has been growing exponentially in recent years. It is among the most popular physical activities, according to global data for adults. Having become a popular and accessible sporting event due to the emergence of sports advisors, with increased demand for specialized training in the longer distance run, half marathon and marathon. The HRV analysis is generally used to assess the ANS functioning in cardiovascular research and in different applications related to human well-being. HRV has been used in countless studies, related to cardiovascular research and different applications in human well-being, as an indirect tool to assess the functioning and balance of the ANS and currently rest measures, during exercise, and recovery after exercise have been used for this purpose.* **Methods:** *A volunteer who had been running for more than five years and in competitive activity with time less than 20 minutes for 5 km competitions. Male, 29 years old, 64.1 kg, 179.5 cm in height, with no reports of health restrictions such as musculoskeletal injuries and a cardiovascular history diseases or thyroid disorders. The maximum speed test was calculated using the equation correction for incomplete stages proposed by Kuipers (2003). Heart rate was recorded using a POLAR® RS800cx heart rate monitor, with a sampling rate of 1000 Hz. The R-R-interval data recorded by the portable heart monitor was transferred to Polar Pro trainer 5® software.* **Results:** *We can observe the variables referring to the autonomic nervous system parasympathetic activity, mean RR, RMSSD and SD1 intervals, as well as the variables used to calculate the sympathetic activity, mean HR, stress index and SD2 for*

each speed of incremental testing. ***Conclusion:*** *We conclude that the use of HRV as a tool makes it possible to identify an individual's physical capacity. We also concluded that the HRV variables are sensitive to the physiological changes imposed by the stress of continuous progressive physical exercise, at high exercise intensities the parasympathetic variables PNS, RMSSD, Mean RR and SD1 decrease, as well as SNS, Stress Index and Mean HR that reflects sympathetic activity increase slightly, without achieving complete recovery after 6 minutes post-exercise from baseline.*

I. INTRODUCTION

Street running has been growing exponentially in recent years, consisting in a physical activity that combines performance, health and leisure. These are running events held on streets or roads. It is among the most popular physical, activities according to global data for adults (Hulteen et al. 2017). Having become a popular and accessible sporting event due to the emergence of sports advisors, with increased demand for specialized training in the longer distance run (5 and 10 kilometers), half marathon (21 kilometers) and marathon (42 kilometers) (Salgado and Mikail 2007).

The heart rate variability (HRV) analysis is generally used to assess the autonomic nervous system (ANS) functioning in cardiovascular research and in different applications related to human well-being (Berntson, 1997). HRV is known to be affected, for example stress, certain heart diseases and pathological conditions. She is a result of ANS regulation of the sinoatrial node. The ANS is divided into sympathetic and parasympathetic branches and its influences on heart rate (HR) and HRV are well known. Roughly speaking, sympathetic activity tends to increase HR and decrease HRV, while parasympathetic activity tends to decrease HR and increase HRV. Parasympathetic (PNS Index) and sympathetic nerve activity (SNS Index) are calculated from HRV components (T. Laitio 2007)

Cardiac vagal activity is known to increase the mean RR interval (ie, it decreases HR), so the mean of the R-R-intervals (Mean RR) is a natural choice for calculating the PNS index. Cardiac vagal activity regulates the magnitude of the respiratory sinus arrhythmia component and is observed as a fast changes in the R-R-interval associated with breathing act. These fast changes can best be captured by the root mean square of successive differences (RMSSD), which is why this parameter is the second input for calculating the PNS index. As the SD1 (Poincare Plot Standard Deviation) is known from the vagal modulation of HR, equivalent to the RMSSD (Brennan et al, 2001), the normalized value of SD1 is used in Kubios HRV as the third input parameter for the calculation of the PNS index (Tarvainen 2014).

Mean HR is an obvious choice for calculating the SNS index, as it is known that an increase in HR is linked to an increase in cardiac sympathetic activation. The Baevsky Stress Index is a widely used index of cardiovascular system stress and is strongly linked to sympathetic nerve activity. The normalized plotting parameter, Poincare SD2, provides a robust index of sympathovagal balance and is therefore used as the third input parameter for calculating the SNS index (Task force, 1996)

Heart rate variability has been used in countless studies, related to cardiovascular research and different applications in human well-being, as an indirect tool to assess the functioning and balance of the autonomic nervous system (ANS) and currently rest measures, during exercise, and recovery after exercise have been used for this purpose (Buchheit et al. 2009; Buchheit 2010).

Continuous monitoring of athletes HRV is important to identify general health variables related to adjustments in cardiac autonomic regulation, influenced by training, guiding an adequate choice of methods and adjustments in training loads (Plews et al. 2012). The HRV ultra-short recording appears to be a practical and viable alternative for recording within the daily training routine (Baek et al. 2015; Pereira et al. 2016).

Despite studies related to running training and its implications for performance (Stöggl and Björklund 2017; Wiewelhove et al. 2018) and HRV analysis have been investigated in several research fields (Vanderlei et al. 2009; Kiss et al. 2016; Holzman and Bridgett 2017), it is still unclear how the autonomic components, sympathetic nervous system and parasympathetic, calculated behave during at a maximal incremental test on a treadmill. Therefore, the aim of the present study was to analyze the heart rate variability of a runner during a maximal incremental test on a treadmill.

II. METHODS

The present study is a descriptive study case. He was approved by the Ethics and Research Committee on Human Beings of the Federal University of Uberlândia-

UFU, opinion number: 3.397.582, CAAE: 13624419.2.0000.5152 and the participant signed an Informed Consent Form, according to Resolution CNS 466/ 12, authorizing their participation.

A volunteer participated in the study, who had been running for more than five years and in competitive activity with time less than 20 minutes for 5 km competitions. Male, 29 years old, 64.1 kg, 179.5 cm in height, with no reports of health restrictions such as musculoskeletal injuries and a cardiovascular history diseases or thyroid disorders. The volunteer received all instructions on the procedures to be performed, the benefits and possible risks of the research and signed an informed consent form.

2.1 MAXIMUM INCREMENTAL TEST

The incremental test was performed on a Movement (brand) treadmill, Model E.740. After a warm-up, the test started at a 10 km/h speed, a 1 km/h load increment was performed every 2 minutes, without pauses between stages, the athlete were instructed and verbally encouraged to keep exercising for as long as possible. possible time, until they reach voluntary exhaustion (Chang et al. 2020). The treadmill inclination was maintained at 1% and throughout the test (Jones and Doust 1996).

The maximum speed test was calculated using the equation correction for incomplete stages proposed by Kuipers (2003), also described in the study by Arantes (2017). The VO_{2max} was calculated using the formula proposed by ACSM's (Glass S 2007; Koutlianos et al. 2013). Thus, the maximum speed in kilometers per hour (km/h) obtained in the incremental test was called maximum aerobic speed (MAV).

2.2 HEART RATE VARIABILITY

Heart rate was recorded using a POLAR® RS800cx heart rate monitor, with a sampling rate of 1000 Hz. The R-R-interval data recorded by the portable heart monitor was transferred to Polar Pro trainer 5® software (Kempele, Finland). Before the R-R-intervals analysis, were visually inspected and the artifacts were removed, using digital filtering in a moderate way in the standard software filter, as shown in Figure 1.

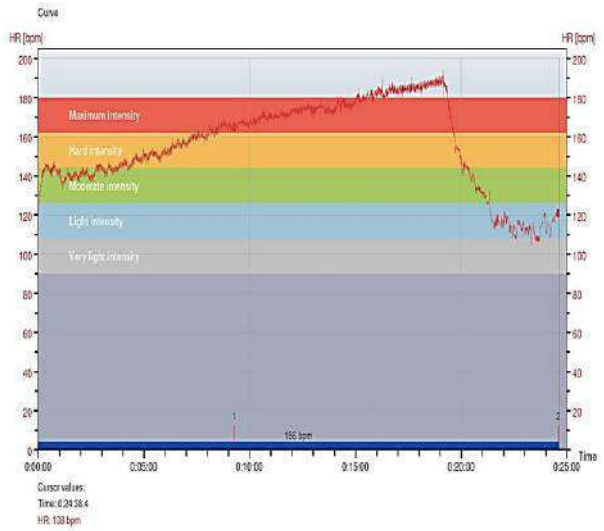


Fig. 1: Heart rate graphic values during maximal incremental test starting at 10 km/h and load increment of 1 km/h every 2 minutes and 6 minutes of post-test recovery (Polar Pro trainer 5®).

Then, 2-minute stretches were selected from the the test beginning and the values of the R-R-intervals were saved in a "txt" format file for each stage, followed by manual filtering in Excel software (Malik et al. 1993; Vanderlei et al. 2009). After data processing, with the ectopic beats and erroneous signals correction, series with more than 95% of sinus beats were included in the study (Godoy, Takakura, and Correa 2005; Vanderlei et al. 2009).

The analysis was performed by the software Kubios® HRV 3.4.3 (Kuopio, Finland) the parasympathetic nervous system (PNS) and the sympathetic nervous system (SNS) index were analyzed (Malik et al. 1993).

III. RESULTS

We can observe in Table 1, the variables referring to the autonomic nervous system parasympathetic activity, mean RR, RMSSD and SD1 intervals, as well as the variables used to calculate the sympathetic activity, mean HR, stress index and SD2 for each speed of incremental testing.

Table 2 presents the data referring to the volunteer's values sympathetic and parasympathetic indexes during the maximal incremental test on a treadmill. Adjustments were verified at each stage, as shown in Figures 2 and 3.

Table 1. HRV values variables related to the parasympathetic and sympathetic index at rest, during each stage of the maximal incremental test and in the post-test Interval values between heartbeats (RR); Square root of the mean square differences between successive RR intervals (RMSSD); Poincaré plot standard deviations (SD1); Mean heart rate (HR); stress index (STRESS) and normalized Poincaré plot parameter (SD2); Post test recovery lasting 2 minutes each (R2, R4 and R6).

	PNS			**SNS**		
Speed (km/h)	**RR (ms)**	**RMSSD (ms)**	**SD1 (%)**	**FC (BPM)**	**Stress**	**SD2 (%)**
Rest	877	31.0	40.3	68	14.9	59.7
10	379	4.2	47.2	158	92.4	52.8
11	425	6.0	44.3	141	68.0	55.7
12	420	5.1	44.6	143	73.8	55.4
13	401	4.6	44.9	150	55.8	55.1
14	362	3.7	49.1	166	96.8	50.9
15	351	3.7	57.3	171	90.3	42.7
16	344	4.4	63.2	174	97.6	36.8
17	335	3.5	52.0	179	111.2	48.0
18	325	3.9	57.1	184	108.6	42.9
19	321	3.4	54.4	187	124.5	45.5
R2	399	4.3	34.0	150	65.4	66.0
R4	506	9.8	39.5	119	45.7	60.5
R6	528	7.7	24.1	114	35.1	75.9

Table 2. Parasympathetic index (PNS) and sympathetic index (SNS) values at rest, during each stage of the maximal incremental test and in post-test recovery.Parasympathetic Index (PNS); sympathetic index (SNS). Normal resting values between -1 and 1 are considered. Post-test recovery lasting 2 minutes each (R2, R4 and R6).

Speed	**PNS**	**SNS**
Rest	-0.41	0.93
10 (Km/h)	-4.24	23.07
11 (Km/h)	-3.81	16.62
12 (Km/h)	-3.88	17.90
13 (Km/h)	-4.06	15.24
14 (Km/h)	-4.38	24.64
15 (Km/h)	-4.45	23.80
16 (Km/h)	-4.46	25.50
17 (Km/h)	-4.55	28.54
18 (Km/h)	-4.60	28.49
19 (Km/h)	-4.64	31.77
R2 (2 min)	-4.10	17.14
R4 (2 min)	-2.95	9.84
R6 (2 min)	-2.97	7.62

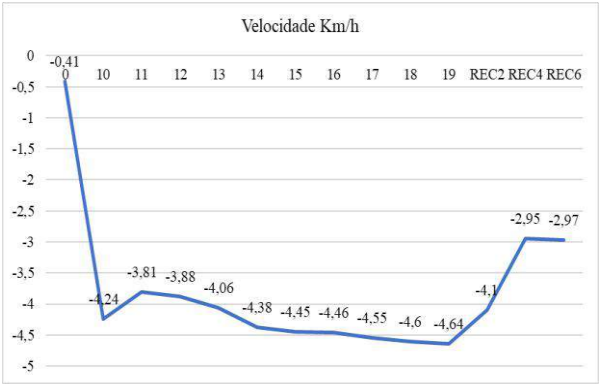


Fig.2. PNS parasympathetic index values at rest, during each stage of maximal incremental testing, and post-test recovery. Parasympathetic Index (PNS). Normal resting values between -1 and 1 are considered. Post-test recovery lasting 2 minutes each (R2, R4 and R6).

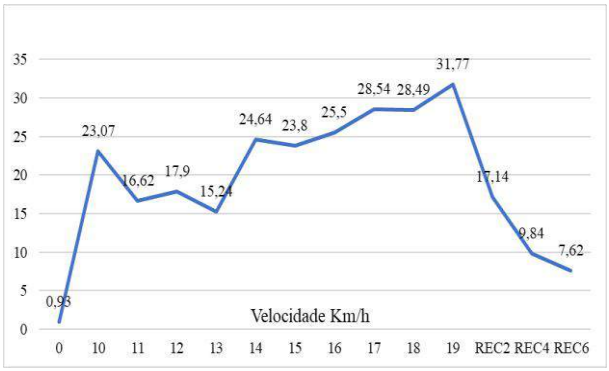


Fig.3. Sympathetic index values during each maximal incremental stage test and post-test recovery. Parasympathetic Index (PNS); sympathetic index (SNS). Normal resting values between -1 and 1 are considered. Post-test recovery lasting 2 minutes each (R2, R4 and R6).

IV. DISCUSSION

Although HRV is typically assessed at rest, recent research suggests that kinetics measurings HRV in response to exercise stressors may have considerable a potential aerobic fitness predictor, exercise performance, and in monitoring training-induced fatigue in elite athletes (Schmitt et al 2013; Schmitt et al 2015). Heart rate variability assessed after exercise cessation has also been used as a parasympathetic reactivation marker to indicate post-exercise recovery status (Michael, Graham & Oam, 2017) and as an training load indicator (intensity and duration of training). exercise) (Kaikkonen, et al 2010; Kaikonnen et al 2012).

In our study, HRV analysis was applied to the stress imposed by physical exercise, in the transition from rest to exercise, during load increments in the maximal incremental test and in recovery after exertion. Our results demonstrate that the HRV variables PNS, SNS, Stress Index followed the intensities of the test, as well the recovery after exhaustion.

We could observe that HRV is a practical, easily accessible, non-invasive and sensitive tool to identify the athlete's training status, observing a parasympathetic predominance (PNS) in relation to sympathetic activity (SNS) at the volunteer rest, as well by the RMSSD, SD1 and HF values, possibly due to their running training adaptations. It has previously been shown that parasympathetic activity increased is associated with improved physical conditioning, as well reduced homeostatic disturbances in response to subsequent stressors (Plews et al 2012; Borresen et al, 2008; Kiviniemi et al 2014).

We also observed that the PNS, SNS and Baevtsky Stress Index, as well as the HRV time domain variables (RMSSD, SD1, SD2, RR and HR), were effective and sensitive to identify the stress imposed by exercise during test load increments. Corroborating our findings, Cruz (2009) et al., analyzed the HRV of 10 athletes under different exercise conditions, and related it to other fatigue indicators, lactate and creatine kinase (CK), and concluded that HRV, as well the CK and lactate concentrations are sensitive markers to detect the fatigue status.

In the post-exertion recovery analysis we found a partial recovery, however, not HRV total recovery variables analyzed 6 minutes after exhaustion, corroborating our findings, Seiler, Haugen & Kuffel (2007), observed in highly trained individuals exposed to intensities below of the anaerobic threshold that the complete HRV values recovery was observed between 10-15 minutes after the exercise's end, in high intensities, a complete recovery can exceed 30 minutes. Kaikkonen, Hynynen, Mann, Rusko & Nummela, (2010) reported that, in the face of high intensity and duration exercises, there is a great decrease in parasympathetic activity (low SD1, and high values of SS and S/PS), and longer duration of exercise recovery in aerobic endurance athletes in running protocols.

We observed that HRV is sensitive to the stress imposed by exercise and we believe that its use in training prescription can help practitioners/coaches to optimize the application time of training stress. It is possible that HRV can be used to predict athlete performance before training and therefore serve as an important indicator of future exercise performance (Chalecon et al 2015).

V. CONCLUSION

We conclude that the use of HRV as a tool makes it possible to identify an individual's physical capacity. We also concluded that the HRV variables are sensitive to the physiological changes imposed by the stress of continuous progressive physical exercise, at high exercise intensities the parasympathetic variables PNS, RMSSD, Mean RR and SD1 decrease, as well as SNS, Stress Index and Mean HR that reflects sympathetic activity increase slightly, without achieving complete recovery after 6 minutes post-exercise from baseline

REFERENCES

[1] Hulteen RM, Smith JJ, Morgan PJ, Barnett LM, Hallal PC, Colyvas K, Lubans DR. Global participation in sport and leisure-time physical activities: A systematic review and meta-analysis. Prev Med. 2017 Feb;95:14-25.

[2] Salgado, J. V. V., & Mikail, M. P. T. C. (2007). Corrida de rua: análise do crescimento do número de provas e de praticantes. *Conexões*, *4*(1), 90–98.

[3] Berntson, G. G., Et Al. Heart Rate Variability: Origins, Methods And Interpretive Caveats. Psychophysiology, P. 623-648, 1997.

[4] Brennan M, Palaniswami M, Kamen P. Do Existing Measures Of Poincaré Plot Geometry Reflect Nonlinear Features Of Heart Rate Variability? Ieee Trans Biomed Eng. 2001;48(11):1342-7K. Elissa, "Title of paper if known," unpublished.

[5] T. Laitio, J. Jalonen, T. Kuusela, H. Scheinin, The role of heartrate variability in risk stratification for adverse postoperativecardiac events, Anesth. Analg. 105 (6) (2007) 1548–1560.

[6] Tarvainen, Mika P., Juha Pekka Niskanen, Jukka A. Lipponen, Perttu O. Ranta-aho, and Pasi A. Karjalainen. 2014. "Kubios HRV - Heart Rate Variability Analysis Software." *Computer Methods and Programs in Biomedicine* 113 (1): 210–20.

[7] Task force of the European society of cardiology and theNorth American society of pacing and electrophysiology,Heart rate variability – standards of measurement,physiological interpretation, and clinical use, Circulation 93(5) (1996) 1043–1065

[8] Buchheit M, Al Haddad H, Millet GP, Lepretre PM, Newton M, Ahmaidi S. Cardiorespiratory and cardiac autonomic responses to 30-15 intermittent fitness test in team sport players. J Strength Cond Res. 2009 Jan;23(1):93-100.

[9] Buchheit M., Chivot A., Parouty J., Mercier D., Al Haddad H., Laursen P. B., et al. (2010). Monitoring endurance running performance using cardiac parasympathetic function. Eur. J. Appl. Physiol. 108, 1153–1167

[10] Plews, Daniel J., Paul B. Laursen, Andrew E. Kilding, and Martin Buchheit. 2012. "Heart Rate Variability in Elite Triathletes, Is Variation in Variability the Key to Effective Training A Case Comparison." European Journal of Applied Physiology 112 (11): 3729– 41.

[11] Baek, H. J. et al. Reliability of ultra-short-term analysis as a surrogate of standard 5- min analysis of heart rate variability. Telemedicine and e-Health, v. 21, n. 5, p. 404–414, 1 maio 2015

[12] Pereira, L. A.; Flatt A. A.; Ramirez-Campillo, R.; Loturco, I.; Nakamura, F. Y. et al. Assessing shortened field-based heart-rate-variability-data acquisition in team-sport athletes. International Journal of Sports Physiology and Performance, v. 11, n. 2, p. 154–158, 1 mar. 2016.

[13] Stöggl TL and Björklund G (2017) High Intensity Interval Training Leads to Greater Improvements in Acute Heart Rate Recovery and Anaerobic Power as High Volume Low Intensity Training. Front. Physiol. 8:562.

[14] Wiewelhove, Thimo, Christoph Schneider, Alina Schmidt, Alexander Döweling, Tim Meyer, Michael Kellmann, Mark Pfeiffer, and Alexander Ferrauti. 2018. "Active Recovery After High-Intensity Interval-Training Does Not Attenuate Training Adaptation." Frontiers in Physiology 9 (APR): 415.

[15] Vanderlei LCM, Pastre CM, Hoshi RA, Carvalho TDD, Godoy MFD. Noções Básicas De Variabilidade Da Frequência Cardíaca E Sua Aplicabilidade Clínica. Rev Bras Cir Cardiovasc. 2009;24(2):205-17.

[16] Kiss, o. Et al. Detailed heart rate variability analysis in athletes. Clinical autonomic research, v. 26, n. 4, p. 245–252, 1 ago. 2016.

[17] Holzman, Jacob B., and David J. Bridgett. 2017. "Heart Rate Variability Indices as Bio Markers of Top-down Self-Regulatory Mechanisms: A Meta-Analytic Review." Neuroscience and Biobehavioral Reviews. Elsevier Ltd.

[18] Chang, Shih Chieh, Alessandra Adami, Hsin Chin Lin, Yin Chou Lin, Carl P.C. Chen, Tieh Cheng Fu, Chih Chin Hsu, and Shu Chun Huang. 2020. "Relationship between Maximal Incremental and High-Intensity Interval Exercise Performance in Elite Athletes." PLoS ONE 15 (5): 1–18.

[19] Kuipers H, Rietjens G, Verstappen F, Schoenmakers H, and Hofman G. 2003. "Effect of Stage Duration in Incremental Running Tests on Physilogica Variables." Int J Sports Med 24 (7): 486–91.

[20] Arantes, Franciel José, Públio Freitas Vieira, Diego Licnerski Borges, and Adriano Alves Pereira. 2017. "Pode o Consumo Máximo de Oxigênio e a Frequência Cardíaca Máxima Medidos Em Teste Laboratórial Serem Preditos Por Equações Em Corredores Amadores?" Revista Brasileira de Prescrição e Fisiologia Do Exercício 11 (8): 343–52.

[21] Glass S, Gregory B. 2007. ACSM's Metabolic Calculations Handbook. Baltimore: Lippincott Williams & Wilkins.

[22] Koutlianos, N. Et Al. Indirect Estimation Of Vo2 Max In Athletes By Acsm's Equation: Valid Or Not? Hippokratia, V. 17, N. 2, P. 136-140, 2013.

[23] M. Malik, A. Camm, Components Of Heart Rate Variability – What They Really Mean And What We Really Measure, Am. J. Cardiol. 72 (11) (1993) 821–822.

[24] Godoy MF, Takakura IT, Correa PR. Relevância da análise do comportamento dinâmico não-linear como elemento prognóstico de morbidade e mortalidade em pacientes submetidos à cirurgia de revascularização miocárdica (Teoria do Caos) como ... 2005;12(4):167-71.

[25] Jones, Andrew M., and Jonathan H. Doust. 1996. "A 1% Treadmill Grade Most Accurately Reflects the Energetic Cost of Outdoor Running." Journal of Sports Sciences 14 (4): 321–27.
[26] Karjalainen. 2014. "Kubios HRV - Heart Rate Variability Analysis Software." Computer Methods and Programs in Biomedicine 113 (1): 210–20.
[27] Schmitt, L.; Regnard, J.; Millet, G.P. Monitoring fatigue status with HRV measures in elite athletes: An avenue beyond RMSSD? Front. Physiol. 2015, 6, 2013.
[28] Schmitt L, Regnard J, Parmentier AL, et al. Typology of "Fatigue" by heart rate variability analysis in elite nordic-skiers. Int J Sports Med 36: 999–1007, 2015.
[29] Michael S, Graham KS, Davis GM Oam. Cardiac Autonomic Responses during Exercise and Post-exercise Recovery Using Heart Rate Variability and Systolic Time Intervals-A Review. Front Physiol. 2017;8:301. Published 2017 May 29. doi:10.3389/fphys.2017.00301
[30] Kaikkonen P, Hynynen E, Mann T, Rusko H, Nummela A. Can HRV be used to evaluate training load in constant load exercises? Eur J Appl Physiol. 2010 Feb;108(3): 435-42.
[31] Kaikkonen P, Hynynen E, Mann T, Rusko H, Nummela A. Heart rate variability is related to training load variables in interval running exercises. Eur J Appl Physiol 112: 829–838, 2012.
[32] Borresen, J.; Lambert, M.I. Autonomic control of heart rate during and after exercise: Measurements and implications for monitoring training status. Sports Med. 2008, 38, 633–646.
[33] Kiviniemi, A.M.; Tulppo, M.P.; Hautala, A.J.; Vanninen, E.; Uusitalo, A.L.T. Altered relationship between R-R interval and R-R interval variability in endurance athletes with overtraining syndrome. Scand. J. Med. Sci. Sport. 2014, 24, 77–85.
[34] Cruz J, Sousa J, Oliveira AG, Silva-Carvalho L. Effects of endoscopic thoracic sympathectomy for primary hyperhidrosis on cardiac autonomic nervous activity. J Thorac Cardiovasc Surg. 2009;137(3):664-9.
[35] Seiler S, Haugen O, Kuffel E. Autonomic recovery after exercise in trained athletes: intensity and duration effects. Med Sci Sports Exerc.2007 Aug;39(8): 1366-73.
[36] Chalecon S, Pichot. V, Roche. F, et alo. Modeling of performance and ANS activity for predicting future responses to training. Eur J Appl Physiol 115:589-596, 2015.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.34

Aspects Related to Breastfeeding in Premature Newborns: A Literature Review

Debora Albuquerque da Silva Siqueira[1], Letícia Victória Sindeaux de Oliveira[1], Lorenna Vidal Rodrigues da Silva[1], Paula Raimunda Araújo Teixeira[1], Luisa Margareth Carneiro da Silva[2]

[1]Institute of Health Sciences, Faculty of Nutrition, Federal University of Pará, Brazil
Email: deboralbuq789@gmail.com/leticia.oliveira@ics.ufpa.br/ lorenna.silva@ics.ufpa.br / paula.teixeira@icb.ufpa.br
[2]CECANE/PA, Federal University of Pará, Brazil
Email: luisamargarett@gmail.com

Received: 28 Apr 2022,
Received in revised form: 16 May 2022,
Accepted: 24 May 2022,
Available online: 31 May 2022

Keywords ***—breastfeeding, breast-feeding, prematurity, preterm newborns***

Abstract—*Exclusive breastfeeding for premature newborn babies faces several challenges in order to be effective and to be able to offer the necessary benefits. This article was based on the selection of 13 studies related to breastfeeding and prematurity found in Scielo, CAPES and BVS in the last six years, which passed inclusion and exclusion criteria. The search was performed using the descriptors: breastfeeding, premature and preterm. It was concluded that the relationship between exclusive breastfeeding and preterm newborns may have difficulties in establishing itself, mainly due to factors related to maternal intention to breastfeed, support from family and health professionals, education, presence of the partner and among others. In addition, there was a lack of essential guidelines and the performance of a multidisciplinary team so that breastfeeding between mothers and their children was effective.*

I. INTRODUCTION

Breastfeeding (BF) is the most natural, safe and complete way to feed the child, capable of meeting all their nutritional and physiological needs, in addition to contributing to the child's growth and development in a healthy way. According to the World Health Organization (WHO) and the Ministry of Health of Brazil, the recommendation is that mothers breastfeed their children for two years or more, and in the first six months breastfeeding must be done exclusively, or that is, with breast milk only. [1]

Breastfeeding rates in Brazil have grown considerably in recent years. According to the National Child Food and Nutrition Study (ENANI) [2], carried out in 2019, at least half of Brazilian children are breastfed for more than 1 year and 4 months. The survey also shows that, in the country, 96.2% of children were breastfed at some point, with 62.4% of babies breastfed in the first hour of life, 45.8% are exclusively breastfed in the first semester, 52, 1% in the first year and 35.5% in the two years of life. Comparing the results with the numbers of the last 34 years, there is an increase of almost 13 times in the rate of exclusive breastfeeding in children under 4 months and about 16 times in those under 6 months. [2, 3]

It is important to emphasize that the act of breastfeeding is not just about nourishing the child, but also promotes a deep interaction between the mother and the baby, which increases the affective bond between both parties, in addition to other benefits for both, such as the significant reduction in infant mortality and a decrease in the incidence of breast, uterine and ovarian cancer in lactating women. [4]

Prematurity is the main cause of infant mortality in Brazil, which is in 10th place in the world ranking, where at least 12% of deliveries are premature. In this context, breastfeeding is extremely important, as it promotes the complete nutrition that the newborn needs. The breast milk of preterm mothers has in its composition different amounts of proteins, calories and immunity protection factors than the milk of full-term mothers. In this way, breastfeeding in these cases is responsible for favoring gastrointestinal maturation and increasing the neuropsychomotor performance of babies, in addition, it has a positive impact on the healthy development of the child until adulthood, by preventing diseases such as diabetes, hypertension and others. In addition, breastfeeding strengthens the bond, often already weakened due to long periods in the Neonatal ICU, between mother and baby. [5]

However, a breastfeeding premature baby is still a major challenge. Some factors tend to interrupt breastfeeding early, or even make it impossible for it to happen. Therefore, the present research seeks to answer the question: "What are the main aspects seen in research on breastfeeding in premature infants in the last 6 years?", with the objective of listing and discussing such circumstances in order to lead students and professionals to a reflection on the current situation, and seek solutions for the complete success of breastfeeding preterm children.

It is expected that this study will provide an expansion of knowledge about breastfeeding in prematurity and improvement of the practice of nutrition professionals in this context, aiming at the development of strategies that help in the BF process of premature babies.

II. METHODOLOGY

This is a literature review, which is characterized by being a method that makes feasible the synthesis of scientific evidence found on a given subject and that can be related to conduct in practice. [6]

The guiding question that this study aims to answer is: "What are the main aspects seen in research on breastfeeding in preterm infants in the last 6 years?" and the objective is to align the results found in order to analyze how they can be related to the exercise of the profession.

For the selection of articles, three data sources were chosen: Scientific Electronic Library Online (Scielo), Coordination for the Improvement of Higher Education Personnel (CAPES) and Virtual Health Library (BVS) where the results were distributed in Lilacs, Medline and BDENF. The research was carried out using the following descriptors: "breastfeeding", "premature" and "preterm". Such words were formulated using the Boolean operator "and".

The inclusion criteria established were: research carried out in the period from 2017 to 2022; be in article format; availability in Portuguese and online and research conducted in Brazil. For the exclusion criteria, we chose: articles that did not answer the guiding question about breastfeeding and preterm babies; theses and dissertations; international surveys and studies that did not contain abstracts.

For further analysis, summaries of the results of each of the surveys were prepared, so that they could be compared and discussed. In addition, for the presentation of the results, the studies were organized in two tables so that the analysis could occur more clearly: one containing the identification used, year of publication, the state where the research was reported, journal in which it was published, together with its impact factor and CAPES Quali; and the other table informing the titles of the articles, the objectives, methods used, main results and conclusions. The articles were identified from A^{1} to A^{13}, according to the proximity of the objectives of each one. All authors were cited in the development process, as well as authors of complementary research that were part of the analysis and discussion.

III. RESULTS

In total, 623 studies were found, 14 in Scielo, 145 in CAPES articles and 464 in VHL. After applying the inclusion and exclusion criteria, 14 studies were selected, 3 in Scielo and 10 in the VHL and 1 in the CAPES platform, however the last one was excluded because it was duplicated. Therefore, in the end, 13 studies were selected for the work. The flowchart below illustrates the process of research and selection of articles:

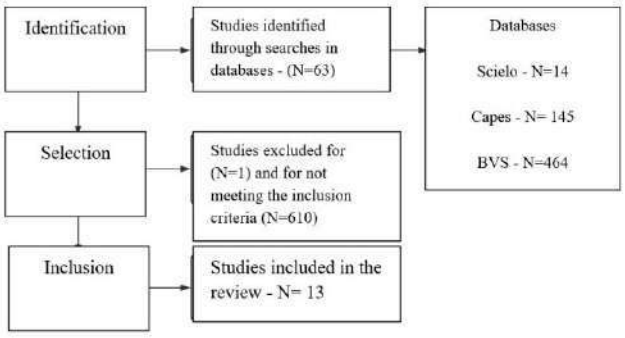


Fig.1- Flowchart of the research process.

Source: Authors, 2022

Table.1: Synthesis of the articles selected for the integrative review.

TITLE (ID)	AIM	METHODOLOGY	RESULTS	CONCLUSION
A[1] - Exclusive breastfeeding of premature infants and reasons for its interruption in the first month after hospital discharge [7]	To estimate the prevalence of exclusive breastfeeding of preterm infants at hospital discharge, at 15 and 30 days, and to identify maternal allegations for its interruption.	Cross-sectional study	The prevalence of exclusive breastfeeding at discharge was 85.2%, 75% at 15 days and 46.3% at 30 days. The main allegation for the introduction of other foods and/or liquids was insufficient milk.	There was a significant reduction in exclusive breastfeeding rates after discharge. The study showed the importance of post-discharge follow-up to avoid early weaning, especially with educational actions that prevent the real and perceived insufficiencies of breast milk.
A[2] - Breastfeeding in preterm infants after hospital discharge: follow-up during the first year of life [8]	To assess the prevalence of breastfeeding among preterm infants after hospital discharge.	Cohort Study.	The results obtained showed the difficulty of breastfeeding in mothers of preterm infants below 33 weeks. 81.3% of babies were receiving breast milk, but most were not exclusively. At AME, the rate was 7.5% both at discharge and in the first month.	Even with difficulties, most mothers managed to maintain BF up to 4 months, but it is necessary to increase these rates to comply with the recommendations. Much is due to the fact that the present hospital is related to the BFHI, perhaps if it were not for this, the rates would be even lower.
A[3] - Predictive factors of interruption of exclusive breastfeeding in preterm infants: prospective cohort [9]	To assess the incidence of exclusive breastfeeding and the risk factors associated with the interruption of exclusive breastfeeding in preterm infants after hospital discharge.	Cohort Study.	The incidence of breastfeeding was 81.4% at hospital discharge and 66.4% at home, representing a 15% drop in the second week after hospital discharge. The results showed the difficulty of establishing EBF among preterm babies until hospital discharge, as well as maintaining it at home.	It is necessary to implement actions that promote the early initiation and maintenance of exclusive breastfeeding in premature infants.

A[4] - Exclusive breastfeeding in preterm infants from Baby-Friendly hospitals: a comparative study [10]	To compare the prevalence of exclusive breastfeeding (EBF) and to verify the factors associated with its interruption in preterm infants admitted to Baby-Friendly hospitals.	Comparative study.	The prevalence of EBF was 29.2% at the University Hospital and 15.3% at the Philanthropic Hospital. At hospital discharge, the clinical characteristics of the babies were predominant in the associations. After 15 days, there was a greater association with the sociodemographic characteristics of the parents.	The prevalence of EBF, which was low at the time of hospital discharge in both hospitals, reduced after discharge, reinforcing that other strategies are needed, in addition to those provided for in Baby-Friendly hospitals, for the promotion and support of EBF in premature infants.
A[5] - Breastfeeding in premature infants discharged from child-friendly hospitals in southeastern Brazil [11]	To describe the prevalence of exclusive breastfeeding (EBF) and associated factors at hospital discharge, in the first month after discharge and at six months, of preterm infants assisted at two Amigos da Criança hospitals in southeastern Brazil.	Descriptive and prospective study.	It was observed that 31% were on exclusive breastfeeding at discharge and in the first month at home, and 9.1% at six months. Exclusive breastfeeding rates in preterm infants are below recommendations, requiring special intervention programs.	It was concluded that EBF rates in preterm infants from the analyzed hospitals, at discharge, in the first month after discharge and at six months of life, are below national and international recommendations. In addition, the results showed that some factors may be associated with the prevalence of EBF in preterm infants.
A[6] - The breastfeeding process of the preterm baby: perspective of maternal records in the “baby diary” [12]	To describe the factors involved in the breastfeeding process of a preterm baby hospitalized in a Neonatal Unit recorded in a “Baby Diary” filled in by the mother.	Descriptive, prospective and longitudinal research.	The success of breastfeeding a preterm baby in the Neonatal Unit depends on several associated factors and remains a challenge for mothers, health professionals and families. Incentive strategies, such as the “Baby's Diary”, proved to be adequate for the maintenance and intervention of nursing in care practice.	It was possible to perceive that the success of breastfeeding a preterm baby depends on several factors, being a challenge for mothers, for health professionals and for the family. Incentive strategies are very important for the success of the process, as in the case of the baby diary, which proved to be adequate for the maintenance and nursing intervention in care practice

A[7] - Support network for breastfeeding in late prematurity [13]	To analyze the support network of mothers of late preterm infants for breastfeeding	Exploratory-descriptive study, with a qualitative approach, supported by the theoretical and methodological framework of the Support Network.	Support networks were small and fragile, and the support received focused on household chores and care for premature babies, with the exception of breastfeeding. In addition, professional support for breastfeeding was also fragile.	It is necessary to include the women's support network in their care and home monitoring so that the infants have the necessary help for the success of breastfeeding.
A[8] - Self-efficacy in breastfeeding among mothers of premature babies [14]	To assess self-efficacy in breastfeeding among premature mothers and babies.	Descriptive, cross-sectional study with a quantitative approach.	All mothers showed self-efficacy in breastfeeding.	The importance of nurses in acting throughout the pregnancy-puerperal cycle is perceived in order to maintain maternal trust, as well as focus on aspects that may interfere with it.
A[9] - Knowledge about the benefits of breastfeeding and disadvantages of the pacifier related to the practice of mothers when dealing with preterm newborns [15]	To assess the knowledge and expectations of mothers of preterm newborns admitted to a neonatal intensive care unit about breastfeeding and pacifier use.	Descriptive, observational study with a qualitative approach.	The participants' expectations regarding breastfeeding were positive, as they reported benefits for both mother and baby, but had difficulties in maintaining exclusive breastfeeding, introducing the bottle, which was already acquired by most of them before birth. The mothers showed knowledge about breastfeeding and the harm of using a pacifier, but they changed their opinion when dealing with the baby in practice.	The mothers demonstrated previous knowledge about the benefits of breastfeeding and the disadvantages of the pacifier, but they changed their opinion when dealing with the baby in practice.
A[10] - Relationship between the duration of the kangaroo position and mother-preterm child interaction at hospital discharge [16]	To analyze the influence of Kangaroo Position duration on the initial interactions of the mother-preterm child dyad	Observational study.	The longer the time in Kangaroo Position, the more newborns made attempts at physical contact with their mothers during breastfeeding; and the longer the time in Kangaroo Position, the less mothers	The Kangaroo position favored contact, the preterm newborn has the ability to go beyond feeding and have the moment of breastfeeding as an opportunity to carry out initial exchanges with the mother.

			talked with their children.	
A[11] - Factors associated with the development of skin allergies in premature infants in the first year of life [17]	To identify factors associated with the development of skin allergies in the first year of life in moderate and late preterm infants.	Sectional research.	The prevalence of skin allergy, in the perception of caregivers, among late and moderate preterm infants was 16%. It is a more intense characteristic in those who present respiratory and gastrointestinal clinical manifestations, whether conditioning or cause-effect. Breastfeeding proved to be a protective factor in the 1st year of life.	Breastfeeding proved to be a protective factor in the 1st year of life against skin allergies.
A[12] - Oral dysfunction and feeding difficulties during complementary feeding in preterm children [18]	To investigate the association between oral motor dysfunction and feeding difficulties during the process of introducing complementary feeding in preterm children.	Cross-sectional, observational and quantitative study.	Complementary feeding was introduced in the sixth month of corrected gestational age by almost half of the mothers, and most reported some type of difficulty in this introduction. Extreme prematurity revealed an association with defensive eating behavior. No significant association was found between oral motor dysfunction and feeding difficulties.	No significant association was found between motor and oral dysfunction and feeding difficulties.

A[13] - Electrolyte and mineral composition of milk from term infants, pre and post pasteurization and raw milk from mothers of preterm newborns [19]	To determine and compare the concentrations of electrolytes and minerals in human milk in three groups: samples analyzed before and after pasteurization of lactating term donors and a sample of raw milk collected at the bedside of mothers of preterm newborns.	Descriptive and cross-sectional study.	A significant reduction in Ca, P and K contents was observed after pasteurization. Raw milk samples collected at the bedside had statistically higher levels of Na than term donor milk, Ca and P only reached the recommended intake if breast milk was offered in a volume of 60 ml every 3 hours. Mg concentrations did not differ between groups.	There was a significant reduction of Ca, P and K in the post-pasteurization samples and the Na values in raw milk collected at the bedside were higher than those pre-pasteurization.

Table.02 Identification of articles, year of publication, state, journal, impact factor and Qualis CAPES

ID	YEAR	STATE	JOURNAL	ImpactFactor	Qualis CAPES
A[1]	2019	RS	Revista Gaúcha de Enfermagem	0,638	B1
A[2]	2018	RJ	Ciências & Saúde Coletiva	1,336	A3
A[3]	2018	SP	Revista Brasileira de Enfermagem	0,705	A2
A[4]	2017	RJ	Online Brazilian Journal of Nursing	0,133	B1
A[5]	2018	GO RJ/SP	Revista Eletrônica de Enfermagem	•	B1
A[6]	2020	PR	Semina: Ciências Biológicas e da Saúde	1,71	B3
A[7]	2020	PR	Ciência, Cuidado e Saúde	•	B2
A[8]	2021	RJ	Revista de Pesquisa Cuidado é Fundamental Online	•	B2
A[9]	2017	SP	Revista Paulista de Pediatria	0,784	B3
A[10]	2017	SP	Revista Paulista de Pediatria	0,784	B3
A[11]	2021	RS	Revista Gaúcha de Enfermagem	0,638	B1
A[12]	2021	BA	CoDAS	0,732	B4

A[13]	2018	SP	Revista Paulista de Pediatria	0,784	B3

Source: Authors, 2022

Of the selected articles, 3 are from 2017, 4 from 2018, 1 were published in 2019, 2 in 2020 and 3 in 2021. As for the state in which the research was published, 4 were in São Paulo (SP), 3 in Rio de Janeiro (RJ), 2 in Paraná (PR), 2 in Rio Grande do Sul (RS), 1 in Bahia (BA) and 1 was published in Goiás (GO), Rio de Janeiro (RJ) and São Paulo (SP). Analyzing by regions, it is possible to see that the achievements and publications of the research used are mainly concentrated in the southeastern region of Brazil, with 53.85%. In the southern region, the percentage is already lower, with 30.77%, and in Bahia, 7.69%.

Furthermore, when analyzing the journals in which the studies were published, as well as the content of the research itself, it can be seen that most of the articles analyzed in this review were written or directed to nursing professionals, a fact that may be related to the intense contact between them and those responsible for preterm babies throughout the period after birth and their respective care. However, this reality reveals that there is a deficiency in the performance and research of the multidisciplinary team in the context of prematurity and breastfeeding, although there is an incentive for all areas to work together, including nutrition.

IV. DISCUSSION

The present review showed that the publications are mainly divided into analyzing the incidence of breastfeeding in preterm babies, listing the factors involved in the breastfeeding process, observing the aspects that contribute to the early interruption of Breastfeeding (BF), examining the success implementation of educational actions on techniques that aim to assist the course of breastfeeding inside and outside the hospital, assess the importance of mothers' knowledge on the subject and explore the importance of instructions and professional monitoring during this period. Articles A[11], A[12] and A[13] have more specific objectives, such as investigating factors associated with the development of skin allergies, oral motor difficulties and their association with breastfeeding and the composition of breast milk of mothers of premature babies.

LIMA et al. [7] in their study, explains that breastfeeding guarantees many benefits to premature babies, promoting a lower incidence of necrotizing enterocolitis, sepsis and retinopathy of prematurity, increased neuropsychomotor performance, strengthening the mother-child bond, decreased hospitalization time and reduction in the occurrence of hospitalizations. However, unfortunately statistics show that breastfeeding starts later and lasts for a shorter period in preterm newborns.

The importance of breastfeeding was described by TEIXEIRA et al. [20] (2022), and is recommended mainly for helping the progression of oral feeding, as it contains immunoprotective and growth substances, which promote gastrointestinal adaptation and maturation, improving dietary tolerance and protecting against infectious and inflammatory diseases. And in his research, he attributed these properties to the greater weight gain observed in the group that was exclusively fed human milk.

In a study carried out in the United Arab Emirates, it was found that the prenatal intention to breastfeed of pregnant women was significantly associated with the initiation of breastfeeding and the duration of exclusive breastfeeding. In addition, support from family and health professionals was significantly associated with initiation of breastfeeding and duration of exclusive breastfeeding. Despite the long-term adoption of WHO recommendations for breastfeeding in the UAE, rates remain suboptimal [21] and these results are similar to the findings of AIRES et al. [22], where it was found that women who have partners tend to be more successful in breastfeeding, compared to single mothers. Education also has an influence on breastfeeding, since women with complete high school and/or higher education are successful in breastfeeding and are more likely to not abandon the lactation process. Regarding gestational age, instruments and a support network are needed to facilitate the process of breastfeeding in preterm newborns during their time in the hospital.

According to CHAVES et al. [14] maternal self-efficacy, which is related to obtaining maternal confidence about the mechanisms and important information for natural breastfeeding to occur, is a relevant factor to be able to maintain exclusive breastfeeding until the baby's sixth month and then complementary breastfeeding. Thus, MINOSSO et al. [23] reiterates the benefits of guidelines for pregnant women in prenatal care, combined mainly with the continuity of this support by the multidisciplinary team in the maternity ward, especially in the interaction of the mother with the baby, reasons that minimize the difficulties of this process, and avoid abandonment. of breastfeeding, in view of the maternal concerns with the

correct latch, postpartum recovery and the support network. CHAVES et al. [14] highlights that the early separation between the mother and the newborn baby, due to hospitalization, represents a great challenge to establish the affective bond between the two, a factor that is essential and responsible for breastfeeding to occur and maintain it.

According to SILVA and BRAGA [24] the environment in the maternity hospital should favor exchanges between the newborn and the mother, the bond established between the two is linked to the development of the baby's emotional behavior, which encompasses the link between feelings emotional and behavioral. The skills that allow interaction and later attachment are what favors the child's physical and psycho-affective development in a healthy way NUNES et al. [16] identified in their study, intended for the kangaroo position in preterm newborns, that the baby presented greater demand and physical contact with the mother when submitted to a longer time in the kangaroo position, in addition, the first exchanges favor aspects of important interactions between mother and child during breastfeeding.

Studies show that there is a lack of essential information for the initiation of breastfeeding among mothers, and thus, strategies for disseminating knowledge about breastfeeding by health professionals in prenatal care, monitoring during hospitalization and after hospital discharge are necessary. , in particular, it is essential to support early breastfeeding, even during hospitalization, in which the multidisciplinary team is essential in this process, to obtain more studies that point out strategies to promote breastfeeding and the encouragement by the services of health in the construction of an environment that highlights the need for breastfeeding and contact between mother and baby [14, 23, 14].

V. CONCLUSION

Research reveals that a breastfeeding premature infant is essential to ensure the healthy development of the child. In this context, aspects that influence breastfeeding and its continuation in the post-discharge period were attested. The separation between the mother and the preterm newborn resulting from early hospitalization is a major challenge for the establishment of breastfeeding, which tends to start later and have a shorter duration. The intention to breastfeed, support from family and health professionals, the presence of a partner and education are also factors that influence the exercise of breastfeeding.

The importance of guidelines regarding BF from prenatal care and the help of the multidisciplinary team was highlighted, which collaborate for the continuity of breastfeeding after hospitalization by encouraging the experience, restoring and strengthening the mother-baby relationship. In this sense, the maternity environment should favor exchanges between the newborn and the mother, in order to reestablish the bond between them, guaranteeing the practice beyond the hospital. In addition, knowledge on the subject generates self-efficacy in infants, a factor that is also very important for ensuring the practice of breastfeeding.

It is believed that the role of health professionals in this scenario is of paramount importance, providing help, knowledge and support to families. There is a need for research, especially in the area of nutrition, that enrich the exercise of the profession and collaborate with teamwork, aiming at encouraging, protecting and supporting breastfeeding in prematurity.

REFERENCES

[1] PAHO - Pan American Health Organization. PAHO highlights the importance of the participation of the whole society in the promotion of breastfeeding, in the launch of a campaign in Brazil. Brasília, 2021. Available at: https://www.paho.org/pt/noticias/29-7-2021-opas-destaca-importancia-participacao-toda-sociedade-na-promocao-do-aleitamento Access on: 09 sea. 2022.

[2] FEDERAL GOVERNMENT (Brazil). Civil House. Breast milk: breastfeeding rates grow in Brazil. [S. l.], 6 Aug. 2020. Available at: https://www.gov.br/casacivil/pt-br/assuntos/noticias/2020/agosto/leite-materno-indices-de-amamentacao-crescem-no-brasil. Access on: 10 Mar. 2022.Accessed on: 10 Mar. 2022.

[3] LEVY, Bel. In: OSWALDO CRUZ FOUNDATION (Rio de Janeiro). Research reveals unprecedented data on breastfeeding in Brazil. Rio de Janeiro, 10 Nov. 2021. Available at: https://portal.fiocruz.br/noticia/pesquisa-revela-dados-ineditos-sobre-amamentacao-no-brasil.

[4] BRAZILIAN SOCIETY OF PEDIATRICS (Brazil). Breastfeeding benefits both the baby and the mother. Goiania, GO, 28 Aug. 2018. Available at: https://www.sbp.com.br/filiada/goias/noticias/noticia/nid/amamentacao-traz-beneficios-para-o-bebe-e-a-mae/ . Access on: 10 Mar. 2022

[5] FIRST CHILDHOOD NATIONAL NETWORK (Brazil). Breastfeeding a premature baby is possible and needs to be encouraged: The NGO Prematuridade.com emphasizes the importance of the availability of health professionals in encouraging premature breastfeeding. [S. l.], 30 Jul. 2019. Available at: http://primeirainfancia.org.br/amamentacao-do-bebe-prematuro-e-possible-e-precisa-ser-incentivada/ .Access on: 10 Mar. 2022.

[6] SOUZA, Marcela Tavares; SILVA, Michelly Dias; CARVALHO, Rachel. Integrative review: what it is and how to do it. Integrative review: what is it? How to do it?, [s. l.], 2009. Available at: https://www.scielo.br/j/eins/a/ZQTBkVJZqcWrTT34cXLjtBx/?format=pdf&lang=pt. Access on: 09 Mar. 2022

[7] Lima, A.P.E; Castro, T.C.; Leal, L.P; Javorski, M.; Sette, G.C.S; Scochi, C.G.S.; de Vasconcelos, M. G. L. Exclusive breastfeeding of premature infants and reasons for its interruption in the first month after hospital discharge / Exclusive breastfeeding of premature infants and reasons for its interruption in the first month after hospital discharge / Exclusive breastfeeding of premature infants and reasons for discontinuation in the first month after hospital discharge. Rev. gaúchsick ; 40: e20180406, 2019. tab, graf Article in Portuguese | LILACS, BDENF - Nursing | ID: biblio-1043014

[8] Méio, Maria Dalva Barbosa Baker et al. Amamentação em lactentes nascidos pré-termo após alta hospitalar: acompanhamento durante o primeiro ano de vida. Ciência & Saúde Coletiva [online]. 2018, v. 23, n. 7 [Acessado 12 Maio 2022] , pp. 2403-2412. Disponível em: <https://doi.org/10.1590/1413-81232018237.15742016>. ISSN 1678-4561. https://doi.org/10.1590/1413-81232018237.15742016.

[9] LUZ, Lucyana Silva et al. Predictive factors of interruption of exclusive breastfeeding in preterm infants: prospective cohort. Brazilian Journal of Nursing, v. 71, p. 2876-2882, 2018.

[10] Monteiro, A. T. A., Rossetto, E. G., Pereira, K. O.,Lakoski, M. C., Birolim, M. M., &Scochi, C. G. S. (2018). Aleitamento materno exclusivo em prematuros de hospitais Amigo da Criança: estudo comparativo. *OBJN - Online Brazilian Journal of Nursing*, *16*(3), 319-330. doi:10.17665/1676-4285.20175627

[11] Balaminut, T., Sousa, M. I. de, Gomes, A. L. M., Christoffel, M. M., Leite, A. M., &Scochi, C. G. S. (2018). Aleitamento materno em prematuros egressos de hospitais amigos da criança do Sudeste. *Revista Eletrônica De Enfermagem*, *20*. https://doi.org/10.5216/ree.v20.50963

[12] Aires, Luana Cláudia dos Passos; Galhardo, Viviane Godoy; Pegoraro, Leila Garcia de Oliveira; Schultz, Lidiane Ferreira; Rossetto, Edilaine Giovanni; Zani, Adriana Valongo; Souza, Sarah Nancy DeggauHegeto de. **Seminacienc. biol. saude** *; 41(2): 217-228, jun./dez. 2020. Ilus, Tab.* DOI: 10.5433/1679-0367.2020v41n2p217

[13] Tronco, C. S., Bonilha, A. L. de L., & Teles, J. M. (2020). Rede de apoio para o aleitamento materno na prematuridade tardia. *Ciência, Cuidado E Saúde*, *19*. https://doi.org/10.4025/ciencuidsaude.v19i0.46479

[14] CHAVES, Anne Fayma Lopes et al. Self-efficacy in breast-feeding between mothers of premature babies Research Journal Care is Fundamental Online, v. 13, p. 262-267, 2021.

[15] Dadalto, Elâine Cristina Vargas e Rosa, EdineteMariaCONHECIMENTOS SOBRE BENEFÍCIOS DO ALEITAMENTO MATERNO E DESVANTAGENS DA CHUPETA RELACIONADOS À PRÁTICA DAS MÃES AO LIDAR COM RECÉM-NASCIDOS PRÉ-TERMO. Revista Paulista de Pediatria [online]. 2017, v. 35, n. 04 [Acessado 12 Maio 2022] , pp. 399-406. Disponível em: <https://doi.org/10.1590/1984-0462/;2017;35;4;00005>. Epub 21 Set 2017. ISSN 1984-0462. https://doi.org/10.1590/1984-0462/;2017;35;4;00005.

[16] NUNES, Cynthia Ribeiro do Nascimento et al. Relationship between the duration of the kangaroo position and mother-preterm child interaction at hospital discharge. Paulista Journal of Pediatrics, v. 35, p. 136-143, 2017.

[17] Jantsch, Leonardo Bigolin et al. Factors associated with the development of skin allergies in premature newborns in the first year of life. Revista Gaúcha de Enfermagem [online]. 2021, v. 42 [Acessado 12 Maio 2022] , e20200261. Disponível em: <https://doi.org/10.1590/1983-1447.2021.20200261>. Epub 16 Jul 2021. ISSN 1983-1447. https://doi.org/10.1590/1983-1447.2021.20200261.

[18] Steinberg, Carla, Menezes, Larissa e Nóbrega, Ana CalineDisfunção motora oral e dificuldade alimentar durante a alimentação complementar em crianças nascidas pré-termo. CoDAS [online]. 2021, v. 33, n. 1 [Acessado 12 Maio 2022] , e20190070. Disponível em: <https://doi.org/10.1590/2317-1782/20202019169>. Epub10 Maio 2021. ISSN 2317-1782. https://doi.org/10.1590/2317-1782/20202019169.

[19] Codo, Carla Regina Bianchi et al. COMPOSIÇÃO ELETROLÍTICA E MINERAL DO LEITE DE LACTANTES A TERMO PRÉ E PÓS-PASTEURIZAÇÃO E DE LEITE CRU DE MÃES DE RECÉM-NASCIDOS PRÉ-TERMO. Revista Paulista de Pediatria [online]. 2018, v. 36, n. 02 [Acessado 12 Maio 2022] , pp. 141-147. Disponível em: <https://doi.org/10.1590/1984-0462/;2018;36;2;00015>. Epub 19 Fev 2018. ISSN 1984-0462. https://doi.org/10.1590/1984-0462/;2018;36;2;00015.

[20] Teixeira, L.R.M; Araujo, T.P.de; Moreira, R. A. de M; Pereira, R.J.Rev. Science Avg. Biol. (Impr.) 20(4): 543-550, Feb 11, 2022.

[21] Taha, Z.; Garemo, M.; El Ktaibi, F.; Nanda, J. Breastfeeding practices in the UAE: antenatal intentions and postnatal outcomes. Nutrients 2022, 14, 806. https://doi.org/10.3390/nu14040806

[22] AIRES, L.C.P; Galhardo, V.G; PEGORARO, L.G.O; Schultz, L.F; ROSSETTO, E.G.; ZANI, A.V; SOUZA, S.N.D.H.de. The preterm breastfeeding process: perspective of maternal records in "baby diary" / The pre-term breastfeeding process: perspective of maternal records in "baby diary." Seminacienc.biol. saude ; 41(2): 217-228, Jun./Dec. 2020. Ilus, Tab Article in Portuguese | LILACS | ID: biblio-1224432

[23] MINOSSO, Kamila Caroline et al. Validation for Portuguese of the breastfeeding knowledge scale. Paulista NursingAct, v. 33, 2020.

[24] SILVA, Brenda Albuquerque Adriano da; BRAGA, Liliane Pereira. Factors promoting the mother-infant bond in the immediate hospital puerperium: an integrative review. Rev. SBPH, São Paulo, v. 22, no. 1, p. 258-279, Jun. 2019

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.35

Hydrological Risk Mitigation from Natural Hazards in Ojirami Dam Edo State Nigeria

Jonathan Abulime[1], Ikri Samuel Obokparo[2]

[1]Department of Civil Engineering, Benson Idahosa University, Benin City, Edo State, Nigeria.
jabulime@gmail.com
[2]Institution of Civil Engineers, London, United Kingdom.
sikri@biu.edu.ng

Received: 19 Apr 2022,

Received in revised form: 11 May 2022,

Accepted: 18 May 2022,

Available online: 31 May 2022

***Keywords*— Reservoir, Catchment area, Spillway, Dam, Return period, Precipitation**

***Abstract*—** *The objective of this paper works is to analyze the rainfall and runoff discharge of the Ojirami dam area, and effective modeling and simulation of hydraulic parameters in water distribution network and design of hydraulic structure (Reservoir water tank). The engineering tools used in this research work are EPANET PROGRAM, AUTOCAD, GOOGLE EARTH and GIS for portable pipe born-water supply, regarding to the relief of the inhabitants towards mitigation of risk from natural hazard, by protecting lives and properties against diseases: such as cholera and dysentery. During investigation and modeling the water network, the following climatic elements are defined: monthly and annual rainfall, maximum wind velocity for prevailing direction, free water surface evaporation, air temperature, relative humidity and sediment transportation. The capacity of the reservoir of the Ojirami dam is equal to 5 Mcm (5 X 10^6) the dam height of 7m and is located within Akuku community boundaries, Akoko-Edo Local Government Area, Edo-State. The area has a moderate slope around the dam too steep in higher parts of the dam. Due to proper researched on the internet and other information collected from Edo state water board and relevant statistics data from census of Nigeria. The dam was constructed across Onyami river the output capacity of the reservoir is about 473m^3 per/hr. The construction dam is used as a source to supply water to the water distribution network. Google earth was used to generate toposheet of Akoko-Edo Local Government boundary, while Geographic information system was used to create Nigeria local government map and boundaries, due to local government shapefile data of Nigeria. Epanet program was used to digitalized the water network, whichis based on census data and to estimate water demand. The Epanet tracks the flow of water in each pipe, the pressure at each node, the height of water in the tanks, and the concentration. The preliminary modeling of the (WDN) concluded that the water distribution network is sufficient to supplied water to communities. The water quality and the cost of modeling the water distribution network (pipe network) were estimated.*

I. INTRODUCTION

The atmospheric part of the circle when the moisture of the atmosphere return to the ground as precipitation. Important engineering problems arise from the variability of precipitation in space and time. They include securing the water supply conveyance for humans, agriculture and industrial needs, providing storm water supply from drainages due to floods ranging in magnitude from minor over bank flows to the largest floods and that in which nature can produce.

In study of hydrology of catchment does not limit to geological nature of specific importance in the determination of maximum rainfall which is critical for hydraulic structural design. Furthermore, the determination of the appropriate reservoir pattern of precipitation, seepage and evaporation. Thus, the acquisition essential for such forecast and design purpose. The basis of hydrological forecasting is the representation of basin processes and the movement of water both through and over the land surface which also represent the aquifer processes such as forecasting can lead to improved water management, including flood and drought prediction or water demand supply. The chorological graphical representation of stage or discharge is often used to portray the behavior of the river during normal weather conditions, flood or droughts.

It is an unfortunate trait of human nature that all professions like to hesitate to advert their failure. Notable successes are broadcast for the world to hear, but the failures are spoken of only in muffled tone. Professionals pride and ethics are the principal reason for this situation. It is nevertheless true that a full knowledge of the failures and their causes provides some of the most valuable information that can possibly serve to guide the engineer or other practitioner.

Most history of hydrology examples of hydrologic failure was as result of faculty understanding of the principle of hydrology failures which include the failure of dams resulting from inadequate spillway capacity, causing overtopping and erosion of embankment, the economic failure of water-power development, storage reservoirs, water supply system etc

A dam is a hydraulic structure of impervious material built across a river to create a reservoir on its upstream side for impounding water for various purposes. These purposes may be irrigation, Hydro- power, water supply navigation. Dam may be built to meet the one of the above, purpose or they may be constructed for fulfilling more than one purpose and as such it can be classified as single or multipurposedam.

A spillway is structures constructed near the dam site to dispose of surplus water from the reservoir to the channel downstream. Spillway is provided for all dams as safety measures against overtopping and the consequent damages and failures. A spillway act as a safety value for the dam, because as soon as the water level in reservoir rises above a predetermined level, excess water is discharged safely to the downstream channel and the dam is not damaged. The spillway must have adequate discharge capacity to pass the maximum flood downstream without causing any damage to the dam or its appurtenant structures. At the same time the reservoir level should not rise above the maximum water level (M. W. L)

A spillway of inadequate capacity may lead to the overtopping of the dam which may cause serious damages and even the failure of the dam. On the other hand, a spillway of much larger capacity than therequired would be an uneconomical design. In addition to provide adequate discharge capacity, the spillway must be hydro dynamically and structurally safe. The spillway surface should be erosion resistance to withstand the high velocities created by the fall of water from the reservoir surface to the tail water. Moreover, the spillway should be located so that the spillway discharge will not undermine the downstream toe of the dam. Generally, some energy dissipating device such as hydraulic jump is providedat the toe for the dissipation of excess energy.

A spillway may be located either in the middle of the dam or at the end of the dam near the abutment. In some cases, the spillway is located away from the dam as an independent structure. If there is a suitable saddle, such a spillway is called a saddle spillway. Generally, a saddle spillway is designed as an auxiliary or an emergency spillway, which is an addition to the main spillway at the dam site.A major portion of the storage volume in the reservoir on the upstream of a dam is below the spillway crest level. Dam outlets are provided in the body of dam or its abutment below the crest level of the spillway so that the water can be withdrawn from the reservoir. Sluiceways are special type of outlets provided in the body of a concrete (or masonry) dam.

Outlet are required for releasing the impounded water as at when needed for various purposes such as hydro-power, irrigation, municipal water supply and pollution control on the downstream. Outlets are also used for diverting water into canals or pipelines. Sometime outlet is design to pass a part of the design flood to the downstream, as a supplement to the spillway. The water released by an outlet may be also used for a combination of multipurpose requirements. An outlets work may also act as a flood control regulator for releasing water stored temporally in the space reserved for flood control or to evacuate storage space in anticipation of high floods. The

outlets may also be used to empty the reservoir up to the crest level to permit inspection to make needed repairs or to maintain the upstream face of the dam or other structures. Outlets are usually provided with gates and valves for controlling the outflow. These gates and valves may be used for regulating the outflow or for completely closing the outflow depending upon their location and design.

An outlet is a closed conduit formed in the body of the dam, it may also be in the form of pipe or tunnel that passes through the hill side at one end of the dam. The function of an outlet is to discharge the stores water into the channel downstream, for a concrete (or a masonry) dam, the outlets pass through the body of the dam, and they are called sluiceways.

For the earth and rock fill dams, the outlet is generally placed outside the limits of the dam. However, the small earth dams sometimes the outlets conduits are permitted to pass through the body of the dam. Generally, there are more than one outlet in a dam. If the outlets discharge varies considerably, it is always better to provide several small outlets than one larger outlet

II. EXPERIMENTAL WORK/METHODOLOGY

2.1 CATCHMENT AREA

The catchment area controlled by the dam is about 600km^2 the towns located in the dam area are Ojirami patesi, Ojirami Afekunu, Dagbala, Uneme – ose, Eturu, Akuku, Enwan, Igara, Okpe, Ikao, Ugboshi.

2.2 GEOLOGY OF THE AREA

The service area lies on the basement complex, the broken edge of a widely extending high rocky plateau that dominate the region. The local crystalline rocky of the basement complex consist of granites, gneisses and schist's comprising derivatives such as grandiose, variably magmatised biotite, quartz biotite, hornblende granites and granite ferrous biotitic genesis. The rock is practically impermeable, and aquifer are defined as cleaved jointed and fractured, the decomposed crystalline loose angular sands, clay and lateral horizon on the surface. This loose mantle normally contains some shallow groundwater mainly along intermittent river course where some local hand dug well has been located.

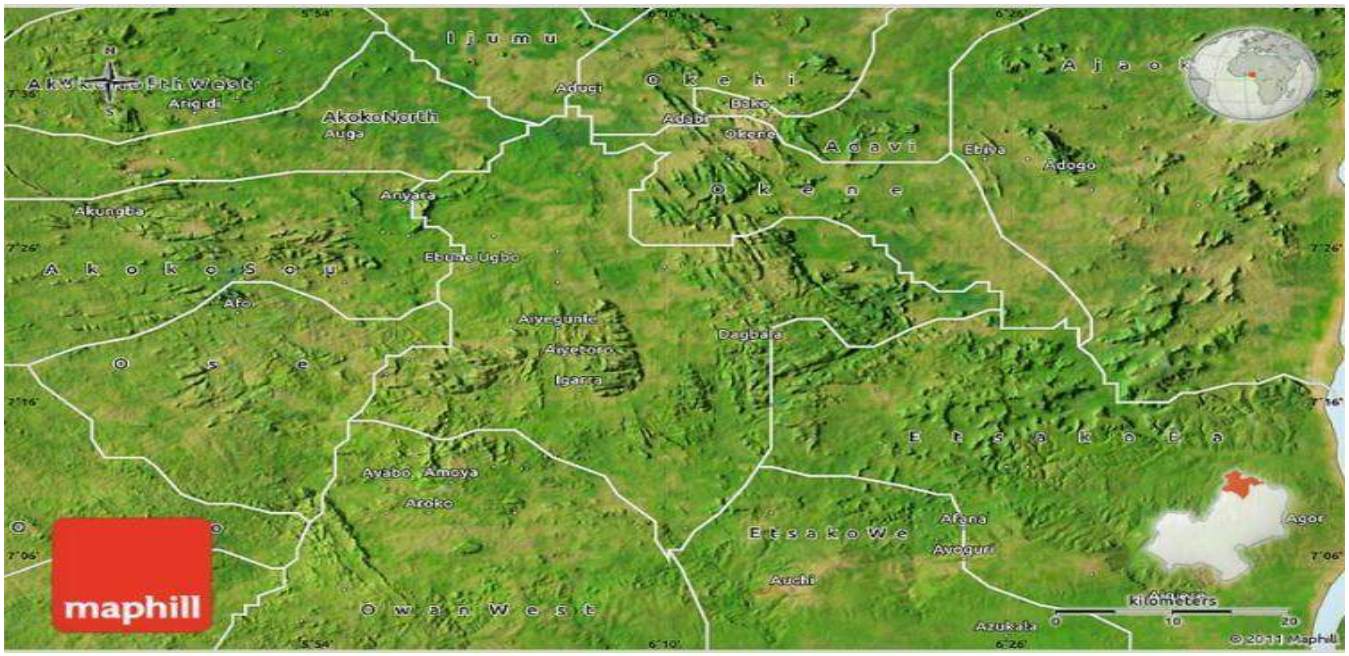


Fig.1: Physically illustrates the natural geographic features of Akoko-Edo terrain, such as themountain and valley

2.3 DAM Description

The dam is an earth fill structure of about 200m long 7m high at its highest section. The earth embankment has a crest elevation of 78 and the upstream face has a slope of about 2.5 to 2.8. the upstream was design to be mostly grassed. The dam is provided with services spillway which are supported with abutment on both sides.

The spillway is made of concrete with a gate made of metal (iron) two set of outlet pipes were installed below for the release of water from the reservoir to the head works, weir and intakes. These outlets are open during period of flow when insufficient water is discharged over the spillway. All pipes are made of PVC of 400mm diameter and thickness of 4mm.

Fig.2: Image of the Ojirami dam

source of water distribution to the network

2.4 RESERVOIR CAPACITY:

The capacity of the reservoir impounded in the dam is approximately, but during my research I found out the present capacity is now 5Mcm.

2.5 USE OF RUNOFF COEFFICIENT

Most analytical procedures of estimating runoff involve the use of a coefficient of runoff, which takes cognizance of the drainage area. The volume of runoff could be estimated using an equationof the form.

Q = KP

Where

Q = runoff or discharge

P = rainfall

K = coefficient whose value depends on the surface of the drainage of the area

2.6 RATIONAL METHOD

This method is used in evaluating peak runoff rate, a vital parameter in the design of hydraulic structures. If rain fall on an impervious surface at a constant rate, the intensity of the resulting runoff would eventually be equal to the rate of rainfall. At the beginning only a portion of the rainwater gets to the outlet but after a period water will start arriving at the outlet from the entire area, when the runoff rate becomes equal to the rate of rainfall. The time required to attain this equilibrium state is referred to as time of concentration (TC). For small impervious area we may assume that if rainfalls continuously at a uniform rate for a period at least to the time of concentration, the peak runoff will be equal to the rate of rainfall. This forms the basin of the rational formula and which may be expressed as;

Qmax = c . I (tc) . A

Where:

Q = Max is the peak flow C = Is a runoff coefficient A = Is the catchment area

I(tc) = Is the intensity of rainfall of duration equal to the tc (as in the IDF curve)

2.7 TIME OF CONCENTRATION (TC)

It is defined as the time needed for water to flow from the most remote point in a watershed to thewatershed outlet. It is also the time necessary for watershed to entirely contribute to the surface flow. The time of concentration depends on topography, land use and geomorphology.

2.8 RECURRENCE INTERVAL OR RETURN PERIODS

Return period (or recurrence interval), Tr is the average time that elapse between two event that equal or exceed a specified level. In other word an "N" year flood is that flood which can be expected to be equaled or exceed on the average once every "N" year. An estimate of its recurrence interval overturns.

Period Tr is given by the Hazen's formula Tr = 2n/2m1

But the most widely used is the Gumbel formula

P = m/n + 1 or Tr = n + 1/m

III. DATA ANALYSIS AND DISCUSSION OF RESULTS

3.1 SEDIMENT TRANSPORT IN ONYAMI RIVER AT OJIRAMI RESERVIOR

The Ojirami reservoir basin has small capacity (5 MCM) and the Onyami river having large inflow (174 MCM), the capacity inflow ratio is low corresponding trap efficiency is also small, Morgan (1986). Most of the inflow is quickly discharged to downstream and the suspended sediment are not able to settle fully.

In general, the greater the capacity inflow ratio, the greater is the trap efficiency. In other words, the sedimentationrate is higher in relatively larger reservoirs. (Abubakar and Sagar, 2013) and (Creaco Enrico,2019)

3.2 STUDY AREA DESCRIPTION

The Akoko-Edo Local Government Area lies between latitudes $7^0 5^{'}59^{''}$ and $7^0 35^{'}24^{''}$N and longitudes $5^0 55^{'}12^{''}$E and $6^0 25^{'}47^{''}$E. It headquarters is at Igarra, approximately 160km from the stste capital. The population as captured by the 2006 population census is 261,567. The total land area is about 1371 km^2 with a population density of three people per square kilometer. The area is made of (fourth) 40 villages which is accessible by major and minor roads, main paths and footpaths which link the villages and towns together.

The area has undulating landscape with highland consisting of granite outcrops east of the area. The study area is characterized by the wet-dry tropical climate (Koppen climate type Am), with two districts season the rainy season (April-October**)** and the dry season (November-March). The average annual rainfall is between 1000 and 1500 mm with temperature as high as 37.7^0 being recorded in the region. The vegetation belt that is most prominent in the study area is the Guinea Savannah which is made up of sparsely distributed tress, herbs, shrubs and grasses,

The major agricultural products in the aera are yams, cassava, plantain, maize, cocoyam, livestock and cash crops such as cocoa, cashew, kolanut, oil palm and coffee. Akoko Edo is very rich in mineral resources. Some of the mineral resources available in Akoko- Edo include Marble in Ikpeshi, Gold in Atte, Dagbala and Ososo, previous stones in Ibillo, Granite in Ikpeshi and Gravel in Igarra

(Ogbeide et al. 2003)

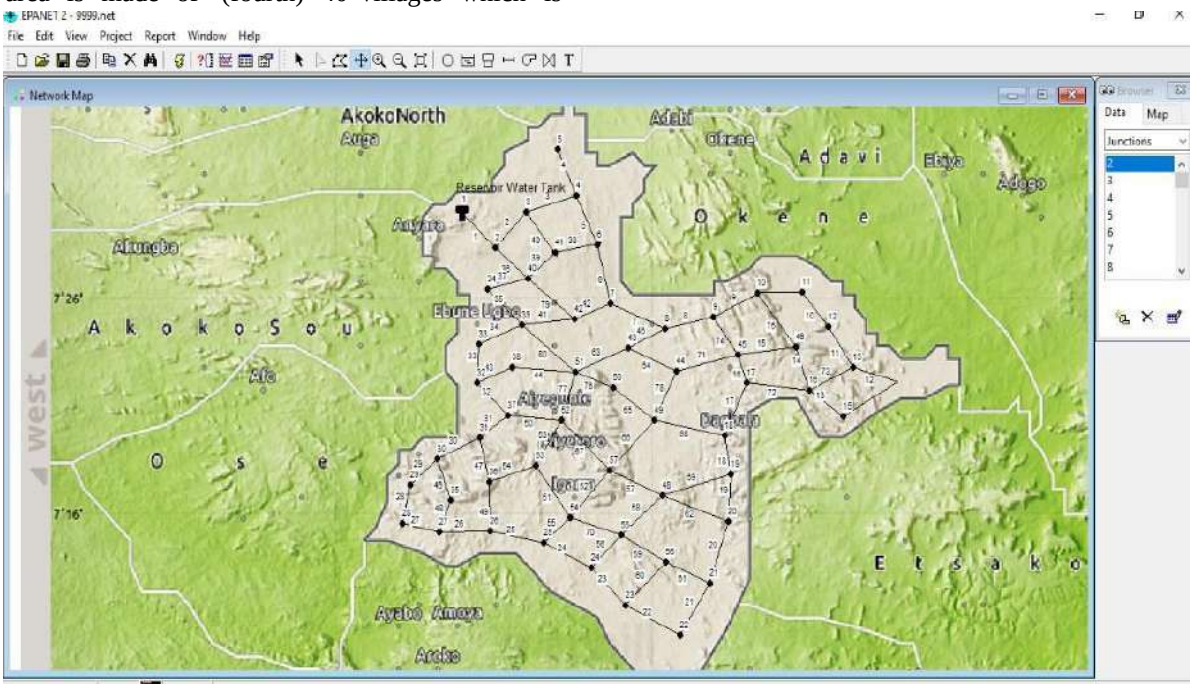


Fig.3: The digitization of the network with Epanet program

3.3 The Schematization of Akoko Edo Distribution Network System (WDN)

The layout of the schematization of the water distribution network due to rule of thumb, in satellite map shown the land surface as it really looked. Based on image taking from the earth orbit.

After the schematization of the network with epanet platform, the next step was to assign network parameters. The parameters include the pipe length, diameter and roughness, coefficient, node and links ID **(Hazen Williams Equation by the Epanet).** These are basic network parameter on which future.

3.3 Water Quality Analysis

The transport of decayed of chlorine was specified in the network due to the manual guide. The bulk coefficient was specified with **-1.0**, the bulk coefficient is what happened in the center of the pipesnear the wall. And the wall coefficient was also specified with **1.0** due to water reaction with the impurities of pipes parameter.

simulation will be based depending on the flow to being simulated. The pipe network is made of asbestoscement pipes varies of different length from (600m, 500m and 400m)

In accordance with the best practice in pipeline analysis, the Hazen Williams friction factor from asbestos cement pipe is 130 (**http://www.primepump.com.au/index**)

3.4 Reaction Report of Water Distribution Network

Since only specified the decayed of the bulk flow, that is where most of the decay is coming from whereby 0.06% is coming from the tank, shown in figure 3

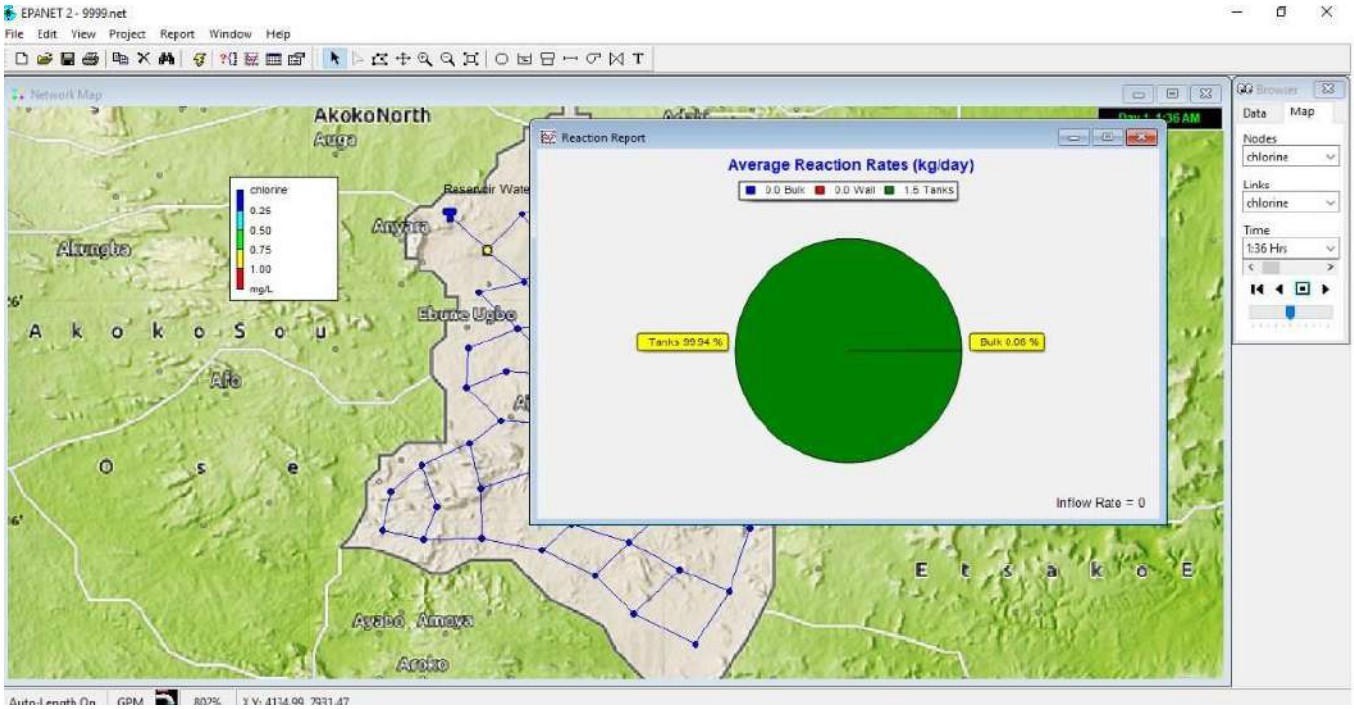


Fig.4: The reaction of bulk flow in water distribution network

3.6 EPANET Analysis of The Network with The Operation Of Water Proposed Tank

The total height of the water tank is 23m, Epanet was used to evaluate the scenario in which the height is elevated and the advantage, is that it increases the pressure head demand at each node. In real world how the installation of elevated water tank and laying of water pipe network is carry out on site is represented in pictures at the end of the result report analysis. (Creaco Enrico, 2019)

3.7 Nodal Head Result under Current Demand

After a proper investigation both on the internet and hydrology and hydraulic textbooks regarding to pressure (psi) in fluid pipes. if the water must move a couple of meters per second, which determine the pressure needed. the longer the pipe the more the energy lost and the greater the pressure drop.

In respect of the akoko-edo schematization water distribution network (wdn), which is designed for both industrial and residential purpose. which include 400,000 inhabitants with 4 stories building and 12meters in height and density area of about 237.8/km^2 with topography area of different elevation and with a pipe length of (600, 500, 400) meters which is little bit longer. since the network has a large density area and different surface elevation and longer pipes installation, thorough investigation shown that the (wdn) need a pressure (psi) of about 60 – 300 for both industrial and residential purposes.

With this pressure of flow in the pipe will enable the network to supply sufficient water to the public and supply water to the upper flood of the building. epanet program was used to digitize the akoko- edo water distribution network with a pressure (psi) ranging from

67 – 236 with shown that the (wdn) is generally good having the capacity to supply water to the public.

The main reason to control the pressure in fluid pipe, if the pressure is too high may damage the pipes and appliances. and if is too low (wdn) cannot supply sufficient water to the public. for the network to be on the safer side it was decided to installed the pressure regulatory device which helps to regulate the pressure (psi) in the fluid pipe. the result of the pressure (psi) is shown below in a tabular form with theepanet program**.**

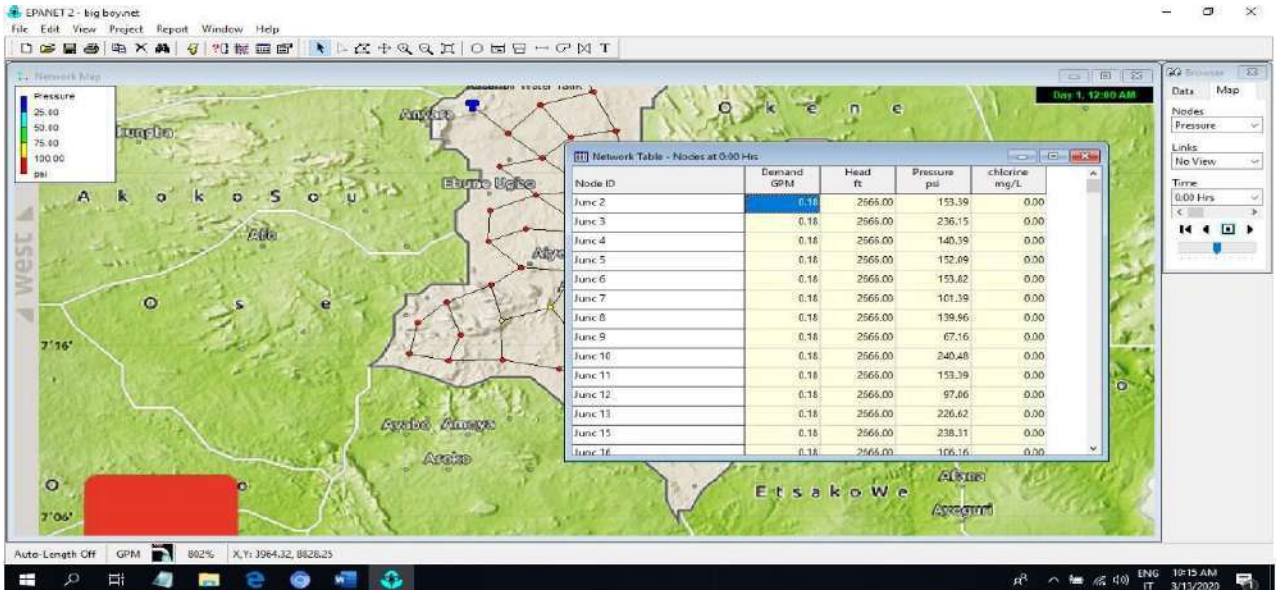


Fig.5: Epanet Result

IV. CONCLUSION

a) In this study, the empirical analysis of the Akoko-Edo Local Government, Edo-State, Nigeria. Water distribution network has been put using epanet computer-based simulation software for water distribution network. Prelude to the analysis a review of literature was carried out whereby the inhabitants leaving in Akoko-Edo Local Government are lacking potable water for drinking.

b) The result of all analysis was supported by charts, screen print and pictures, the current analysis revealed sufficient water supply to the communities attached to the network.

c) The result of the analysis shows that the network has very good pressure heads at reach nodes, and the velocity in the pipes has adequate flow rate.

V. RECOMMENDATION

The objective of a dam operation been able to manage at any moment resources accumulated in the storage capacity and the expected ones to face the need and to avoid loss of water or lack of storage. So, hydrological studies of dam during the design step as well as in the operation period are essential. As a result, hydrological studies of dam and reservoir can provide better guaranteed on waterallowance for various-uses.

REFRENCES

[1] Abubakar, A.S and Sagar, N.l. (2013): Design of NDA water distribution network using epanet, international journal of emerging and engineering (IJESE) ISSN: 2319-6378, volume 1, issue 9.

[2] Akintola J.O. “Rainfall distribution in Nigeria (1892-1983) impact publisher Nigeria Ltd, Ibadan. (1986)

[3] Arora K.R “Irrigation, waterpower and water resources engineering” standard publisher distribution (2004)

[4] Creaco Enrico, lecture slide for Hydraulic infrastructures, university of pavia, Italy.

[5] Mario Martina, lecture slide for Hydrological risk, IUSS, Pavia, Italy

[6] Paolo Ghilardi, fluvial hydraulic, for sediment transport, university of pavia, Italy.

[7] Paolo Ghilardi and Patricia Gabriella, lecture slide for flood propagation and structural measures for flood risk mitigation. University of pavia, Italy

[8] LInsley R.K “Water resources engineering” McGraw-Hill book company Inc. New York, N.Y (1986)

[9] Ogbeide H.E. Uyigue E, Oshodin O. (2003) “The impact of dams on the environment and people of Nigeria-Okhore and Ojirami dam in Edo-State as a case study, submitted to society for water and public health protection (SWAPHEP) supported by the global green grant/tide’s foundation.

[10] Taylor D.M. Leslie M.K and Johnson R.C “Ground water modelling key to isolating contamination” wastewater international USA (1989).

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.36

The Contribution of Health Professionals in Reducing Alcohol Use by Pregnant Women in Primary Health Care

A Contribuição de Profissionais da Saúde na Redução do (AB)Uso de Álcool por Gestantes na Atenção Primária a Saúde

Richardson Lemos de Oliveira[1], Wilder Kleber Fernandes de Santana[2], Fábio José Antonio da Silva[3], Guilherme de Andrade Ruela[4], Luiziane de Oliveira Geraldo da Silva Correia[5], Vítor Diego de Pontes Simões[6], Luciana Aparecida de Morais Brigido[7], Laura Cristina de Oliveira[8], Géssika Alves[9], Dija da Silva Macedo Costa[10], David Costa da Silva[11], Giselle Vasconcelos de Oliveira[12], Maria Cleudiane de Souza Santos[13]

[1]Universidade Nacional de La Plata
[2]Universidade Federal da Paraíba
[3]Universidade Norte do Paraná
[4]Universidade Federal de Minas Gerais
[5]Universidade Federal do Rio de Janeiro
[6]Centro Universitário Augusto Motta
[7]Universidade Federal dos Vales Jequitinhonha e Mucuri
[8]Faculdade Bezerra de Araújo
[9]Centro Universitário UNIABEU
[10]Universidade Castelo Branco
[11]Faculdade Celso Lisboa
[12]Instituto Israelita de Ensino e Pesquisa Albert Einstein
[13]Instituto Nacional do Câncer

Received: 30 Apr 2022,
Received in revised form: 18 May 2022,
Accepted: 23 May 2022,
Available online: 31 May 2022

***Keywords*— Alcohol, pregnant women, Brazil.**

***Palavras-chave*— Álcool, Gestantes, Brasil.**

***Abstract*—** *The present study aimed to discuss the contribution of health professionals in reducing the (ab)use of alcohol by pregnant women in Primary Health Care. It was necessary to carry out a small historical journey to reach the Brazilian contemporaneity. It was found that the marginalization of alcohol consumption by women appears linearly over time. The loss of credibility, intra-family violence, abusive and troubled relationships are some of the aspects that we can highlight. As for the theoretical-methodological aspects, an integrative review was carried out, a method that provides the synthesis of knowledge and the incorporation of the applicability of results of significant studies in practice. Therefore, this study delimited as objective to carry out a debate, in the current literature, about alcohol, its damages and consequences for women in the gestational period.*

Resumo— *O presente estudo se propôs a discutir sobre a contribuição de profissionais da saúde na redução do (ab)uso de álcool por gestantes na Atenção Primária à Saúde. Foi preciso realizar um pequeno percurso histórico até chegar na contemporaneidade brasileira. Averiguou-se que a marginalização, sobre o consumo de álcool pelas mulheres, apresenta-se de forma linear de acordo com o tempo. A perda de credibilidade, violência intrafamiliar, relações abusivas e conturbadas são alguns dos aspectos que podemos destacar. Quanto aos aspectos teórico-metodológicos, foi realizada uma revisão integrativa, método que proporciona a síntese de conhecimento e a incorporação da aplicabilidade de resultados de estudos significativos na prática. Sendo assim, este estudo delimitou como objetivo realizar um debate, na literatura vigente, sobre o álcool, seus danos e consequências a mulheres em período gestacional.*

I. INTRODUÇÃO

Ao longo dos séculos, o álcool, substância psicoativa com propriedades viciantes, tem sido amplamente utilizado em diversas culturas. Seu uso de modo frequente, segundo a OPAS (2020), tem apresentado impactos significativos para a saúde, além de avanços em níveis social e econômico. No que diz respeito à sua ingestão, o álcool afeta pessoas de diversos níveis e características singulares e seus impactos/efeitos são quantificados de acordo com os padrões de consumo.

Melani e Laranjeira (2004) apontam que no mundo, inúmeras culturas adotam o consumo de bebidas alcoólicas e associam o seu uso a celebrações, situações empresariais e sociais, cerimônias religiosas, eventos culturais e entre outros. Por outro lado, o consumo exacerbado de álcool é responsável por cerca de 3% de todas as mortes no mundo, desde cirrose, quedas, intoxicações, homicídios, câncer até acidentes automobilísticos.

Estudos com o teor epidemiológico apontam que as mulheres se destacam no fortalecimento e manutenção desta realidade. Nos países ocidentais, onde o álcool é consumido de modo regular, 90 % das mulheres desde grupo o consomem regularmente e, pelo menos 3% desta parcela, relata exceder os limites de consumo (Fraga et al., 2022)

Um estudo desenvolvido por Castillo (2011), na Espanha, demonstra que em 2003, 32,9 % das mulheres de 15 a 34 anos afirmaram ter consumido álcool em pelo menos oito ocasiões por mês. No ano de 2005, a prevalência do uso entre mulheres grávidas, nos últimos 12 meses consecutivos, de 15 a 34 anos, foi de 20, 9%, valor que subiu para 23,2 % entre os anos de 2007 e 2008, com a idade mediana do primeiro consumo de álcool no caso de a população total ser de 16,8 anos**.**

Desde a virada para o século XXI já era possível perceber, a partir dos estudos de Diez (1997) e, no mesmo ano, de Eiman (1997), a prevalência de grávidas que consumiram álcool durante a gravidez, atingindo 55,7%, valor que não é insignificante. Além disso, cabe salientar que as características se assemelham dentro de diferentes estudos em diferentes lugares do mundo, como por exemplo: idade (comumente entre 18 e 39 anos); desemprego ou subemprego; estado civil (maior ocorrência em mulheres solteiras); história de dependência de álcool familiar, dependência de álcool compartilhada com o marido; interferências socioculturais; baixa escolaridade e etnia (maior ocorrência em mulheres não brancas).

Entretanto, se nota unânime entre autores a estreita ligação entre fatores socioculturais e o consumo de bebidas alcoólicas durante a gestação. Desse modo, tal consumo irá variar em função do nível de escolaridade, da situação laboral, da idade da mãe, da ingestão pelo parceiro e outros fatores. Sendo assim, este estudo delimitou como objetivo identificar, na literatura vigente, quais as estratégias e ferramentas disponíveis para redução do (ab)uso de álcool por mulheres em período gestacional.

II. MÉTODO

Quanto aos aspectos teórico-metodológicos, foi realizada uma revisão integrativa de natureza qualitativa que, segundo Souza, Silva e Carvalho (2010, p. 103), é a mais ampla abordagem metodológica referente às revisões, "permitindo a inclusão de estudos experimentais e não-experimentais para uma compreensão completa do fenômeno analisado". Ainda conforme as autoras, "Combina também dados da literatura teórica e empírica, além de incorporar um vasto leque de propósitos: definição de conceitos, revisão de teorias e evidências, e análise de problemas metodológicos de um tópico particular" (Souza; Silva; Carvalho, 2010, p. 103).

Para a construção do presente estudo, foi realizada uma revisão integrativa que segundo Souza et, al (2010), é um método que proporciona a síntese de conhecimento e a incorporação da aplicabilidade de resultados de estudos significativos na prática. Logo, foram percorridas as seguintes etapas para realização de tal método: a) Fase que consiste na elaboração da questão que norteará o estudo; b) Fase em que se realiza a busca da amostragem com base nas literaturas. c) Fase destinada à coleta de dados. d) Fase consistirá na análise crítica dos estudos selecionados. e) Fase da discussão dos resultados e a última f) Fase que consiste na apresentação da revisão integrativa.

Quanto a natureza do estudo utilizou-se métodos qualitativos que segundo Pereira et al. (2017) são aqueles nos quais é importante a interpretação por parte do pesquisador com suas opiniões sobre o fenômeno em estudo.

Os critérios de inclusão para a seleção de estudos para tal fase da revisão interativa serão: artigos publicados em português, com os resumos indexados nas bases de dados selecionadas. Para o recorte temporal foi proposto um período de cinco anos (2011 a 2022). Foram selecionados apenas artigos originais em texto completo, dentro do recorte temporal de onze anos e no idioma português. Serão excluídas dissertações, teses, revisões sistemáticas, estudos randomizados, relatos de experiências mesmo que retratem questões pertinentes à temática anteriormente mencionada os estudos que não atenderem os critérios de inclusão, que apresentarem-se em outro idioma que não seja português, que apresentarem-se em duplicata, estudos fora do recorte temporal, estudos que não possuírem os métodos selecionados.

Para análise dos artigos incluídos/selecionados, ou seja, de todos aqueles que atenderam rigorosamente os critérios de inclusão, será construído um quadro especificamente para este fim que contemple: O título do artigo selecionado, nome dos autores do estudo, idioma, periódico que foi publicado, ano de publicação.

A última etapa consiste na elaboração da revisão integrativa, onde, com base nos estudos anteriormente selecionados e avaliados minuciosamente, permite com que o autor atinja seus objetivos. Assim, podendo contribuir de forma positiva e de qualidade com a ciência e com a saúde pública. Não haverá necessidade de o estudo passar por avaliação do comitê de ética como preconiza a Resolução de Nº 466 de 12 de dezembro de 2012, pois não entrevistará seres humanos.

A seguir, dispomos dos principais estudos que nortearam nossa pesquisa, distribuídos no quadro 1 por meio das seguintes categorias: *Título do estudo; Nome dos autores; Periódico; Idioma; Ano de publicação.*

Quadro I – Disposição dos dados

TÍTULO DO ESTUDO	NOME DOS AUTORES	PERIÓDICO	IDIOMA	ANO
Rastreio do Consumo de Bebidas Alcoólicas em Gestantes	Lorrainie De Almeida Gonçalves; Claudete Ferreira De Souza Monteiro; Fernando José Guedes Da Silva Júnior; Lorena Uchoa Portela Veloso; Adélia Dalva Da Silva Oliveira; Benevina Maria Vilar Teixeira Nunes	REV MIN ENFERM	PORTUGUÊS	2020
Malformação e Morte X Alcoolismo: Perspectiva da Enfermagem Com a Teoria Da Transição em Gestantes	Tharine Louise Gonçalves Caires; Rosângela Da Silva Santos	REV BRAS ENFERM.	PORTUGUÊS	2018

Prevalência e Fatores Associados ao uso de Álcool Durante a Gestação em uma Maternidade De Goiás, Brasil Central	Vanessa Alves Guimarães; Kelly Silveira Fernandes; Roselma Lucchese; Ivânia Vera; Bruno César Teodoro Martins; Thiago Aquino De Amorim; Rafael Alves Guimarães	CIÊNCIA & SAÚDE COLETIVA	PORTUGUÊS	2016
Padrão do Consumo de Álcool em Gestantes atendidas em um Hospital Público Universitário e Fatores de Risco Associados	Líbera Helena Ribeiro Fagundes De Souza; Maria Célia Dos Santos; Luiz Carlos Marques De Oliveira	REV BRAS GINECOL OBSTET	PORTUGUÊS	2012
Associação entre Abuso de Álcool durante a Gestação e o Peso ao Nascer	Ivelissa Da Silva; Luciana De Avila Quevedo; Ricardo Azevedo Da Silva; Sandro Schreiber De Oliveira; Ricardo Tavares Pinheiro	REV SAÚDE PÚBLICA	PORTUGUÊS	2011

Fonte: Criação dos próprios autores

No quadro anteposto foram selecionados cinco estudos publicados em revistas brasileiras tendo como recorte temporal os últimos 11 (onze) anos. O posicionamento temático assumido para seleção da amostra consistiu em estudos que abordassem sobre alcoolismo, gestantes e fatores que correlacionassem as causas e consequências do uso excessivo. Em sequência, realizamos uma investigação, na literatura vigente, sobre o álcool, seus danos e consequências a mulheres em período gestacional.

O álcool, seus danos e consequências a mulheres gestantes

A marginalização sobre o consumo de álcool pelas mulheres apresenta-se de forma linear de acordo com o tempo. A perda de credibilidade, violência intrafamiliar, relações abusivas e conturbadas são alguns dos aspectos que podemos destacar. No entanto, os aspectos envolvidos nesses associados ao uso de álcool e outras drogas, resultam em estigmas socioculturais, desabilitando a mulher como pilar do núcleo familiar. Para Caires e Santos (2018), esse contexto é preciso ser observado com o olhar sensibilizado, visto as fragilidades, no que tange, a saúde mental desta usuária vem sofrendo implicações de cunho negativo.

Durante a gestação, a discussão do uso de álcool apresenta-se de modo mais intensificado, pois além de gerar impactos diretos ao feto, o estudo de Gonçalves et. al (2020) evidencia que não há níveis mínimos alcoólicos para a quantificação de exposição de gravidas, levando em conta que ainda com o uso moderado, pode desenvolver danos ao feto, isto é, qualquer padrão de consumo dessa substância na gestação é considerado de risco, sendo recomendada a abstinência entre gestantes.

Mulheres no período gravídico sofrem mudanças psicológicas, físicas e hormonais, tornando-as vulneráveis ao consumo de substâncias psicoativas. O uso de álcool agrava traços na personalidade negativos (por ex.: aumento da impulsividade e agressividade), propicia eventos negativos na vida (por ex.: separação conjugal e isolamento social) e aumenta o risco de co-morbidades psiquiátricas (por ex.: depressão), o que aumenta o risco de comportamentos suicidas. (Guimarães et al, 2016)

Gestantes geralmente são cientes de que o uso de álcool é danoso ao feto, e tendem a omitir o uso de bebida alcoólica por receio de serem desaprovadas tanto pela sociedade quanto pelos serviços de saúde. (Silva et. al, 2011) Devido a estigmas sociais, a grávida pode relatar um consumo alcoólico menor ou negá-lo, a fim de contornar possível repreensão e desaprovação pelo profissional de saúde. (Souza e Santos et. al, 2012)

Atualmente, não são esclarecidos, completamente, os mecanismos de ação utilizado pelo álcool para atingir o feto. Acredita-se que as concentrações de álcool na qual o feto fica exposto possuem taxas similares as taxas circulantes na corrente sanguínea materna o que proporciona um ambiente improprio favorecendo o

surgimento da Síndrome do Alcoolismo Fetal[1], por exemplo.

As literaturas mostram maior risco de aborto espontâneo, déficit cognitivo, anomalias congênitas não hereditárias e malformações fetais. (Caires e Santos, 2018). Contudo, o uso e abuso de álcool representa um dos principais fatores de risco para diabetes mellitus, uma vez que tem efeito no pâncreas, interferindo no sistema metabólico e levando à resistência insulínica. (Guimarães et al, 2016)

Em alguns casos, o consumo de álcool pode ser subdiagnosticado durante a gestação, provavelmente pelo despreparo dos profissionais da saúde para investigar adequadamente ou valorizar as queixas compatíveis com o hábito de bebe, mas é importante ressaltar que os profissionais de saúde que atendem as gestantes devem saber utilizar as ferramentas próprias para o diagnóstico de consumo alcoólico e reconhecer seus fatores de risco sem, no entanto, se prender a estereótipos. (Souza e Santos et. al, 2012; Silva et al, 2011). Por isso, é de suma importância a intensificação durante o período de pré-natal a busca pelo diagnostico e aconselhamento por parte de profissionais da saúde.

Existem ferramentas, na atualidade, que contribuem para a práxis profissionais, viabilizando a identificação de transtornos decorrentes do uso de álcool. O questionário CAGE[8] (acrônimo referente às suas quatro perguntas- Cut down, Annoyed by criticism, Guilty e Eye-opener) é utilizado com um ponto de corte de duas respostas afirmativas sugerindo screening positivo para abuso ou dependência de álcool. Segundo a literatura, a sua sensibilidade varia de 43% a 100% e a especificidade, de 68% a 96%, dependendo do tipo de amostra estudada. (Paz Filho, et. al, 2001).

Apresenta-se a seguir, a tabela com as perguntas que compõem o questionário CAGE para a sua aplicação:

Tabela 1: questionário CAGE

C – (cut down)	*Alguma vez sentiu que deveria diminuir a quantidade de bebida ou parar de beber?*
0 – ( ) não	*1 – ( ) sim*
A – (annoyed)	*As pessoas o (a) aborrecem porque criticam o seu modo de beber?*
0 – ( ) não	*1 – ( ) sim*
G – (guilty)	*Se sente culpado (a) pela maneira com que costuma beber?*
0 – ( ) não	*1 – ( ) sim*
E – (eye opened)	*Costuma beber pela manhã (ao acordar), para diminuir o nervosismo ou a ressaca?*
0 – ( ) não	*1 – ( ) sim*

FONTE: Acolhe USP. Programa de acolhimento relacionado ao uso de álcool e outras drogas;

O questionário possui alta sensibilidade para diagnostico facilitando a identificação e medidas de intervenção profissional de forma oportuna e multidisciplinar.

Para reduzir o consumo de bebida alcoólica durante a gestação é necessário trabalho multidisciplinar. Quando diagnosticado o uso de álcool, a paciente deve prontamente receber tratamento intensivo, com apoio psicológico e abordagens que a motivem para a mudança. Ações educativas desde o início da gravidez e visitas domiciliares aumentam a adesão ao tratamento e as chances de redução ou abandono do álcool durante o período da gestação. (Guimarães et. al, 2020)

Considerações finais

Ao longo do nosso estudo foi possível averiguar A efetividade da contribuição de profissionais da saúde na redução do (ab)uso de álcool por gestantes na Atenção Primária à Saúde. Foi preciso realizar um pequeno percurso histórico até chegar na contemporaneidade brasileira.

Constatou-se que a marginalização, sobre o consumo de álcool pelas mulheres, apresenta-se de forma linear de acordo com o tempo. A perda de credibilidade, violência intrafamiliar, relações abusivas e conturbadas são alguns dos aspectos que podemos destacar. Quanto aos aspectos teórico-metodológicos, foi realizada uma revisão integrativa, por meio de um método que proporcionasse a síntese de conhecimento e a incorporação da aplicabilidade de resultados de estudos significativos na prática. Nessas condições interpretativas recorreu-se à literatura vigente sobre o álcool, seus danos e consequências a mulheres em período gestacional.

Esperamos que esta pesquisa, inserida no campo das Ciências da Saúde, possa atuar como um dispositivo a influenciar mais pesquisadores a se debruçarem sobre temáticas tão relevantes contextos que se desenvolvem por

[1] A Síndrome do Alcoolismo Fetal, caracteriza-se por danos ao sistema nervoso central, que causam anomalias neurológicas, craniofaciais, deficiência no crescimento pré e pós-natal, disfunções comportamentais e dificuldades emocionais. (Freire, Padilha e Sauders, 2009; Machado e Melo, 2005).

meio de dependências químicas e/ou emocionais. De igual modo, ressaltamos a imprescindibilidade desses profissionais da saúde a atuarem a favor da vida e no combate aos ab(usos) do álcool por mulheres gestantes.

REFERÊNCIAS

[1] Caires, TLG, & Santos, RDS (2020). Malformação e morte X Alcoolismo: perspectiva da Enfermagem com a Teoria da Transição em gestantes. *Revista Brasileira de Enfermagem* , *73* .

[2] Brasil. I Levantamento Nacional sobre os padrões de consumo de álcool na população brasileira / Elaboração, redação e organização: Ronaldo Laranjeira ...[et al.] ; Revisão técnica científica: Paulina do Carmo Arruda Vieira Duarte. Brasília : Secretaria Nacional Antidrogas, 2007.

[3] Da Silva Mota, Ivanise Correia. Síndrome Alcoólica fetal – consequências e diagnóstico. Revista EVS-Revista de Ciências Ambientais e Saúde, v. 48, n. 1, p. 8771, 2022.

[4] Díez T. Encuesta alcohol y gestación. Enferm Científ 1997; p. 178-179.

[5] Eiman M, et al. Estudio sobre consumo de alcohol durante el embarazo. Área de Salud V de la Comunidad de Madrid. Boletín Epidemiológico Semanal. Instituto de Salud Carlos III 1997; 32(5): 301-312.

[6] Freire K, Padilha PC, Saunders C. Fatores associados ao uso de álcool e cigarro na gestação. Rev Bras Ginecol Obstet. 2009; 31(7):335-41.

[7] Freire TM, Machado JC, Melo EV, Melo DG. Efeitos do consumo de bebida alcoólica sobre o feto. Rev Bras Ginecol Obstet. 2005;27(7):376-81.

[8] Gonçalves, L. D. A., Monteiro, C. F. D. S., Júnior, F. J. G. D. S., Veloso, L. U. P., Oliveira, A. D. D. S., & Nunes, B. M. V. T. (2020). Rastreio do consumo de bebidas alcoólicas em gestantes. *Revista Mineira de Enfermagem*, *24*, 1-6.

[9] Guimarães EAA, Velasquez-Meléndez G. Determinantes do baixo peso ao nascer a partir do sistema de informação sobre nascidos vivos em Itaúna, Minas Gerais. Rev Bras Saude Matern Infant. 2002;2(3):283-90. DOI:10.1590/S1519-38292002000300009

[10] Guimarães, V. A., Fernandes, K. S., Lucchese, R., Vera, I., Martins, B. C. T., Amorim, T. A. D., & Guimarães, R. A. (2018). Prevalência e fatores associados ao uso de álcool durante a gestação em uma maternidade de Goiás, Brasil Central. *Ciência & Saúde Coletiva*, *23*, 3413-3420.

[11] Laranjeira R e Hinkly D (2002). Avaliação da Densidade de Pontos-de-Venda de Álcool e Sua Relação com a Violência. Revista de Saúde Pública, 36:455-61.

[12] Machado JC, Melo EV, Melo DG. Efeitos do consumo de bebida alcoólica sobre o feto. Rev Bras Ginecol Obstet. 2005;27(7):376-81

[13] Meloni JN e Laranjeira R (2004). Custo Social e de Saúde do Consumo do Álcool. Revista Brasileira Psiquiátrica, 26 (supl. I):7-10.

[14] Marques, a. C. P. R.; campana, a.; Gigliotti, a. P.; Lourenço, m. T. C.; Ferreira, m. P. Laranjeira, r. Consenso sobre o tratamento da dependência de nicotina. Rev bras psiquiatr 2001; 23:200-14.

[15] Oliveira, R. L. De; Santana, W. K. F. De; Veiga, D. De O. C. Da .; Maconato, A. M.; Pequeno, B. E. De M.; Barros, R. R. De .; Reis, L. D.; Pacheco, L. F. .; Macedo, H. A. De .; Gomes, J. C. T.; Araújo, I. de O. de . Interpretation of prescription from the perspective of elderly patients functional and low schools. Research, Society and Development, *[S. l.]*, v. 10, n. 2, 2021.

[16] OPAS. Organização Pan-americana da Saúde. Álcool. Disponível em: https://www.paho.org/pt/topicos/alcool Acesso em: 12.04.2022

[17] Paz Filho, G. J. et al. Emprego do questionário CAGE para detecção de transtornos de uso de álcool em pronto-socorro. Revista da Associação Médica Brasileira, v. 47, p. 65-69, 2001.

[18] Silva, I. D., Quevedo, L. D. A., Silva, R. A. D., Oliveira, S. S. D., & Pinheiro, R. T. (2011). Asociación entre abuso de alcohol durante la gestación y el peso al nacer. *Revista de Saúde Pública*, *45*(5), 864-869.

[19] Souza, L. H. R. F. D., Santos, M. C. D., & Oliveira, L. C. M. D. (2012). Padrão do consumo de álcool em gestantes atendidas em um hospital público universitário e fatores de risco associados. *Revista Brasileira de Ginecologia e Obstetrícia*, *34*(7), 296-303.

[20] Vakeflliu Y, Argjiri D, Peposhi I, Agron S, Melani AS. Tobacco smoking habits, beliefs, and attitudes among medical students in Tirana, Albania. Prev Med. 2002;34:370-3

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.37

Kangaroo Method and the Nutritional Status of Premature Infants: A Literature Review

Bárbara Vitória Monteiro Reis Augusto[1], Alessandra de Jesus Monteiro[1], Ana Júlia Melo da Silva[1],Alan de Sousa Nunes[1], Natasha Assunção Oliveira[1], Paula Rayssa Lobato da Silva[1], Rosângela Santos Nonato[1], Bruna Macedo Lopes[1], Paula Raimunda Araújo Teixeira[1],Bruna Macedo Lopes[1], Fabiana Costa Cardoso[2], Luísa Margareth Carneiro da Silva[2]

[1]Instituto de Ciências da Saúde, Faculdade de Nutrição, Universidade Federal do Pará, Brasil
Email: barbaramonteiro1003@gmail.com/ paula.teixeira@icb.ufpa.br
[2]CECANE/PA, Universidade Federal do Pará, Brasil
Email :luisamargarett@gmail.com

Received: 01 May 2022,
Received in revised form: 21 May 2022,
Accepted: 25 May 2022,
Available online: 31 May 2022

***Keywords*— Kangaroo Method, Premature, Children, Mother.**

***Abstract*—** *The Kangaroo Method (KM) is a model of humanized care in which minimally invasive practices are used through skin-to-skin contact between the baby and the mother or other family members. Objectives: To investigate the literature on the Kangaroo Method and its impacts on the nutritional status of preterm infants. Methods: This was a qualitative study, using the norms of a bibliographic review. The period of collection by electronic means published was from 2017 to 2022. Results: The physiological development of the premature baby may be directly associated with the prevalence of the Kangaroo Method to minimize invasive procedures for the baby. Breastfeeding during the Kangaroo Method is a positive factor for the contribution of its quality and influences its exclusivity. In addition, skin-to-skin contact makes the affective bond stronger and thus helps in the mother-baby relationship. Maternal complications are breast lesions and musculoskeletal pain. The multi-professional team is essential for the evolution of the kangaroo method and for the knowledge of family members about the correct method. Conclusion: The kangaroo method is a positive factor for preterm development. As it is a light treatment technology, non-invasive, easy to perform and economical, it should be encouraged.*

I. INTRODUCTION

Worldwide, an average of 15 million children are born prematurely each year, before 37 weeks of gestation, while 21 million are born with low ideal birth weight. It is crucial to emphasize that preterm babies are predisposed to develop health risks and complications, such as developmental delays, infections and nutritional changes. Such factors foster data in which they point out that the main causes of death among children fewer than 5 years of age are related to prematurity [1].

The Ministry of Health (MS) characterizes as a newborn (NB) the human being who is during the neonatal period, which runs from birth to 28 days after it. Newborns soon after delivery have different needs according to birth weight and gestational age (GA), these being important markers for classifying and identifying babies at greater

risk of developing some complication, and consequently their death. When verifying any abnormality during pregnancy or after birth, this individual should be referred for monitoring [2].

According to data from the Department of Health Analysis and Surveillance of Non-Communicable Diseases (DASNT), of the Health Surveillance Department, in 2020 alone, 2,687,651 children were born in Brazil, of which 303,903 were premature babies born at less than 37 weeks, representing 11% of births. In the northern region in that same year, 34,972 premature births were registered, only in the state of Pará there were 15,832 reported cases, Belém presented itself as the second capital of the region with the highest percentage of records 2,430, accounting for 15% of registered premature births in the state [3].

The Kangaroo Method (KM) is a model of humanized care in which minimally invasive practices are used through skin-to-skin contact between the baby on her stomach and the mother's chest or abdomen, or other family members. Studies show that the CM influences the affective bond between the baby and his family, thermal regulation, reduction of considerable levels of pain, assists in Breastfeeding (BF) and influences the preterm hospitalization time. The CM is divided into three stages, starting in the Neonatal Intensive Care Unit, moving on to the Kangaroo Neonatal Intermediate Care Unit (UCINCa), and therefore the third stage at home, after hospital discharge [4, 5, 6].

Food plays a fundamental role for human survival, being a decisive factor for a better prognosis of the Preterm Newborn (PTNB). This fact is related to her role in physiological and neurological issues, due to the immaturity of the premature's organism, a good relationship between them can lead to a decrease in problems related to swallowing, breathing and sucking. Thus, the MC is a factor of study in which the method is used as a means of analysis between the reductions of intercurrent factors such as infections, inadequate growth, low immunological resistance, neuropsychomotor development and the deficient Oral Sensory-Motor System (OSS) and surrounded by a good nutritional supply[7,8, 4] (BUENO, 2005; CABRAL et al. 2009; LUZ, et al. 2020).

The development of techniques and technological measures that help in the development of the NB as well as the scientific development in hospital care directly contributes to helping the baby's prognosis, as well as the preterm survival. Therefore, the objective of the present study is to investigate the literature on the Kangaroo Method and its impacts on the nutritional status of preterm infants.

II. METHODOLOGY

2.2 Type of study

This study is a qualitative study, using the norms of a bibliographic review.

2.2.1 Study period

A review of the articles available in the literature in electronic media published from 2017 to 2022 was carried out. Data collection took place between February and March 2022.

2.2.2 Sample

The research was carried out in the academic database (BIREME), using the descriptors: Kangaroo Method, Breastfeeding, Preterm, Hospital Discharge, Weight Gain, Development, and Premature. The connective AND was used between the descriptors, Kangaroo Method AND Breastfeeding, Kangaroo Method AND Preterm, Kangaroo Method AND Hospital Discharge, Kangaroo Method AND Weight Gain, Kangaroo Method AND Development, Kangaroo Method AND Premature.

After data collection, the moment of analysis took place through a selective reading of the articles through the research theme, being probed according to the research objectives, in order to investigate an analysis on the Impact of the Kangaroo Method for the nutrition status of premature baby. Portuguese was the chosen language.

2.2.3 Inclusion criteria

Articles that observed premature babies who underwent the kangaroo method during the period of hospitalization were included.

2.2.4 Exclusion criteria

Duplicate articles, dissertations, non-indexed publications, theses and monographs were excluded.

After a brief reading to obtain the results, the sample consisted of 13 articles.

2.2.5 Data Collection and Analysis

After reading and selecting the articles, data were systematically obtained for the work, with classification, distribution and final analysis. Three steps were used for the analysis of qualitative data.

The first phase was the pre-analysis, starting from the separation through general readings.

The second stage took place through the analysis and organization to find relevant topics, for this, a spreadsheet assembled in the Microsoft Excel 2019

program, detailing topics of interest: year of publication, author, title, objectives, results and conclusions.

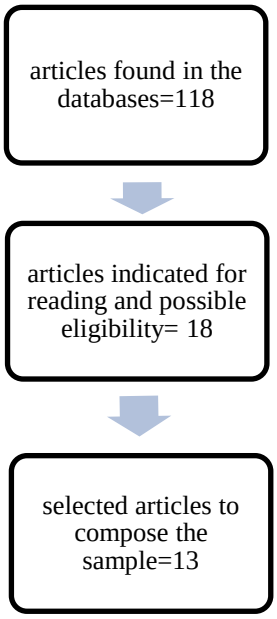


Fig.1: Flowchart of the integrative review articles selection process.

Source: Authors, 2022

The third stage consists of processing the articles filtered and analyzed with their assessments, formed in the theoretical framework of the program, giving rise to the results of the present study.

2.2.6 Ethical Aspects

Regarding the ethical aspects of the research, as it is a literature review, there was no need to submit it to the Research Ethics Committee, supported by resolution 466/12 of the National Health Council (CNS). However, all ethical means will be treated and taken care of to promote the veracity of the information and to protect the privacy and confidentiality of the research subject's data.

III. RESULTS

Table 1 represents the synthesis of the articles used in this review.

Table.1 presents the year, author, title, objectives, results and conclusion of the studies.

YEAR	AUTHORS	TITLE	OBJECTIVES	RESULTS	CONCLUSION
2017 [8]	NUNES, C. R. N.*; et al.*[9]	Relationship of duration of kangaroo position and mother-child interaction at hospital discharge	To analyze the influence of the Kangaroo Position duration on the initial interactions of the mother-preterm child dyad.	The longer the time in Kangaroo Position, the more newborns made attempts at physical contact with their mothers during breastfeeding (r=0.37; p=0.03).	The longer the time in Kangaroo Position, the more newborns made attempts at physical contact with their mothers during breastfeeding (r=0.37; p=0.03).

2017	FARIAS, S. R.*et al.*[10]	Kangaroo position in very low birth weight preterm newborns: a descriptive study	To describe the number of periods in which PTNBs, weighing less than 1500g, were in the kangaroo position throughout hospitalization and to seek relationships between maternal and neonatal variables with the performance of the Kangaroo position.	The beginning of the kangaroo position occurred on average at 30.8 days of postnatal life (SD=18.5) and the number of periods in which they were in the kangaroo position was on average 10.7 times.	We investigated 38 subjects, whose hospitalization period ranged from 18 to 136 days. The beginning of the kangaroo position occurred on average at 30.8 days of postnatal life (SD=18.5) and the number of periods in which they were in the kangaroo position was on average 10.7 times. The occurrence of the kangaroo position was less frequent than the opportunities arising from the maternal presence and was related to the greater supply of milk on demand.
2018	MEDEIROS, A. M. C.; *et al*. [11]	Feeding transition time in the tube-breast technique in low birth weight newborns of the Kangaroo Method.	Check the time spent in the transition from gavage feeding to exclusive oral feeding, using the tube-chest technique.	The history of medical complications significantly influenced the total transition time. Subgroups G1-A (10 days), G1-B (9 days) and G2-A (12 days), when compared to group G2-B (16 days), showed a greater chance of early discharge.	NBs without significant clinical complications had a shorter chance of discharge. NBs with clinical complications, who made the transition from gavage exclusively on the chest, had a shorter transition time than those who used cup/bottle complementation. The feeding transition using the probe-breast technique is important to be recommended in speech therapy in Neonatology.
2018	SILVA, J. M. G. P.; *et al.*[12]	Painful complaints in kangaroo care participants	To measure the main painful complaints in MMC participants using the visual analogue scale (VAS) and to verify the correlation between these complaints and the baby's age and weight.	It was observed that 46.16% reported some pain complaint at the time of admission and, on the seventh day, this percentage was 50%. The most affected site was the lumbar region with 66.7% and 61.3% in the two moments of the analysis being classified as moderate pain for 100% and 84.6%	KMM does not seem to interfere with the onset and worsening of musculoskeletal pain. However, puerperal women have significant muscle discomfort that can increase according to the weight gain of the RNBP, and the KMM is beneficial for the newborn. Adequate monitoring of these women can help in

				respectively, there was a correlation between increased pain and weight gain of the patient. newborn.	adherence to the method.
2018	SOUZA, A. K. C.; *et al.*[13]	Weight gain in newborns submitted to skin-to-skin contact	To compare weight gain between newborns submitted to skin-to-skin contact and those not submitted.	The history of medical complications significantly influenced the total transition time. Subgroups G1-A (10 days), G1-B (9 days) and G2-A (12 days), when compared to group G2-B (16 days), showed a greater chance of early discharge.	Skin-to-skin contact positively influences the weight gain and length of hospital stay of neonates. Use of infant formula does not influence weight gain for dyads in body contact. Gestational age, corrected gestational age, birth weight, weight on the first day of follow-up, time of gastric tube use, time of oral feeding is not correlated with weight gain.
2019	SOUSA, S. C.; *et al.*[14]	Strengthening the bond between the family and the premature neonate	To identify which are the Nursing interventions carried out in a Neonatal Intensive Care Unit that promote the strengthening of the bond between the family and the premature newborn.	It was observed that the most used interventions to strengthen the bond between premature newborns and the family is free entry of parents to the Neonatal Intensive Care Unit; diaper changes; diet administration; use of music and books to soothe babies; in addition to the kangaroo method.	It is concluded that the Nursing team that assists the high-risk neonate seeks to be attentive to the dimension of this phenomenon, seeking to develop interventions to strengthen the bond, in the best possible way, given that the benefits are mutual for all involved.

2020	NIETSCHE, E. A.; *et al.*[15]	Kangaroo Method: Continuing Education strategies for its implementation and execution	Knowing the context in which the kangaroo method is developed in a Neonatal ICU from the actions of Permanent Education in Health.	Three categories of analysis emerged: kangaroo method – conceptions and understandings; permanent education – teaching-learning strategies; and kangaroo method and teamwork – limits and possibilities.	It was observed that the institution was concerned with offering educational activities to professionals in the Neonatal ICU before implementing the kangaroo method, but it is necessary that discussions on the subject are constantly raised to improve the work developed by the health team.
2020	LEMOS, G. C.; *et al*. [16]	Effects of hydrotherapy on relaxation and weight gain in preterm infants in the neonatal care unit.	To investigate the effects of hydrotherapy on relaxation and weight gain in clinically stable PTNBs.	There was no statistically significant difference in weight gain (p=0.127). Regarding hemodynamic variables, the population studied showed an increase in respiratory rate (RR) on day 2 (p=0.028), and a decrease in body temperature on day 1 (p=0.014) and on day 2 (p=0.005). Regarding pain assessment, there were no statistically significant differences on both days.	Although the relaxation provided to the study population through the application of the method was observed, no statistically significant data were obtained to prove the relationship between the relaxation provided by the hydrotherapy and the weight gain of the PTNBs studied in the present study.
2020	DINIZ, K. T.; *et al.*[17]	Short-term effect of the kangaroo position on the electromyographic activity of preterm infants: a randomized clinical trial	To verify the short-term influence of the Kangaroo Position on the electromyographic activity of premature newborns.	In the Kangaroo Method Group (n = 21), there was variation in the values of electromyographic activity between the three moments of recording activity of the biceps brachii and hamstrings muscles. In the Control Group (n = 23), there was no statistical difference between the recording moments.	CP increases the short-term electromyographic activity of the biceps brachii and hamstring muscles

2020	SANTOS, K. E. F.; *et al.*[18]	Six Months of Exclusive Breastfeeding in the Very Low Weight Preterm Undergoing Kangaroo Method	To know the frequency and factors associated with exclusive breastfeeding in preterm follow-up.	Exclusive breastfeeding was present in 22 (26.8%) patients and 60 (73.2%) had already started using formula. Mean maternal age was 28/29 years, gestational age 30.3/30.4 weeks, birth weight 1295/1434g, duration of mechanical ventilation 5.0/5.8 and total hospital stay 56/49 days in the groups G1 and G2, respectively. The frequencies of cesarean delivery 68/61%, necrotizing enterocolitis 4.5/8.3%, severe peri-intraventricular hemorrhage 4.5/8.3%, late sepsis 19/16.9%, and readmission after discharge4,5 /6.8% in G1 and G2 patients.	Compared to other cohorts and to the service itself in 2010, the rate of breastfeeding was high and, in particular, exclusive breastfeeding, a condition associated with better preterm development, and perinatal variables were not determinants of the success of exclusive breastfeeding. in these patients treated by the kangaroo method.
2020	SENA, M. R. D.; *et al.*[19]	Influence of the kangaroo position on the cardiopulmonary system of premature infants in a Neonatal Intensive Care Unit in the Amazon	To analyze the effect of the kangaroo position on the cardiopulmonary system of premature newborns admitted to a Neonatal Intensive Care Unit (NICU) in Pará.	Variation of results was observed, revealing a significant increase in body temperature of preterm infants during CP, reaching a median of 36.8°. In the other variables, BSA, HR, RR and SpO2, there were no statistically significant changes.	It was concluded that CP promoted an increase in the body temperature of premature newborns, where a better thermal control was observed, essential for the term regulation of preterm infants.
2021	ALVES, F. N.; *et al.*[20]	Impact of the second and third stages of the kangaroo method: from birth	Assess whether the Kangaroo Method has an impact on breastfeeding rates	The GCCa group showed superior results in terms of exclusive breastfeeding at hospital discharge, first outpatient consultation, fourth month of corrected gestational age, in	The second and third stages of the Kangaroo Method favored the practice and maintenance of exclusive breastfeeding, in addition to presenting lower readmission rates up to the sixth month of

		to the sixth month		addition to lower readmission rates.	corrected gestational age.
2022	TEIXEIRA, M. A.; *et al.*[21]	Profile of preterm infants undergoing speech therapy at a follow-up outpatient clinic	To describe the profile of preterm children, according to sociodemographic, clinical and care aspects, and the association with perinatal and postnatal data.	There was statistical significance ($p \leq 0.001$) in the association of gestational age with the following variables: birth weight, height, head circumference, use of the Kangaroo Method, feeding at discharge, ototoxic drugs, intracranial hemorrhage, sepsis and jaundice. Most babies (99.9%) performed the Guthrie Test with adequate results (95.3%).	Most families were low-income, with babies presenting late prematurity. Statistical significance was observed for the variables: type of delivery, weight, height, head circumference, use of ototoxic drugs, intracranial hemorrhage, sepsis and jaundice, with predominant alterations in extremely preterm infants.

IV. DISCUSSION

4.1 Weight Gain and Physiological Development

Amaral et al. [22] sought to assess the correlation between post-discharge feeding of newborns and the parameters of length of stay in the ICU and gestational age, a fact that resulted in the Kangaroo Method contributing to nutritional development as a positive response. These research methods were associated with Souza et al. [13] in a study with 46 neonates that sought to compare the weight gain in newborns who underwent skin-to-skin contact with those who were not in the Kangaroo Method. The results of this research highlighted those newborns that were in skin-to-skin contact showed greater weight gain compared to newborns that did not have this skin-to-skin contact. The authors referenced here highlight the possible benefits of CM when correlated with breastfeeding, these findings indicate that skin-to-skin contact results in the baby's development and consequently with weight gain.

Furthermore, a cross-sectional study by Leite et al. [23] aimed to seek the incidence of Breastfeeding after hospital discharge, showed that 95% of newborns on Exclusive Breastfeeding (EBF) in contribution to the Kangaroo Method obtained the necessary weight gain after hospital discharge. These findings cooperate with the results of Souza et al. [13] in a qualitative cross-sectional study, sought to analyze which factors influenced the weight gain of babies hospitalized in a Neonatal Unit in Rondônia. The results described that babies who were in the kangaroo method gained more weight when compared to low birth weight newborns who did not undergo KM. With this, it can be highlighted that the Kangaroo Method when directly associated with contexts such as Breastfeeding are positive factors for the nutritional development of the baby.

According to Bera et al. [24] in a controlled clinical trial with 500 pairs of mothers and babies sought to analyze the effects of MC on the development of Indian babies. This author highlighted that low birth weight babies who underwent KM quickly reached physical growth parameters similar to babies with normal control patterns. These findings reinforce the studies by Diniz et al. [17] who through a randomized clinical trial that in their results proved the influence that the period of Kangaroo Method resulted in the development on the physiological characteristics of the newborn. Through this, one can demonstrate the relevance of the CM for the

physiological development of the premature baby and thus, the minimization of invasive procedures for the baby.

Mwendwa et al. [25] in a randomized controlled clinical trial with 157 babies admitted to the Kenyatta National Hospital in the city of Nairobi, Kenya, who underwent CM an average of 8 hours a day, obtained positive results regarding the babies submitted to CM, which developed faster than babies who did not use the CM, consequently being discharged more quickly. The previous study was similar to the randomized study by Diniz et al. [17] who concluded that skin-to-skin contact and the Kangaroo Position provide various sensory stimuli to premature newborns, contributing to tonic-postural adjustment with a positive impact on their baby's neuro-motor development. Thus, the skin-to-skin contact performed by the CM directly contributes to the baby's neurophysiological progress.

A cohort study carried out by Menezes et al. [26] sought to assess the clinical evolution, weight and rate of exclusive breastfeeding during the development of 137 preterm infants treated at a Public Maternity Hospital in the Northeast, in which they pointed out in their results that most of the studied individuals were with the ideal weight for remaining in CM even after hospital discharge. This study agrees with the findings of Farias et al. [10] in an observational study that analyzed the period that newborns were in KM and what their relationships were between maternal variables, resulting in that babies who had more time with skin-to-skin contact developed positively until the hospital discharge. These findings corroborate the perception that the CM time between the mother-baby binomial contributes to the improvement of the baby's clinical status.

Mota et al. [27] in a study with 14 premature newborns, observed their sensorimotor development, having as a response that babies who were in skin-to-skin contact, obtained a positive stimulus, being in a state of greater attention, and consequently more likely to be discharged from hospital. This finding is similar to the research by Farias et al. [10] who analyzed the time in which 38 NB were in Kangaroo Position in a Neonatal Unit of a Baby-Friendly hospital, highlighting positive results between the days of life in which the kangaroo position was started and the days of hospitalization of the babies, where babies who were in greater contact with the CM developed faster. Given the above, it is important to correlate the time of contact with the CM with the minimization of the hospitalization time.

Srinath et al. [28] in their prospective study in preterm newborns in a tertiary neonatal unit in Toronto sought to correlate the physiological and biochemical responses of the mother-infant binomial after KM. The results identified positive changes in the physiological components measured through temperature and salivary cortisol in both the baby and the mother. This study is similar to the study by Lemos et al. [16] in a quantitative study in 10 preterm infants in the kangaroo method submitted to the treatment of hydrotherapy, in which they sought to answer the relationship between the hot bath and relaxation and weight gain, obtaining results in which the MC can be correlated with the reduction of stress levels and harmful stimuli. In this way, it is worth mentioning the positive effects of skin-to-skin contact and the benefits for the newborn's temperature and reduction of the baby's stress levels during the hospitalization period.

Çaka et al [29] in a randomized study with 80 preterm infants sought to analyze the effects of hot baths in reducing the duration of crying and in the physiological measures of the newborn, with positive results in the reduction of behavioral stress symptoms, such as crying, agitation and pulling arms after the immersion bath. Similar to the later study, by Lemos et al. [16] observed preterm that when they were subjected to hot baths, the signs of irritation and crying decreased. Thus, we can say that the relationship between the CM and the immersion bath is a contributing factor for the development of premature infants and, thus, the reduction of pain.

4.2 Breastfeeding

In a randomized clinical trial by Ward and Collaborators [30] with the objective of implementing practices to improve Exclusive Breastfeeding at an Urban University Hospital in Ohio, it was shown in results that the majority of mothers, in the Kangaroo Method housing, opted for exclusive breastfeeding. Such findings agree with the findings of Alves et al. [20] who described that the second and third stages of the Kangaroo Method favored the practice and maintenance of exclusive breastfeeding. Given the above, it can be observed that breastfeeding during KM is a positive factor for the contribution of breastfeeding, making it a quality factor and influencing its exclusivity.

A study by Vaz et al. [31] in their descriptive and qualitative research, aimed to describe the conception of mothers inserted in the second stage of the CM regarding breastfeeding. The survey results highlighted that mothers understand that breastfeeding allows the growth and development of their children, contributing to the increase in breastfeeding rates during the period of prematurity of the baby. This finding is similar to the study by Alves et al. [20], where increases in Exclusive Breastfeeding rates are described after the period of contact through the Kangaroo Method and later after the period of hospital discharge

from the RNPB. In this way, the files help to state that Breastfeeding in contribution to the CM becomes an essential applicability factor for the development of the RNPB.

Mazumder et al [32] through a randomized control trial in a community in Haryana, India, where their main objective was to evaluate the effect of CM in low birth weight babies, relating it to neonatal survival. The research results were in agreement with the objectives sought, which reported that the group of preterm infants who were in skin-to-skin contact developed better in the ideal latch on breastfeeding, when compared to the group that were not in the CM. These data are similar to the research by Medeiros et al. [11] who observed the success in the breastfeeding stage, in addition to highlighting that direct contact with the mother's breast proved to be a relevant performance in the baby's oral route, helping in the progress of the aspects of skill, coordination, adequate weight gain and not occurrence of clinical changes. These findings demonstrate that breastfeeding helps both in the development of the PTNB and in the baby's coordination performances.

Likewise, Morelius et al. [33] through a randomized study with 37 premature infants in a hospital in Switzerland, sought to correlate the effects of skin-to-skin contact with breastfeeding, observed that mothers who had skin-to-skin contact with their babies had higher rates of exclusive breastfeeding, consequently increasing the levels of nutritional development of preterm infants. This study is similar to the study by Medeiros et al. [11] who, in their cohort study with 165 preterm infants, reported that babies who breastfeed during skin-to-skin contact gained more weight than the population that used cup/bottle feeding. . In view of the studies analyzed, the agreement that breastfeeding through skin-to-skin contact is more favorable for the development of preterm infants.

4.3 Affective Bond

Costa et al. [34] researched what the feelings of mothers would be during the experience of the Kangaroo Method in a descriptive study carried out in a Neonatal Unit in a teaching hospital in the South of Brazil, concluding that through the interviews, it can be highlighted that the CM builds emotional bonds and approximation and contact with the baby. In an observational study with 32 pairs of the mother-baby binomial, Nunes et al. [9] with the aim of understanding whether initial interactions of the mother-preterm child dyad had an influence on the duration of the Kangaroo Position, noting that the duration had a positive effect in the relationship between mother and child. Due to these findings, it is worth emphasizing the importance of the CM for the bond between the mother-baby binomial and its positive effects on both sides.

Cooijmans et al. [35] in a randomized clinical study with 116 mothers and their preterm babies, had positive results in the contact of the CM with the increase of the affective bond between the mother and the baby, reducing depressive symptoms, stress and anxiety. Similar to the findings of Nunes et al. [9] who verified the influence of the contact between the mother-baby binomial during skin-to-skin contact, resulting in a positive effect on communication and mother-child interaction. From this, it is worth mentioning that the prevalence of the affective bond between the mother prevails during the contact of the MC.

Vittner et al. [36] in a study with 28 preterm infants admitted to a Neonatal Intensive Care Unit, whose objective was to examine changes in salivary oxytocin (OT) and salivary cortisol (SC) levels of the baby and parents during skin contact to skin, observed that during skin-to-skin contact, oxytocin levels increased in parallel with reduced stress levels in both parents and babies. Similar to this finding, Sena et al. [19]in a study with 11 PTNBs in a NICU in Pará sought to analyze the effect of the kangaroo position on the cardiopulmonary system of hospitalized newborns, resulting in an increase in the body temperature of newborns, a factor that is directly linked to the release of oxytocin, and thus, stabilizing the baby's physiological parameters. These positive results may explain the influence of the bond between the family member and the baby and its positive effects during skin-to-skin contact.

Furthermore, Neu et al. [37] compared the impact of two different transfer techniques used in skin-to-skin care (nurse transfer and parent transfer) on the physiological stability of 15 premature babies, who in their results described that the babies were depleted. of energy, however, after skin-to-skin contact, the babies did not obtain energy expenditure, increasing their body self-regulation. Similar to this, Sena et al. [19] described that skin-to-skin contact helps in family bonding and better thermal control of the newborn. In view of the findings, it is essential to report that skin-to-skin contact makes the affective bond stronger and thus helps in the relationship of the binomial and consequently in the balance of the premature body temperature.

4.4 Maternal Intercurrences

In a study with 49 mothers of premature babies in an Intermediate Neonatal Care Unit (NICU) of a university

hospital in the interior of São Paulo, Castral et al. [38] MC time. This research is in agreement with the study by Silva et al. [38] who, in their longitudinal method carried out in a public maternity hospital in Recife, highlighted that muscle discomfort is a common complaint among mothers during the postpartum period and is correlated with physical overload, which is related to baby care and breastfeeding. In the meantime, it can be said that musculoskeletal pain when related to psychological factors can be a postpartum intercurrence factor for women.

Cirico et al. [40] in their quantitative research with 19 women in an accommodation at a University Hospital at the University of São Paulo reported that the majority had pain during breastfeeding due to fissures or other difficulties in breastfeeding. Research by Silva et al. [38] are in consensus regarding problems in breastfeeding, as pain from clefts was the main complaint of puerperal women in the process of breastfeeding in the MC of the maternity. These studied statements demonstrate that the pain caused by clefts during breastfeeding can be considered a maternal complication during breastfeeding in the CM.

A prospective study by Miracle and Collaborators [40] with the aim of analyzing which maternal decisions about the supply of milk to a low birth weight baby in a Tertiary Urban Neonatal Intensive Care Unit, the findings highlighted that the majority of mothers interviewed chose to breastfeed through of formulas because they were afraid of breast pain. This study is similar to the findings of Santos et al. [18], who in a cross-sectional cohort research, whose objective was to investigate the rate of Exclusive Breastfeeding (EBF) in preterm low birth weight, with the results of 60% of mothers opted for the non-exclusivity of EBF, often caused by pain and fissures. These studies emphasize that breastfeeding and its complications are still issues to be studied so that alternative means can be developed in order to reduce negative rates of discouraging the feeding method.

Kent et al. [42] sought to analyze the most recurrent factors regarding nipple pain in mothers during breastfeeding, resulting in the most recurrent factors being wrong positioning, tongue tied, infection, and inverted nipples. This study is similar to the research by Santos et al. [18] had negative responses regarding breastfeeding of mothers of preterm infants, in which most preferred to leave EB due to maternal complications. Given the above, the search for interventional means in the management of pain when breastfeeding should be encouraged.

4.5 Interdisciplinary within the kangaroo method

Medeiros et al. [43] when carrying out an observational and descriptive study, with the aid of collecting data from medical and speech therapy records of 38 newborns, of both genders, admitted to the Kangaroo Neonatal Intermediate Care Unit (UCINCA), in a public maternity hospital in the city of Aracaju (SE), from August 2012 to April 2013, sought to investigate the association between gestational age and speech therapy intervention time to start oral feeding, when using the feeding transition technique of tube directly to the chest, and noted that when using this method in high-risk newborns with a close mean gestational age, with the same speech-language intervention time, the babies showed greater ability to coordinate sucking/breathing/swallowing movements, which as a consequence, effective breastfeeding at the mother's breast exclusively. This study presented similarities with those observed in the study by Teixeira et al. [21], in which it was possible to observe that most children who were followed up in the speech therapy sector managed to evolve at hospital discharge to exclusive breastfeeding, especially in babies born between 32 and 37 weeks. In this way, the inclusion of the speech therapist in neonatal units and in the Kangaroo Method, integrated into the interdisciplinary team, should be encouraged, since the latter can act early in the promotion of the practice of breastfeeding, contributing to promote and stimulate, in a safe, oral feeding, assist in the transition from the use of the tube to the mother's breast, contributing to the improvement of the quality of life of these NBs.

Basso et al. [44] and Segala et al. [45] in their studies on speech therapy performance in the Kangaroo Method in consecutively a Neonatal Intensive Care Unit (NICU), an Intermediate Neonatal Care Unit (NICU) and at the Kangaroo Method Neonatal Intermediate Care Unit (UCINCA) of the Hospital da Criança e Maternity of São José do Rio Preto and in a Rooming-in Unit at the University Hospital of Santa Maria (UFSM), identified that early stimulation performed by the speech-language pathology team contributes to an improvement in the prognosis and better response of NBs to exclusive breastfeeding. , the continuity of breastfeeding after discharge and the improvement in the quality of life of this population. These favorable outcomes are also observed in the work by Teixeira et al. [21]in which the multidisciplinary team is essential for the progress of the little ones. In this way, in order to contribute to the clinical evolution of premature babies, the union of the Kangaroo methodology application and the speech therapy work corroborate the promotion of early breastfeeding, contributing in such a way that neonates are often able to be discharged from hospital probes and other devices used to assist in breastfeeding, showing the effectiveness of collaboration within the team.

Araújo et al. [46] in an exploratory descriptive study with 10 mothers in a kangaroo ward of the Maternity School Santa Monica, in Maceió, Brazil, discussed the importance of the multidisciplinary team in helping mothers during the baby's hospitalization process, to alleviate their fears, insecurities through support and information exchange. The findings corroborate the same line of reasoning as Nietsche et al. [15]in their qualitative approach study carried out in a Neonatal ICU of a university hospital, located in the interior of Rio Grande do Sul (RS), proved that the participation of the multidisciplinary team is essential to ensure the success of the practice of MC. Given the above, it is essential to reaffirm that the multidisciplinary team must be able to provide the necessary support to family members during the hospitalization period.

In a descriptive study carried out by Silva et al. [12] with nursing professionals who worked in the Neonatal ICU of a Maternity Hospital in Rio de Janeiro, sought to describe the multi-professional work in humanization programs in the NICU environment, which include the Kangaroo Method. The results described that the means of humanization, such as the MC, bring a satisfactory development to the evolution of the little ones hospitalized. This study is similar to that of Nietsche et al. [15] concluded that educational actions for health professionals regarding CM aim to enhance the assistance provided by the team to the NB and help their family. These findings contribute to reporting the importance of training on the kangaroo method from the perspective of professionals in the hospital environment.

Brant et al. [47] in a study with a qualitative approach, in which 32 pairs of mothers-infants who participated in a breastfeeding guidance and support group at the Exclusive Breastfeeding Outpatient Clinic of a Hospital located in Espírito Santo, Brazil. The women interviewed found that guidance on breastfeeding creates spaces for both informative and affective exchanges. These findings are confirmed by the research by Sousa et al. [14] in their study whose objective was to identify the actions of health professionals to strengthen the bond between the baby and the family, found that professionals should be mediators in establishing methods to provide a strengthening of affective bonds between the newborn. -born and their family within the NICU. In view of the highlighted topics, the importance of the multidisciplinary team in guiding family members during the breastfeeding period should be highlighted, as the exchange of information brings mutual benefits to all involved.

In a study carried out by Baptista et al. [48]sought to understand the importance of the clinical management of breastfeeding carried out through the support of health professionals in the Neonatal Intensive Care Unit of the Antônio Pedro University Hospital, in Rio de Janeiro, showed that professionals must develop a sensitive listening behavior, observing and answering questions about nursing mothers and their difficulties with breastfeeding, encouraging the team's role in helping the mother to achieve a positive development through lactation, and in the bond between the mother-baby binomial. This content agrees with the findings of Sousa et al. [14] in their qualitative and descriptive research, concluded that nurses felt fulfilled and satisfied in being able to contribute to this strengthening of the affective bond of the premature newborn with the family.

V. CONCLUSION

This study sought to investigate in recent literature the influence of the kangaroo method on the nutritional status of premature infants. In the research, it can be seen that the longer the baby remains in the kangaroo method, the greater its development, whether physiological, neurological, and consequently weight gain. In this sense, this tool has been essential over the years for the evolution with discharge of the little ones, who need more complex care.

Through the research, it was highlighted that the kangaroo method is a positive factor for the development of preterm infants, since the searches showed the prevalence of notorious responses in the sensorimotor development of these, reduction of stress levels, neuro-motor development of the baby. and on the physiological characteristics of the newborn.

Furthermore, the findings in the literature corroborate that the kangaroo method is an auxiliary factor in the quality of breastfeeding. The practice of skin-to-skin contact influences breastfeeding due to the increased demand for mother-baby time and the affective bond, making the conduct continue after hospital discharge. The development of breastfeeding after hospital discharge reduces the levels of early weaning, and promotes the influence on exclusive breastfeeding until the baby's sixth month.

The main maternal complications related to the kangaroo method found in the literature highlighted are breast fissures and musculoskeletal pain that bring discouragement during skin-to-skin contact. In the same sense, psychological factors such as emotional exhaustion influence premature infants to give up exclusive breastfeeding. The findings in the literature still need to be analyzed to find viable means of intervention in order to

reduce negative rates of discouraging the exclusive breastfeeding method in preterm infants included in skin-to-skin contact.

The kangaroo method, as it is a non-invasive and easy-to-perform treatment method, deserves greater appreciation. With this, it is essential that public policies are implemented in order to value this method and thus use resources to propagate the performance in hospital institutions and in primary health care, promoting today a line of care for premature infants and thus reduce case fatality rates in this population.

REFERENCES

[1] OPAS - Organização Pan-Americana da Saúde. Nova pesquisa destaca riscos de separar recém-nascidos de suas mães durante a pandemia de COVID-19. Genebra, 17 mar. 2021. Disponível em:https://www.paho.org/pt/noticias/16-3-2021-nova-pesquisa-destaca-riscos-separar-recem-nascidos-suas-maes-durante-pandemia

[2] Brasil. Ministério daSaúde. Secretariade Atenção à Saúde. Departamento deAções Programáticas Estratégicas. Método Canguru : manual da terceira etapa do Método Canguru na Atenção Básica / Ministério da Saúde, Secretaria de Atenção à Saúde, Departamento de Ações Programáticas Estratégicas. – Brasília : Ministério da Saúde, 2018. 98 p. : il.

[3] Brasil. Ministério da Saúde. Mês da prematuridade: Ministério da Saúde defende separação zero entre pais e recém-nascidos. Novembro, 2021.

[4] Luz, S. C., Backes, M. T. S., Rosa, R., Schmit, E. L., & Santos, E. K. A. (2021). Kangaroo Method: potentialities, barriers and difficulties in humanized care for newborns in the Neonatal ICU. *Revista Brasileira de Enfermagem [online]*, 11 (2).

[5] Krebs, V. A. (2022). Repercussões fisiológicas e psicossociais do contato pele a pele durante o desenvolvimento do recém-nascido.*Brazilian Journal of Health Review*, 5 (1), 1475-1485. doi:10.34119/bjhrv5n1-126

[6] Nunes, A. M. L. A. (2022). Importância Do Método Canguru Para Recém- Nascidos Prematuros E/Ou De Baixo Peso Ao Nascer.*Revista Ibero - Americana de Humanidades, Ciências e Educação***,** 8 (2). doi:org/ 10.51891/rease.v8i2.4186

[7] BUENO, T. M. Repercusióndelaseoenla estabilidade térmica delreciénnacido de extremado bajo peso durante lasprimeras dos semanas de vida. AnalesPediatría, Barcelona, v. 63, n. 1, p. 5-13, 2005

[8] Cabral IE, Groleau D. Breastfeeding practices after Kangaroo Mother Method in Rio de Janeiro: the necessity for health education and nursing intervention at home. *Esc Anna Nery Rev Enferm* 2009; 13(4):763-771.

[9] Nunes, C. R. N., Campos, L. G., Lucena, A. M., Pereira, J. M., Costa, P. R., Lima, F. A. F.,& Azevedo, V. M. G. O. (2017). Relação da duração da posição canguru e interação mãe-filho pré-termo na alta hospitalar.*Rev. paul. pediatr*, 35(2), 136-143. doi: https://doi.org/10.1590/1984-0462/;2017;35;2;00006

[10] Farias, S. R., Dias, F. de S. B., Silva, J. B. da, Cellere, A. L. de L. R., Beraldo, L., & Carmona, E. V. (2017). Posição canguru em recém-nascidos pré-termo de muito baixo peso: estudo descritivo. *Revista Eletrônica De Enfermagem*, *19*.https://doi.org/10.5216/ree.v19.38433

[11] Medeiros, A. M. C., Ramos, B. K. B., Bomfim, D. L. S. S., Alvelos, C. L., Silva, T. C., Barreto, I. D. C., Santos, F. B., & Gurgel,R. Q. (2018). Tempo de transição alimentar na técnica sonda-peito em recém-nascidos baixo peso do Método Canguru. *CoDAS 30 (2)*. https://doi.org/10.1590/2317-1782/20182017092

[12] Silva, J. M. G. P., Andrade, M. A., Nepomuceno, E. J., Cunha, C. M. P., & Maia, J. N. (2018). Queixas dolorosas em participantes no método mãe canguru. *Fisioterapia Brasil, 19 (1). doi:*https://doi.org/10.33233/fb.v19i1.2177

[13] Souza, A. K. C. M., Tavares, A. C. M., Carvalho, D. G. L., & Araújo, V. C. (2018). Ganho de peso em recém-nascidos submetidos ao contato pele a pele. *Rev. CEFAC., 20(1), 53-60*.doi: doi: 10.1590/1982-021620182018317

[14] Sousa, S. C., Medino, Y. M. S., Benevides, K. G. C. B., Ibiapina, A. S., & Ataíde, K. M. N. (2019). Fortalecimento Do Vínculo Entre A Família E O Neonato Prematuro. R*ev enferm UFPE on line, 13(2)*, 298-306.doi: https://doi.org/10.5205/1981-8963-v13i02a236820p298-306-2019

[15] Nietsche, E. A., Papa, M. M., Terra, L. G., Reisdorfer, A. P., Ramos, T. K.,& Antunes, A. P. (2020). Método Canguru: estratégias de Educação Permanente para sua implementação e execução. *RevCuid., 11(1).*doi: http://dx.doi.org/10.15649/cuidarte.897

[16] Lemos, G. C., Almeida, T. V. C., Pinto, M. M., & Medeiros, A. I. C. (2020). Efeitos da ofuroterapia no relaxamento e ganho de peso em recém-nascidos prematuros na unidade de cuidados neonatal. *RevPesquiFisioter., 10 (3)*, 393-403. doi: 10.17267/2238-2704rpf.v10i3.2953

[17] Diniz, K. T., Cabral Filho J. E., Miranda, R. M., Lima, G. M., Figueredo, N. P., & Araújo, K. F. (2020). Short-time effect of the kangarooposition on electromyographic activity of premature infants: a randomized clinical trial. J Pediatr (Rio J), 96 (6). Doi: https://doi.org/10.1016/j.jped.2019.10.003

[18] Santos, K. E. F., Vilela, J. C. G., Costa, T. P., Castro, É. F., & Maia, C.R. S. (2020). Seis meses de aleitamento Materno exclusivo no pré-termo de muito baixo peso submetido ao método canguru. ResidPediatr. 0(0):

[19] Sena, M. R. D., Frare, P. B. F. S., da Cunha, V. S. M., & da Silva, R. L. F. (2020). Influência da posição canguru no sistema cardiopulmonar de prematuros em uma Unidade de Terapia Intensiva Neonatal na Amazônia. *REAS/EJCH, 41 (1)* DOI: https://doi.org/10.25248/reas.e2419.2020

[20] Alves, F. N., Wolkers, P., Araújo, L., Marques, D., & Azevedo, V. M. G. O. (2021). Impacto da segunda e terceira etapas do método canguru: do nascimento ao sexto mês. *Revista de Enfermagem do Centro-Oeste Mineiro*, 11 (1), 4200. doi: https://doi.org/10.19175/recom.v11i0.4200

[21] Teixeira, M. A., Britto, D. B. O. Escarce, A. G., de Paula, D. D., & Lemos, S. M. A. (2022). Perfil de prematuros em atendimento fonoaudiológico em um ambulatório de followup. *AudiolCommun Res.*, 27 (1). doi: https://doi.org/10.1590/2317-6431-2020-2430

[22] Amaral, D. A., Matos, D. A. A., Gregório, E. L. (2015). Impacto De Uma Intervenção Pró-Aleitamento Nas Taxas De Amamentação De Prematuros Inseridos No Método Mãe Canguru. *Rev. APS*, 18(1), 57 - 63.

[23] Leite, P. F. P., Freire, A. I. M. M., Ribeiro, S. P. A., Cabral, L. N., & Guilherme, J. P. (2017). Incidência de aleitamento materno no momento da alta da terceira etapa do método canguru da Maternidade Ana Braga. *Rev. Ciências de Saúde da Amazônia*, 1 (1).

[24] Bera, A., Ghosh, J., Singh, A. K., Hazra, A., Mukherjee, S., &Mukherjee, R. (2014). Effect of kangaroo mother care on growth and development of low birthweight babies up to 12 months of age: a controlled clinical trial. *Acta Paediatrica*, 103(6), 643–650. doi:10.1111/apa.12618

[25] Mwendwa, A. C., Musoke, R. N., &Wamalwa, D. C. (2012). Impact Of Partial Kangaroo Mother Care On Growth Rates And Duration Of Hospital Stay Of Low Birth Weight Infants At The Kenyatta National Hospital, Nairobi. *East African medical journal*, *89*(2), 53–58.

[26] Menezes, M. A., Garcia, D. C., de Melo, E. V., &Cipolotti, R. (2014). Preterm newborns at Kangaroo Mother Care: a cohort follow-up from birth to six months. *Revista paulista de pediatria :orgao oficial da Sociedade de Pediatria de Sao Paulo*, *32*(2), 171–177. https://doi.org/10.1590/0103-0582201432213113

[27] Mota, L. A. da, Sá, F. E. de, & Frota, M. A. (2012). Estudo comparativo do desenvolvimento sensório-motor de recém-nascidos prematuros da unidade de terapia intensiva neonatal e do método canguru. *Revista Brasileira Em Promoção Da Saúde*, *18*(4), 191–198. https://doi.org/10.5020/943

[28] Srinath, B., Shah, J.,Kumar, P., &Shah, P. S. (2016).Cuidado canguru por pais e mães: comparação de respostas fisiológicas e de estresse em bebês prematuros. *J Perinatol*36 (1), 401–404. https://doi.org/10.1038/jp.2015.19

[29] Çaka, S. Y., &Gözen, D. (2017). Effects of swaddled and traditional tub bathing methods on crying and physiological responses of newborns.Journal for Specialists in Pediatric Nursing, 23(1), e12202. doi:10.1111/jspn.12202

[30] Ward, L. P., Williamson, S., Burke, S., Crawford-Hemphill, R., & Thompson, A. M. (2017). *Improving Exclusive Breastfeeding in an Urban Academic Hospital.Pediatrics, 139(2), e20160344.* doi:10.1542/peds.2016-0344 .

[31] Vaz, D. C., Silva, D. S., Santos, D. S. S., Bonfim, M. V., & Abreu, R. M. (2014). Concepção Materna Sobre A Amamentação Em Lactentes De Um Programa Do Método Mãe Canguru. *Revista Baiana de Saúde Pública*, 38 (2), 225-242.

[32] Mazumder, S., Taneja, S., Dube, B., Bhatia, K.,Ghosh, R., Shekhar, M., … Bhandari, N. (2019). Effect of community-initiated kangaroo mother care on survival of infants with low birthweight: a randomised controlled trial.*The Lancet*.doi:10.1016/s0140-6736(19)32223-8

[33] Mörelius, E., Örtenstrand, A., Theodorsson, E., &Frostell, A. (2015). A randomised trial of continuous skin-to-skin contact after preterm birth and the effects on salivary cortisol, parental stress, depression, and breastfeeding. *Early Human Development*, 91(1), 63–70. doi:10.1016/j.earlhumdev.2014.12.

[34] Costa, R., Heck, G. M. M., Lucca, H. C., Santos, S. V. (2014). Da Incubadora Para O Colinho: O Discurso Materno Sobre A Vivência No Método Canguru. RevEnferm Atenção Saúde [Online], 3 (2), 41-53. doi:https://doi.org/10.18554/

[35] Cooijmans, K. H. M., Beijers, R., Rovers, A. C., &Weerth, C. (2017). Effectiveness of skin-to-skin contact versus care-as-usual in mothers and their full-term infants: study protocol for a parallel-group randomized controlled trial. BMC Pediatrics, 17 (154).doi:10.1186/s12887-017-0906-9

[36] Vittner, D., McGrath, J., Robinson, J., Lawhon, G., Cusson, R., Eisenfeld, L., … Cong, X. (2017). Increase in Oxytocin From Skin-to-Skin Contact Enhances Development of Parent–Infant Relationship. *Biological Research For Nursing*, 20(1), 54–62. doi:10.1177/1099800417735633

[37] Neu, M., Browne, J. V., &Vojir, C. (2000). The impact of two transfer techniques used during skin-to-skin care on the physiologic and behavioral responses of preterm infants. *Nursing research*, *49*(4), 215–223. https://doi.org/10.1097/00006199-200007000-00005

[38] Castral, T. C., Warnock, F. F., Ribeiro, L. M., Vasconcelos, M. G. L., Leite, A. M., Scochi, C. G. S. (2012). Fatores maternos influenciam a resposta à dor e ao estresse do neonato em posição canguru. Rev. Latino-Am. Enfermagem, 20 (3).

[39] Silva, L., Leite, J. L., Silva, T. P., Silva, I. R., Mourão, P. P., & Gomes, T. M. (2018). Management challenges for best practices of the Kangaroo Method in the Neonatal ICU. *RevBrasEnferm [Internet]*, 71(6), 2783-91. doi: https://doi.org/10.1590/0034-7167-2018-0428

[40] Cirico, M. O.,Shimoda, G. T., & Oliveira, R. N. G. (2016) Qualidade assistencial em aleitamento materno: implantação do indicador de trauma mamilar. Rev Gaúcha Enferm., 37(4) :e60546.

[41] Miracle, D. J., Meier, P. P., & Bennett, P. A. (2004). Mothers' Decisions to Change From Formula to Mothers' Milk for Very-Low-Birth-Weight Infants. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 33(6), 692–703.doi:10.1177/0884217504270665

[42] Kent, J., Ashton, E., Hardwick, C., Rowan, M., Chia, E., Fairclough, K., … Geddes, D. (2015). Nipple Pain in Breastfeeding Mothers: Incidence, Causes and Treatments. *International Journal of Environmental Research and Public Health*, 12(10), 12247–12263.doi:10.3390/ijerph121012247

[43] Medeiros, A. M. C., Sá, T. P. L., Alvelos, C. L., & Novais, D. S. F. (2014). Intervenção fonoaudiológica na transição alimentar de sonda para peito em recém-nascidos do Método Canguru. *Audiology-Communication Research*, 19 (1), 95-103.

[44] Basso, C. S. D., Arroyo, M. A. S., Saes, M. A. B. F., Beani, L., Maia, A. B., &Lourenção, L. G. (2020). Índice de aleitamento materno e atuação fonoaudiológica no Método Canguru. *Revista Cefac*, 21 (5). doi:http://dx.doi.org/10.1590/1982-0216/201921511719

[45] Segala, F., Bolzan, G. P., Nascimento, M. D., Gonçalves, D. S., Melchior, A., Moraes, M. V. M., &Weinmann, A. R. M. (2022). Influência do estímulo gustativo na pressão de sucção de recém-nascidos a termo. *CoDAS*, 34 (3). doi: https://doi.org/10.1590/2317-1782/20212021002

[46] Araujo, A. M. G., Melo, L. S., Alves de Souza, M. E. D.C., Freitas, M. M.S M., Lima, M. G. L., & Lessa, R. O. (2016). A Experiência Do Método Canguru Vivenciada Pelas Mães Em Uma Maternidade Pública De Maceió/Al Brasil. *Rev. iberoam. educ. investi. Enferm.*, 6(3), 19-27

[47] Brant, P., Affonso, H., & Vargas, L. (2009). INCENTIVO À AMAMENTAÇÃO EXCLUSIVA NA PERSPECTIVA DAS PUÉRPERAS. *Cogitare Enfermagem*, *14*(3), 512-517. doi:http://dx.doi.org/10.5380/ce.v14i3.16182

[48] Baptista, S. de S., Alves, V. H., Souza, R. de M. P. de, Rodrigues, D. P., Cruz, A. F. do N. da, & Branco, M. B. L. R. (2015). Manejo clínico da amamentação: atuação do enfermeiro na Unidade de Terapia Intensiva Neonatal. *Revista De Enfermagem Da UFSM*, *5*(1), 23–31.https://doi.org/10.5902/2179769214687

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.38

Aspects of Infant Eating Behavior in Children from 0 to 10 Years: An Integrative Review

Natasha Assunção Oliveira[1], Bárbara Martins de Sales Santos[1], Bárbara Vitória Monteiro Reis Augusto[1], Beatriz Cibele Brabo Mauro[1], Fabíola dias da Silva[1], Lorenna Vidal Rodrigues da Silva[1], Paula Rayssa Lobato da Silva[1], Paula Raimunda Araújo Teixeira[1], Rodrigo Aires Andrade[1], Tatiane Abreu Fonseca[1], Thalya Cristina Ribeiro Brasil[1], Luísa Margareth Carneiro da Silva[2]

[1]Institute of Health Sciences, Faculty of Nutrition, Federal University of Pará, Brazil
Email: natasha.oliveira@ics.ufpa.br/ lorenna.silva@ics.ufpa.br / paula.teixeira@icb.ufpa.br
[2]CECANE/PA, Federal University of Pará, Brazil
Email: luisamargarett@gmail.com

Received: 02 May 2022,

Received in revised form: 20 May 2022,

Accepted: 26 May 2022,

Available online: 31 May 2022

Keywords *— **eating behavior, eating habits, eating disorder, childhood, food advertising.***

Abstract *— Childhood is an essential phase in the formation of eating habits and eating behavior of an adult individual, and the construction of children's eating behavior can positively or negatively influence the child's health. Thus, in this literature review, the objective was to survey aspects of children's eating behavior in children aged 0 to 10 years. The review used the following databases: MEDLINE, LILACS, BDENF, BBO, Coleciona SUS and SCIELO, and was developed in six stages: 1. elaboration of the research question, 2. definition of the sources for the selection of primary studies and the criteria for inclusion and exclusion, 3. definition and extraction of data, 4. evaluation of included studies, 5. critical analysis of the results, 6. presentation of the synthesis of the evidence found. Twelve studies were selected, which showed that the eating behavior of parents and guardians influenced children's food choices, and reward strategies had negative effects on eating habits and behavior. Regarding the school environment, there was a high consumption of processed and ultra-processed foods and a low consumption of in-natura foods, however, the benefits of nutritional education and the role of parents and caregivers in building healthy eating habits and in the development physical and mental.*

I. INTRODUCTION

The first years of life are fundamental for the growth and development of children, and are essential for the formation of habits that will have a direct impact on the promotion and maintenance of health. In this context, food plays a decisive role in human health conditions [1]. There is a consensus that food can provide protection or worsen various diseases, such as chronic non-communicable diseases, which currently represent the largest cause of mortality in the world [2].

The State of the World's Children 2019 report found that a third of children under the age of 5 are undernourished or overweight, and two thirds are at risk of malnutrition and hidden hunger due to the poor quality of their food [3].

Childhood is considered an essential phase in the formation of eating habits. In recent years, aspects related to infant feeding have drawn the attention of several researchers, as this stage in the construction of eating behavior is made up of complex factors that can impact the individual's subsequent eating behavior [4].

The author Marle Alvarenga [5] defines eating behavior as a set of cognitions and affections that govern the individual's eating actions and behaviors, it is also all kinds of food constructs, such as: consumption habits, eating habits, and where to eat.

It is in childhood that eating behavior has its bases fixed, it is at this stage that eating attitudes will be formed that can have positive and negative impacts on the child's health. Eating habits learned in childhood are difficult to change in adulthood. Therefore, as a rule, the eating behavior built in the first years of life will accompany the individual in his later years [6].

In view of the above, it is necessary to understand the factors that constitute children's eating behavior, as well as their impacts on children's health. Therefore, in this literature review, the objective was to survey aspects of children's eating behavior in children aged 0 to 10 years.

II. METHODOLOGY

2.2 Type of study

Descriptive-analytical cross-sectional study of literature review, which was carried out in the following steps: 1- Choice of research topic, 2- Definition of descriptors, 3- Search in databases, 4- Selection of articles, 5- Critical analysis of the selected studies, 6- presentation of the synthesis of the evidence found.

2.2.1 Scenery

In November 2021, a survey of scientific articles published in the last 5 years in Portuguese was carried out, using the electronic database MEDLINE, LILACS, BDENF - nursing (Brazil), BBO - dentistry (Brazil), Coleciona SUS (Brazil), SCIELO Brasil – Scientific Electronic Library online, from the CAPES Portal through the Virtual Health Library of the Ministry of Health – BVS MS, which has been available on the internet since 2001, being responsible for publishing bibliographic publications produced by the Ministry of Health, as well as information in the area of health sciences.

2.2.2 Descriptors

To define the search, the following descriptors were used: Eating behavior; Food habit; Eating disorder; Children and Food Advertising.

2.2.3 Inclusion and Exclusion Criteria

For the selection of studies, the following inclusion criteria were adopted: Works published between 2016 and 2021, written in Portuguese.

We excluded from the sample, works that did not address the behavioral aspects of infant feeding, and that did not include the age group from 0 to 10 years.

2.2.4 Data collection

During the research in the databases, filters were applied to include only studies published in Portuguese, in the period from 2016 to 2021. After applying the filters, the five descriptors were inserted together in the databases, however, none article was found in the search. Then, four searches were performed by entering the descriptors in pairs.

In the first search, the descriptors used were: “Eating behavior” and “childhood”, obtaining 45 articles as a result, of which 10 were pre-selected. Then, the descriptors used were: “Food behavior” and “Food advertising”, 8 articles were found, 3 were eliminated by repetition and 1 was pre-selected. In the third search, the terms “eating disorder” and “childhood” were used to delimit the research, where 4 works were obtained as a result, 1 being eliminated by repetition and none pre-selected. The last search was performed using the terms “eating habits” and “childhood”, 68 articles were found, 6 were excluded by repetition and 3 were pre-selected.

At the end of the search, 12 articles were selected for literature review.

III. RESULTS

Through the search in the databases, a total of 125 articles published in Portuguese in the last five years were found. A considerable part of this sample was not selected for the review because it did not satisfactorily address the topic discussed in this study. 10 articles were excluded due to duplication and 14 were pre-selected. After a complete reading of the studies, 2 were excluded because they did not cover the topic of interest in the present study. Thus, 12 studies were selected to be discussed in this review.

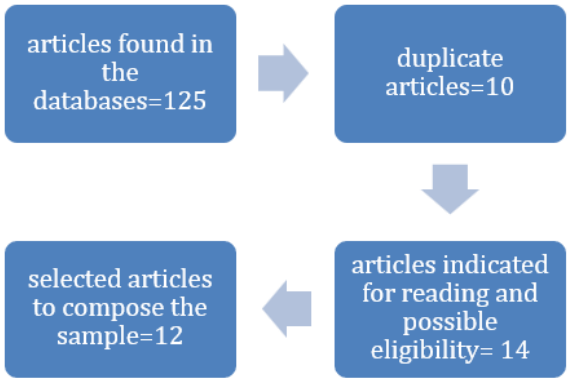


Fig.1: Flowchart of the integrative review articles selection process.

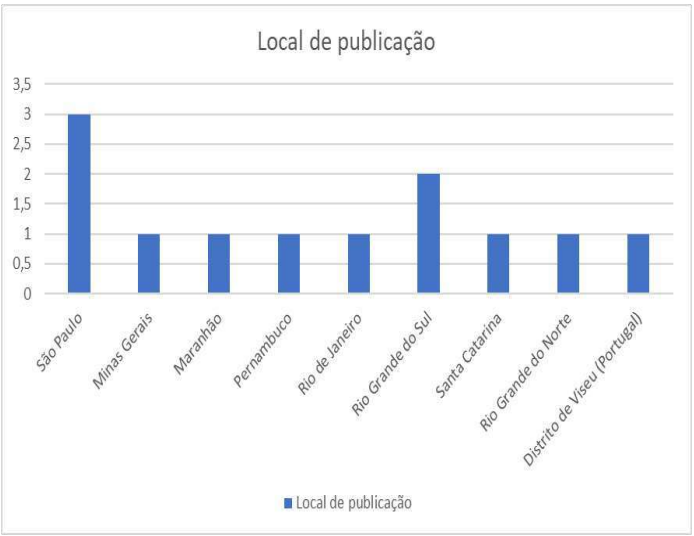
Source: Authors, 2022

Graph 1: Year of publication of the studies included in the sample.

Source: Authors, 2022.

As described in the methodology, all selected studies were published in the period between 2016 and 2021. It is possible to observe that in 2017 there was a greater volume of publications of the articles chosen for this review

Graph 2: Place of publication of the studies included in the sample.



Source: Authors, 2022.

During the search for articles in the databases, a filter was applied to display only articles published in Portuguese, thus, 92% of the studies were published in Brazilian cities, and 1 article was published in the district of Viseu in Portugal.

Table 2 presents the methodology, objectives, results and conclusion of the primary studies.

Table.2: Synthesis of the articles selected for the integrative review.

TITLE	AIM	METHODOLOGY	RESULTS	CONCLUSION
Parents' knowledge about infant feeding: relationship with sociodemographic characteristics and nutritional status of the child [7]	Classify the child's nutritional status; to analyze the influence of sociodemographic variables on parents' knowledge about child	Quantitative, cross-sectional, descriptive and correlational study, carried out in a non-probabilistic sample, for convenience of 114 parents and children, mothers with a mean age of 34.40 years and fathers 36.50 years old. Of the children, 56.1%	The questionnaire was answered mainly by the children's mothers in a total of 103 (90.4%) and only by 11 (9.6%) by the fathers. As for the parents' education, 47.1% had secondary education, 35.6% had primary education and 17.3% of the mothers had higher	The results indicate that parents' knowledge about child nutrition remains insufficient and associated with the sociodemographic context of health inequalities. Thus, it is important to promote the strengthening of

	nutrition; to relate the nutritional status of the child with the parents' knowledge about food	were preschool age and 43.9% school age, ranging from 3 years to 9 years. For the collection of information, the questionnaire "Knowledge of Parents on Infant Feeding (QAI)" by Aparício, Nunes, Duarte and Pereira (2012) was used. In order to classify the BMI, an anthropometric assessment was carried out on children in kindergarten, elementary schools and in child health surveillance consultations at the Personalized Health Care Unit (UCSP) in a municipality in the district of Viseu. and the NCHCS cut-off points (CDC, 2000) were used to classify nutritional status..	education. in relation to Parents, 50.0% had basic education and higher education, respectively. As for the nutritional status of the children, 57.0% of the children were normal weight, 16.7% were pre-obese, 13.2% were obese (29.9% overweight) and 13.2% were in a situation of Low weight. As for the result of the questionnaire, it was found that 43.9% had sufficient knowledge, 30.7% good knowledge and 25.4% had insufficient knowledge.	the family, improving their knowledge about child nutrition, which can be one of the strategies for preventing childhood obesity and minimizing health inequities.
Parental eating practices: the perception of children about the educational strategies used in the conditioning of eating behavior [8]	To evaluate the children's perception of the eating practices used by their parents, namely: control of food made by the child, use of food to control emotions, encouraging balance and food variety, environment with healthy food, food as a reward , involvement,	The study was carried out through the Food Practices Verification Questionnaire (QVPA) - Children Version (Mayer, 2011). Research participants were included via non-specific sampling. -probabilistic, whose participation was voluntary and anonymous. A total of 114 children from public and private schools in São Luís (MA) participated in the study, aged between eight and 11 years (M = 9.8 years; SD = 1), 63 of them from women. .	The analysis of parental feeding practices indicated several correlations between them. Several practices considered adequate correlated with each other, in all crossings. And as for inappropriate practices, emphasis is given to the correlation between the use of food as a reward and the use of foods to control emotions, showing that both practices sometimes appear together in the same family context.	The analysis of parental feeding practices indicated several correlations between them. Several practices considered adequate correlated with each other, in all crossings. And as for inappropriate practices, emphasis is given to the correlation between the use of food as a reward and the use of foods to control emotions, showing that both practices sometimes appear together in the same family context

	modeling, monitoring, pressure to eat, dietary restriction for health, dietary restriction for weight control, and nutrition education. To characterize the discourse made possible in advertisements and food advertisements aimed at children.			
Mothers' perception of children's food advertising [9]	To characterize the discourse made possible in advertisements and food advertisements aimed at children.	Two methods were applied in this research: the first was the in-depth interview, where seven mothers with children between the ages of 2 and 12 years, and different social classes were interviewed: and the other method applied in the study was the Focus Group, which is a qualitative technique done through in-depth interviews in groups. In this method, 13 class A mothers with children between the ages of 2 and 12 years were gathered.	Mothers were helpless in the face of the current panorama of children's advertising, and reported feeling deceived by advertisements.	Changes are needed in several ways so that children's advertising is positively recognized by mothers.
Childhood obesity: family experiences related to the nutritional counseling process [10]	Describe, interpret and understand family experiences related to nutritional counseling for	Qualitative, exploratory research, with data production through focus groups. The participating subjects were the family members of children who undergo nutritional	The study sample was 100% composed of women, which demonstrates that the female role is still predominant in the care of children in general. As for the perceptions of	Food has shown to have functions that go beyond the supply of biological needs by adding cultural, behavioral and affective meanings from which

	children with obesity	monitoring due to the diagnosis of obesity at the Policlínica Centro de São Bernardo do Campo.	the children's body image, the family members feared that the child would suffer prejudice because of their physical appearance, it was also possible to observe that some families consider overweight in certain age groups as a positive health indicator. Concerning children's body self-image, children's desire to lose weight in order to reach a socially accepted standard of beauty was notorious.	individuals relate. The experiences and life trajectories of each of these families are unique and underlie the way situations are individually experienced by them and directly impact their attitudes and behaviors. Food and eating proved to be linked to history, memories and the affective dimension that makes up each of these people.
Food purchase and consumption habits in families under five years of age in a municipality in northeastern Brazil [11]	To evaluate food purchase and consumption habits in families with children under five years of age in a municipality in Northeast Brazil	Cross-sectional research, with a quantitative approach, carried out with 138 individuals in the six basic urban health units in the city. A structured interview was carried out with the application of questionnaires on socioeconomic information, food purchase and consumption habits, food safety, self-reported weight and height..	Among the consumption habits evaluated, it was verified that the consumption of raw salad (83.8%), fruits (95.9%) and fruit or pulp juice (93.8%) on at least one day a week were associated with higher education. While the higher frequency of purchase and consumption in restaurants and snack bars was associated with a higher income, having a job and not participating in social programs.	Hábitos de compra e de consumo de alimentos mais saudáveis foram associados com maior escolaridade e condições de trabalho e renda. Assim como acesso à restaurantes e lanchonetes em indivíduos com melhor poder aquisitivo.
The influence of the media on children's food consumption: a literature review [12]	Discuss the influence of the media in children's food consumption.	Bibliographic review including scientific articles, dissertations and theses published between 2009 and 2016, located in the online databases/research portals: Scientific Electronic Library Online, Latin American and Caribbean Literature	Studies have shown that children are attracted by the artifices used in advertising and feel the urge to purchase the advertised foods, especially those that use gifts and children's characters.	It can be observed that the media has a great influence on children's eating habits, using the most different artifices to induce consumption. Studies indicate that the dissemination of high-calorie and low-nutrition foods has

		on Health Sciences Information, Virtual Health Library and Google Scholar. The keywords used were: child food consumption, childhood obesity, food marketing and advertising.		contributed to an obesogenic environment and a considerable increase in NCDs. It is also emphasized that the role of the family is fundamental for the promotion of healthy habits for children and for guiding them that not everything that the media propagates brings health benefits.
Participation of ultra-processed foods in the diet of Brazilian schoolchildren and their associated factors [13]	To evaluate the contribution of ultra-processed foods (UPF) in the diet of schoolchildren and their associated factors.	Cross-sectional study carried out with children between eight and 12 years of age in public schools in a Brazilian capital. Anthropometric data and dietary and lifestyle habits were investigated.	The average energy consumption was 1,992 kcal/day, 25.2% of which came from the AUP. The students had a mean age of 9.8±0.5 years, 53.4% were female and 32.6% were overweight. The most consumed UPAs were industrialized pasta, sweet biscuits, sausages, powdered chocolate and soft drinks. Schoolchildren with the habit of eating in front of the television and overweight had 1.87 (95% confidence interval [95%CI] 1.03–3.39) and 2.05 (95%CI 1.01–4, 20) times more likely to have a greater participation of AUP in the diet, respectively.	The AUP contribution was significant in the schoolchildren's diet and was positively associated with overweight and the habit of eating while watching television. These findings denote the importance of nutritional interventions to promote healthy habits, thus preventing overweight in childhood.
Healthy eating related to eating behavior and social conduct [14]	Develop the Composite Indicators of Social and Food Condition and characterize the population according to unsatisfactory/satisfactory and	This is a quantitative, descriptive, cross-sectional study carried out with 208 students from the 4th and 5th grades. The collection was carried out through interviews, covering four indicators for the Social Condition and ten	It is noted, in relation to the Composite Indicator of Food Condition, that the majority of respondents reported liking healthy foods and food preparations more, and the intake of unhealthy foods and drinks influenced the	It is observed that the economic conditions of families that have a per capita income lower than one minimum wage/month contribute to poor eating habits.

	unhealthy/healthy conditions	for the Food Condition.	result regarding the Composite Indicator of Unhealthy Food Condition . It appears that per capita income was the indicator that most contrasted with the result obtained by the others; In order to determine the Composite Indicator of Social Condition, a satisfactory socioeconomic situation was recorded, although it was the closest to the real living conditions of the students.	
Factors that influence those responsible for the selection of foods for children in early childhood education: a bioethical reflection in an exploratory study [15]	Conduct a bioethical contextualization on the factors that affect those responsible for the acquisition and selection of food offered to research participants	This is a cross-sectional and exploratory study, developed in 2013, at Escola Municipal de Educação Infantil (EMEI) Profa. Lourdes Heredia Mello, located in the southern region of the city of São Paulo. We included 162 guardians of children aged 4 to 6 years who adequately answered the research questionnaire consisting of 6 semi-open questions previously tested for data collection.	The "healthy" factor of gender food was highlighted by the interviewees as a determinant for the acquisition of the genre (77.2%), while the media was reported as the least influential factor in the purchase (63%).	The present study showed that there is some concern on the part of those responsible for the choices of food to be bought and offered to children. Ethical aspects must always be considered against economic and other secondary interests such as Social
Perceptions of families about the eating habits of children who are obese [16]	To describe the family influence on the eating habits of children aged 6 to 10 years who are obese	Trata-se de uma pesquisa descritiva exploratória com abordagem qualitativa. Participaram 20 familiares e 33 crianças, matriculadas em escolas do norte de Santa Catarina. Realizou-se aferição de medidas antropométricas, cálculo de índice de massa corpórea, entrevistas e	It was found that families have already understood that their attitudes interfere with their children's food preferences; that they don't have healthy eating habits, because they don't have them either; that there is difficulty in teaching good eating habits due to the lack of daily	It is considered that school, after the family, is a very rich environment for obtaining new and favorable health habits. The partnership between the health sector, school, families and children needs strategies that strengthen the participation of all

		atividade educativa. Para a coleta dos dados, utilizou-se um formulário semiestruturado	coexistence between family members, due to the long working hours of the parentes.	those involved in the search for resources that teach children healthy habits of life.
Feeding difficulties in early childhood: A systematic review [17]	Research the relationship between feeding problems and parenting practices and styles	Systematic review of the specialized international literature on feeding difficulties in early childhood, of items published in the last five years, in the Ebsco Host databases (Academic Search and Medline), Pubmed/Medline, Psychinfo, Science Direct, Scopus, BVS and Scielo. Twenty-four articles in the field of Psychology were selected.	It was identified that the quantitative method with prospective and longitudinal characteristics was the most used among studies. Furthermore, the European continent is responsible for most publications. There was a growth of studies on the food issue in childhood from the year 2010 and the Participants were, for the most part, mothers and pairs of mothers and babies.	Although there is no consensus on the origin of feeding difficulties in children in the studies reviewed, the scientific production analyzed shows that family relationships and the environment in which the child is inserted are of great importance in order to understand the origin of their difficulties. . In addition, there was a concern to find out how these problems present themselves throughout the child's development, suggesting the design of longitudinal studies. At the same time, the causes of feeding difficulties in early childhood point to a multiplicity of variables that are still not well understood.
Healthy eating in childhood: social representations of families and school-age children [18]	Investigate the social representations of healthy eating in families and school-age children	Multiple case study, with semi-structured interviews and graphics. Eight families of medium and low socioeconomic class participated, five with security and three food insecurity	The analysis revealed that rural food, in the parents' childhood, was a difficult time, however, considered healthier. Although the families expressed normalized conceptions of healthy eating, various forces, proximal and distal, tended their current practices in another direction. Easy access to unhealthy	Os achados apontam que as representações sobre alimentação saudável abarcam diferentes contextos de sociabilidade da criança e são atravessados pelo contexto histórico e cultural das famílias, desafiando noções baseadas no conhecimento formal

			foods and financial restrictions added to the families' busy lives and pleasurable meanings associated with "crap/junk" (in their words) as a way to get out of the routine.	

From the analysis of the sample studies, it was observed that the most discussed topic in the articles was the contribution of new dietary patterns to the increase in the emergence of chronic non-communicable diseases in children, this subject was discussed in 50% of the articles, followed by family influence and income conditions on children's eating patterns, which were addressed in 35% of the studies. Emphasis was also given to the influence of the media on children's eating behavior, and to the level of parents' knowledge about healthy eating, both themes were addressed in 25% of the articles.

IV. DISCUSSION

4.1 Food marketing and advertising

The influence that the media exerts on the population's eating patterns is notorious. The high rate of advertisements, especially for ultra-processed and high-calorie foods, end up attracting consumers to their products, especially children.

In the research by Iba & Spers [9], the purchase and consumption behavior of food products aimed at children was evaluated from the perspective of mothers. The interviewed mothers claimed to feel deceived by the advertisements, and helpless due to the lack of correct information in the advertisements of the food they buy, or may buy for their children.

Leung, Passadore, & Silva [15], in their study, found as a result that the media does not seem to exert great influence on the purchase of food products, the decisive factors according to the caregivers' reports were: price, "healthiness" and the request of children.

Although the media has not been presented as a major factor of influence in the purchase of food, approximately a quarter of the parents interviewed by Leung et al. claimed to be directly influenced by advertisements.

Ceccatto, Spinelli, Zanardo, & Ribeiro [19], comment that the food industry sees children as consumers, and it was identified that the child influences approximately 90% of the family's food purchases, so it is understood that they exert great influence on parents' purchasing decisions, causing the food industry to invest even more in marketing aimed at children. This fact is corroborated in the study by Leung et al., where it was noticed that the child's request greatly influences the purchase of the product, which should not happen, as it is up to parents to shape the child's eating habits and behavior by offering food. healthy foods and promoting proper habits.

Ceccatto et al. [19] observed in their review that the media exerts its power to influence children's food choices through the use of animated characters and artists in advertisements. Due to the seduction devices used by the industry, children are induced to associate the consumption of ultra-processed foods with happiness and social acceptance.

Leung et al. [15] also state that frequent exposure to unhealthy food marketing can modify children's eating patterns and affect their growth and development. Therefore, it is the duty of parents to limit the child's access to this type of advertisement, especially during meals, as well as to reduce the supply of these foods and provide children with access to healthy foods.

Exposure to food-related commercials for just 30 seconds is capable of influencing the choice of a particular product. The high rate of advertisements that encourage the consumption of unhealthy foods, especially ultra-processed foods, can cause serious damage to health. Evidences state that the media exerts a direct influence on consumers' food choices, especially children, who are easily attracted by the artifices used by the industry in order to induce them to consume a certain product [12].

These results lead to the reflection that new public policies could be produced in order to protect children, who are exposed to the frequent maneuvers of media influence.

4.2 Influence of parents and caregivers

The family nucleus has a decisive character in the formation of children's eating behavior, which has its bases

fixed in the first years of life. Knowing that in childhood, especially in the early years, child behavior is mostly reproduced, it is of fundamental importance that parents and caregivers understand their decisive influencing role in the child's feeding and development, the behavior of parents in the formation of the child's eating habits. it can lead to physical and emotional complications in the child's later years [20]

Considering that eating habits are built in childhood, this phase becomes the most favorable for nutritional education, health promotion and disease prevention. Knowing that the family is the main influencer of children's eating behavior, it is extremely important that family members offer nutritionally adequate food for the child's growth and development. In this way, in addition to promoting the child's health, the family will be introducing healthy eating habits to the child's eating behavior [21]

Leung et al. [15] state that the family acts as the first trainer of children's eating behavior, from the stage of food introduction, as the way in which foods are introduced can impact negatively or positively on the child's eating habits.

Muller, Salazar & Donelli [17] also found as a result that the introduction of solid foods, when done at age and incorrectly, may be associated with poor diet quality.

Vasconcelos et al. [14], claim that family eating habits directly influence children's food preferences, and reinforce the importance of parents adopting healthy eating habits, as well as having family meals, so that children learn good eating habits.

Silveira, Henn & Gonçalves [18] interviewed family members of students in the first year of elementary school, in order to investigate the strategies used by the family to promote healthy eating habits for children, and to assess their conception of healthy eating.

Most of the parents interviewed considered rural food, mostly in natura, healthier than the food found in large urban centers, which in turn consists of large amounts of ultra-processed foods. Parents also reported having difficulties in inserting healthy foods into their children's diets. In addition, it was possible to perceive that those responsible for the children understand that their examples are of great influence for the formation of the children's eating behavior, since they tend to imitate their parents' behavior in different situations, including at the table.

The children interviewed showed the same conception of healthy eating as their parents, demonstrating that the parents advised them on healthy eating and served as models of good eating habits.

As for the strategies used by parents, it was possible to notice that they usually use food as a reward, which can negatively influence the child's food preferences, Carozzo & Oliveira [8] also considered this practice negative.

Carozzo & Oliveira [8] pointed out 12 strategies (positive and negative) used by parents to condition their children's eating behavior.

Parental educational practices are strategies that make it possible to install appropriate behaviors and extinguish inappropriate behaviors, it is believed that they also play roles in the installation and maintenance of eating behavior.

In their research, Carozzo & Oliveira [8] pointed out some negative strategies used by parents, such as: the use of food as a reward, and the use of food to control emotions. These practices can induce incorrect eating habits, such as “emotional eating” which can be defined as a consequence of the lack of emotion regulation, where food is used to reduce negative emotions, or as a reward, this behavior causes harm. in the child's eating behavior, both in childhood and in later years.

Among the appropriate practices addressed in the study, the following stand out: teaching about nutrition to children, combined with the practice of encouraging balance and food variety. The benefits are not only attributed to the guidelines regarding adequate nutrition, but also due to the promotion of communication between parents or caregivers and their children. Establishing a good dialogue with the child makes them feel welcomed and understood, providing a more peaceful family environment, favoring a better understanding and acceptance of the guidelines given by the parents.

Most of the practices considered positive involved the involvement of parents in the lives of their children, whether teaching about nutrition, encouraging food variety, or striving to serve as a model for the formation of good eating habits for their children. Thus demonstrating the importance of caregivers in the formation and maintenance of children's eating behavior.

In the study by Lervolino, Silva, & Lopes [16], it was concluded that parents have already understood their role in influencing their children's food preferences, they are also able to describe a healthy diet, however, they continue to offer foods of low nutritional value to their children. children, and avoiding offering food that the children do not like due to lack of time and convenience. It was also possible to observe that the absence of parents

during meals made it possible for children to replace meals with ultra-processed snacks.

Participants in Antunes' survey [10] demonstrated that they understand the value of shared eating and that they prioritize having family meals whenever possible. The act of eating as a family does not only provide nutritional value, it is also a moment of fraternization, affection and is the moment where children observe their parents' eating habits and form their eating behavior.

Pinto [20] reinforces that it is important for parents to have knowledge about healthy eating, so that they can offer food of adequate quality and quantity to children, always offering varied foods of high nutritional value, respecting the child's signs of satiety so as not to cause excessive ingestion.

Despite being observed that there is a tendency where parents and caregivers better understand the value of a healthy diet, and choose to purchase foods with greater nutritional value, Leung et al. [15] in their research, observed that some of the foods most offered to children outside the main meals were: soft drinks, sweets and packaged snacks, which were offered in practically the same proportion, respectively: 39.5%, 37.0 % and 35.2%.

These results suggest that it is necessary for parents and caregivers not only to understand the importance of healthy eating and its influential role in the formation of the child's eating habits, but also to implement good eating habits throughout the family, contributing to the good formation of the child's eating behavior and promoting the health of the whole family.

4.3 Changes in dietary patterns and increased consumption of ultra-processed foods

The processes of urbanization and globalization, allied to the insertion of women in the labor market, and the growing power of influence of the media - especially on children - have caused numerous changes in the Brazilian family context, including the population's dietary pattern. [22]

It was possible to observe the occurrence of the food transition phenomenon, which is characterized by a decrease in the consumption of in natura foods, accompanied by an increase in the intake of ultra-processed and easy-to-prepare foods. It is observed that the reason for the increase in demand for these foods is attributed to the practicality offered by these products, the palatability and high exposure to advertisements of these foodstuffs.

In the research by Lacerda et al. [13], it was observed that approximately 25% of the TEV in the diet of the students evaluated in their study came from ultra-processed foods. The results indicated an association between the higher consumption of ultra-processed foods with the habit of eating while watching television, and with being overweight.

Lacerda et al. [13] state that the act of eating while watching television increases twice the probability of consuming UPFs due to exposure to advertisements for these products, and the decrease in the perception of satiety.

Vasconcelos et al. [14] recommend that meals are preferably eaten in the company of family members, and not in front of screens, as this distraction diverts the focus from the satiety signal.

Sabendo que é na infância onde se constroem as bases do comportamento alimentar, duas instituições são consideradas fundamentais na formação dos bons hábitos alimentares da criança: a família e a escola.

Vasconcelos et al. [14] recognize the importance of the school as an important agent in the formation of children's eating behavior, and state that schools should promote actions that guide caregivers and children about healthy eating, as well as encourage the practice of physical activities to reduce indices of sedentary lifestyle and childhood obesity.

Silveira et al. [18] also considered the school as a major influencer of children's eating habits, it was possible to observe that children tended to consume more healthy foods when teachers provided guidance on good eating habits. On the other hand, the food offered in the school canteen mainly involved fried snacks and sweets, demonstrating a contradiction between the discourse and the food offer. In some schools, events such as "garbage day" were observed, this day was reserved for children to take sweets and sugary foods to consume at snack time, in order to reinforce the idea that sometimes it is necessary to get out of the routine of healthy eating

The analysis highlights the dangers that the new dietary patterns bring to health. In the current nutritional scenario, it is extremely important that the population is guided to make healthier food choices. In the same way, it is essential that these healthy eating practices are implemented from the moment the child is introduced to food, so that these habits last and make up the eating behavior at all stages of the individual's growth.

4.4 Socio-economic issues of the family

In a survey that evaluated the purchase and consumption habits of foodstuffs in households with children up to five years of age, Costa et al. [11], identified a lower consumption of vegetables, greens and fruits in groups that are in socioeconomic vulnerability. On the

other hand, these groups showed high consumption of ultra-processed foods, such as soft drinks, snacks and stuffed cookies.

73% of participants in the survey by Costa et al. (2020) had a family income of up to one minimum wage, and 64% were food insecure, of which approximately 70% said they never or almost never consumed healthy foods. In this research, there was also a higher frequency of consumption of natural juices, fruits and vegetables in individuals with a higher level of education.

Vasconcelos et al. [14], in their study, also pointed out that the family's precarious financial conditions make it difficult to acquire healthy foods, as well as to cultivate better eating habits. A fact corroborated by Silveira et al. [18], who also found that families' financial restrictions make it difficult for them to access a greater variety of healthy foods.

These results make it clear that socioeconomic issues directly interfere with the family's food purchase and consumption profile, which influences the eating habits of the entire family nucleus, including children, who are still in the process of forming their eating behavior.

4.5 Feeding difficulties faced in childhood

In the research by Pinto [20], it was possible to observe that approximately 45% of children with normal development and 80% of children with developmental delays present some feeding problem, such as the absence or delay in the development of signs of readiness food, refusal to eat based on taste, texture and other sensory characteristics, inappetence, food neophobia, etc. It was also noted that, in recent years, eating disorders have become more frequent due to multifactorial causes.

Pinto [20] emphasizes that in the preschool phase, food neophobia is a frequent problem. Caregivers find it difficult to introduce new foods into the children's diet, impairing food variety, which is one of the practices that were considered positive in the study by Carozzo & Oliveira.

In his review, Pinto [20] found a study that evaluated food neophobia in children, and associated higher prevalence rates of food neophobia in children who had a lower intake of healthy foods and a high BMI.

It is recommended that you continue to offer food to the child, in order to increase acceptance and reduce the neophobic condition, as it is believed that the child will accept food if offered otherwise on another occasion.

The author details the phases of early childhood eating behavior, where some complications naturally occur, such as: lack of interest in food, greater selectivity and irregular appetite up to two years of age. After the second year, it is observed that the child easily diverts his attention from the table, becomes even more selective, and refuses new foods.

From the age of 5, when the child starts to have more social interactions, it is possible to notice a greater interest in foods rich in fat and sugar, it is believed that this preference is influenced by the social environment in which the child is inserted, and the media. .

Muller & Donelli [11] also state that eating disorders are frequent until the sixth year of life, these disorders can be mild, or more severe eating disorders.

Pinto [20] also reinforces that it is natural for the child to lose interest in food after the first year of life, however, this situation ends up causing concern and frustration in parents and caregivers. Muller & Donelli [11] point out that the child's refusal to feed mainly causes the feeling of maternal insufficiency in mothers, which leads them to take actions that can aggravate the child's difficulties. The author also states that the lack of knowledge about the child's developmental stages and their real nutritional needs may be possible causes of the feeding difficulties faced by children.

It was noticed that caregivers end up adopting practices such as pressure for the child to eat, which in turn causes children to avoid food. This practice was considered negative by Carozzo & Oliveira [8], because in this case the control of food intake is determined by an order from the parents, and not by the child's feeling of hunger and satiety.

The results found bring the importance of offering support to families who face these difficulties, to resolve doubts and implement good practices in the child's eating behavior, since the family is the most important institution in the formation of eating behavior and in promoting the health of the child.

V. CONCLUSION

It was evidenced through this integrative review that although parents or caregivers do not feel pressured by the media to purchase food products, some studies have shown the opposite, with children being responsible for the greater purchase of food in family groups. However, adequate nutritional guidance and healthier food offerings should come from parents/caregivers, who are primarily responsible for the acquisition of healthy habits by children.

Regarding the eating behavior of parents/caregivers, studies have shown a strong link

between the development of healthy eating habits in young children and the habits presented by those responsible, since children tend to imitate their family members. Further emphasizing the role of caregivers in early childhood. Another point addressed was the use of a reward strategy used by parents during feeding, but such a strategy can have negative influences on the child's eating behavior.

The use of nutritional education and emotion control measures are indicated in order to develop a healthy relationship between the individual and food.

With regard to food in the school environment, research has indicated greater consumption of ultra-processed foods in this place, in addition to indicating an association between greater consumption of ultra-processed foods with the habit of eating while watching television, and overweight in children. And just like parents/caregivers, studies recognize the importance of the school in the development of good eating habits, and some studies have reported an increase in the consumption of fresh foods by students when guided by educators.

In short, this review demonstrated the importance of working together between parents and teachers in the development of healthy eating habits in children in early childhood, mainly due to the strong influence of large food companies on this audience. Thus, nutritional education is necessary both in the family and school environment during the early stages of development of individuals, aiming to maintain physical and mental health throughout life.

REFERENCES

[1] BRAZIL. Ministry of Health (MS). (2019) Food guide for Brazilian children under 2 years old. Brasilia.

[2] BRAZIL. Ministry of Health (MS). (2014). Food guide for the Brazilian population. Brasilia.

[3] UNICEF. World situation of children. (2019). Brasilia.

[4] Silva, G.A., Costa, K.A., & Gilgliani, E.R. Infant feeding: beyond the nutritional aspects. Journal of Pediatrics. p.p. 2-7. Rio de Janeiro.

[5] Alvarenga, M., Figueiredo, M., Timerman, F., Antonaccio, C. (2019). Behavioral Nutrition. (Rev. ed). Sao Paulo: Manole.

[6] Oliveira, M.N., Sampaio, T.M., Costa, E.A. (2014). Nutritional education of preschoolers - A case study. Oikos: Brazilian Journal of Home Economics. V.25, no. 1, p.p. 093-113.

[7] Pinto, L.P. (2017). Parents' knowledge about infant feeding: relationship with sociodemographic characteristics and child's nutritional status. Masters dissertation. Polytechnic Institute of Viseu.

[8] Carozzo, N.P., & Oliveira, J.H. (2017). Parental eating practices: children's perception of the educational strategies used in conditioning eating behavior. Psych Rev. V.26, no. 1, pp. 187-209.

[9] Iba, J.B. & Spears, E.E. (2017). Mothers' perception of children's food advertising. Food Hygiene. v.31, no. 274/275.

[10] Antunes, N.J. (2018) Childhood obesity: family experiences related to the nutritional counseling process. Masters dissertation. Postgraduate Program in Public Health. Sao Paulo.

[11] Costa, A.C., Bezerra, M.S., Pinheiro, D.D., Garcia, L.R., Sousa, L.C., Goes, P.A. (2020). Food purchase and consumption habits in families under five years of age in a municipality in northeastern Brazil. Plural Science Magazine. 2020; 6(3): 154-173.

[12] Micheletti, N.J., & Mello, A.P. (2020). The influence of the media in the formation of the eating habits of children and adolescents. Disciplinarum Scientia. V.21, nº2, p.p. 73-87.

[13] Lacerda, A.T., Carmo, A.S., Sousa, T.M., Santos, L.C. (2020). Participation of ultra-processed foods in the diet of Brazilian schoolchildren and their associated factors. Paulista Journal of Pediatrics. 2020; 38: e2019034. Belo Horizonte

[14] Vasconcelos, C.M., Vasconcelos, E.M., Raposo, M.C., Vasconcelos, A.L., Araújo, E.C., Oliveira, R.V, Ramos, V.P., Silva, S.M. (2021). Healthy eating related to eating behavior and social status. Nursing Journal UFPE Online.

[15] Leung, M.C., Passadore, M.C., & Silva, S.M. (2016). Factors that influence those responsible for the selection of foods for children in early childhood education: a bioethical reflection in an exploratory study. The World of Health. 40(4): 490-497.

[16] Lervolino, S.A., Silva, A.A., Lopes, G.S. (2017). Perception of families about the eating habits of children who are obese. Science, care and health. Jan/Mar 2017.

[17] Muller, Salazar & Donelli. (2017). Feeding difficulties in early childhood: A systematic review. Studies and research in psychology. V.17, no. 2, pp. 635-652.

[18] Silveira, C.L., Henn, R.L., Gonçalves, T.R. (2019). Healthy eating in childhood: social representations of families and school-age children. Aletheia. Jul/Dec 2019. V.52, no. 2, pp. 80-96.

[19] Ceccatto, D., Spinelli, R.B., Zanardo, V.P. & Ribeiro, L.A. (2018). The influence of the media on children's food consumption. A literature review. Perspective. V.42, no. 157, p.p. 141-149.

[20] Pinto, L.P. (2017). Parents' knowledge about infant feeding: relationship with sociodemographic characteristics and child's nutritional status. Masters dissertation. Polytechnic Institute of Viseu.

[21] Oliveira, A.M., & Oliveira, D.S. (2019). Parental influence on the formation of eating habits in early childhood. Estacio Recife Electronic Magazine. V.5, no. 2.

[22] Rossi, A., Moreira. E.A., & Rauen, M. (2008). Determinants of eating behavior. A family-focused review. Online nutrition magazine. V.21, no. 6, pp. 739-748.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.39

The role of nurses in the sterilized material center: Literature review

A atuação do enfermeiro na central de material esterilizados: Revisão de literatura

Gleison Faria[1], Ana Paula do Nascimento Pinheiro[1], Dhieniffer Naiara da Silva[1], , Iuri Santana de Jesus[1] , Francisco Leandro Soares de Souza[1], Gilvan Salvador Junior[1], Taís Loutarte Oliveira[1], Juliana Peixoto dos Santos[1], Karolayne Soares Cavalcanti[1], Márcia Gisele Peixoto Kades[1], Loara de Assis Souza[1], Mariana Kely Diniz Gomes de Lima[1], Paulo Henrique Campos da Silva[1], Claudio Henrique Marques Pereira[1], Clicia da Silva Castro[1], Greyci Kelly Santos Araújo[2], Diuliane Rocha Fuester[2], Diulia Rocha Fuester[2], Lilian Caldas Ornelas[2], Mirian Ulkowski[2], Millrihe Vieira da Silva[2], Queila Schulze de Almeida[2], Giselen Maleski Cargnin[3], Francielly Maira Bordon[4], , Jessica Lene Ferreira Araújo dos Santos[5], Pedro Washington Moreira[6], Marco Rogério da Silva[7], Viviane de Fátima da Silva[8]

[1]Nurse at the Faculty of Biomedical Sciences of Cacoal – FACIMED – RO, Brazil. E-mail: gleisonfaria@hotmail.com
[2*]Graduated from Higher Education in Cacoal, FANORTE, Rondônia, Brazil
[3]Nurse at the Claretian University Center - CEUCLAR - Porto Velho – RO
[4]São Lucas University Center, Ji-Paraná, Rondônia, Brazil
[5]Graduated in Higher Education from the Union of Higher Schools of Rondônia, Rondônia, Brazil
[6]Graduating from Faculdade Uneouro - Ouro preto do Oeste - Rondônia, Brazil.
[7]Nurse at the University of Vale do Rio dos Sinos – UNISINOS - São Leopoldo, Rio Grande do Sul, Brazil
[8]Nursing student at Unopar - Vilhena - Rondônia, Brazil

Received: 01 May 2022,
Received in revised form: 18 May 2022,
Accepted: 24 May 2022,
Available online: 31 May 2022

***Keywords*— Material Central, Nurse, To manage.**

***Palavras chaves* - Central de material,**

***Abstract*—** *The Center for Materials and Sterilization (CME) is the department responsible for processing health products (PPS) and its mission is to provide properly processed materials for nursing services. This study aimed to describe the role of nurses in the sterilized material center. The Methodology is a bibliographic review of the literature, with a search in the Scopus, Latin American and Caribbean Literature on Health Sciences (Lilacs), Scientific Electronic Library Online (SciELO), PubMed and Virtual Health Library (BVS) databases.). Central axes of the work of nurses in the CME stand out, such as the development of department management and educational activities. In addition, some of the challenges faced by professionals can be identified. The nurse's role in the CME begins in the unit's planning phase, where he selects the physical and human resources based on the activities to be carried out in the sector. The*

Enfermeiro, Gerenciar.

nurse is responsible for the selection, training and adequacy of the team, taking into account the operations and activities to be carried out in the unit. It is concluded that the nurses who work in the CME and evaluate the frequency with which the activities assigned to this professional were carried out in this professional unit, which is characterized as a sector of a health institution and whose work process includes specific knowledge and practices, whose goals and objectives differ from the other units of the institution. Due to its characteristics, it is recognized for the nature of the work of indirect production of care, which instrumentalizes help in the field of health, providing the necessary support for the various care activities.

Resumo— *A Centro de Materiais e Esterilização (CME) é o departamento responsável pelo processamento de produtos para saúde (PPS) e tem como missão fornecer materiais devidamente processados para os serviços de enfermagem. Este estudo teve como objetivo descrever a atuação do enfermeiro na central de material esterilizado. A Metodologia trata-se de revisão bibliográfica da literatura, com busca nas bases de dados Scopus, Literatura Latino-Americana e do Caribe em Ciências da Saúde (Lilacs), Scientific Electronic Library Online (SciELO), PubMed e Biblioteca Virtual em Saúde (BVS). Destacam-se eixos centrais do trabalho do enfermeiro no CME, como o desenvolvimento da gestão do departamento e das atividades educativas. Além disso, alguns dos desafios enfrentados pelos profissionais podem ser identificados. A atuação do enfermeiro no CME começa na fase de planejamento da unidade, onde ele seleciona os recursos físicos e humanos com base nas atividades a serem realizadas no setor. O enfermeiro é responsável pela seleção, treinamento e adequação da equipe, levando em consideração as operações e atividades a serem realizadas na unidade. Conclui-se que os enfermeiros que atuam no CME e avaliar a frequência com que as atividades atribuídas a esse profissional eram realizadas nessa unidade profissional, que se caracteriza como um setor de uma instituição de saúde e cujo processo de trabalho inclui conhecimentos e práticas específicas, cujas metas e objetivos diferem das demais unidades da instituição. Por suas características, é reconhecida pela natureza do trabalho de produção indireta do cuidado, que instrumentaliza a ajuda no campo da saúde, fornecendo o suporte necessário para as diversas atividades assistenciais.*

I. INTRODUCTION

The Center for Materials and Sterilization (CME) is the department responsible for processing health products (PPS) and its mission is to provide properly processed materials for nursing services. In this area, recycling, cleaning, sterilization, inspection, packaging and distribution of materials to various consumer areas take place (MADEIRA et al., 2015; WANG et al., 2018).

CME plays a complex role in ensuring that PPS is sanitized and delivered with adequate quality, helping to reduce healthcare-associated infection rates (HAI) and clean healthcare. The sector provides indirect assistance to patients, providing safety items that assist in direct care, with the primary objective of handling, storing and distributing materials, inserting the attributes of nurses in this work environment (GOUVEIA et al., 2016; BASU et al., 2016; BASU et al. al., 2017).

In addition to supervising the activities of the nursing team that works in the sector, the nurse is also responsible for managing and operationalizing all the steps that make up the movement of materials (HOYASHI et al., 2015). In this sense, the nurse's role requires specific knowledge related to different equipment, items, surgical instruments and how they are handled, as well as the management of MSC (LUCON et al., 2017; BUGS et al., 2017).

The ability of nurses to perform their activities guarantees the effectiveness of the MSC process, in addition to cooperating for the prevention of HAI, but the importance of their work needs to be constantly emphasized to the nursing team, by the team and presented

to nurses, others in the units of the institution to obtain the recognition they deserve, not stealthily (SANCHEZ et al., 2018).

Thus, it is reasonable to carry out further research on the work of CME nurses, highlighting their attributes and activities and the relevance of their work, as well as the challenges of doing so.

The general objective of the research is to describe the role of nurses in the sterilized material center.

II. MATERIALS AND METHODS

This is a qualitative study carried out through a thorough literature review. This type of scrutiny makes it possible to analyze scientific research in a systematic and broad way, facilitating the characterization and dissemination of the resulting knowledge. Its purpose is to collect and synthesize research results on a specific topic or issue in a systematic and orderly manner.

The following inclusion criteria were used: Complete articles on research objectives published in scientific journals and online libraries in Portuguese, English and Spanish between 2010 and 2021. The exclusion criteria were studies published in congresses, blogs, forums or studies that did not meet the research objectives or deadlines. To this end, 14 scientific articles related to the topic were analyzed, published between 2010 and 2021 in the following databases: National Library of Medicine (PUBMED), Literature, Health Sciences of Latin America and the Caribbean (LILACS), Virtual Libraries of the Ministry da Saúde (BVS), Scientific Electronic Library Online (SciELO), Brazilian Journal of Nursing (REBEN) and Google Scholar.

The bibliographic research raises the question: How is the performance of nursing professionals in the preparation of material in the material and sterilization center? The articles that try to explain the topic are selected in Portuguese, English and Spanish.

This review, organized from December 2021 to January 2022, provides researchers with guidance on relevant topics so they can formulate hypotheses for children seeking solutions to common care-related problems.

III. LITERATURE REVIEW

Literature Review

By means of a bibliographic survey, central axes of the work of nurses in the MSC are highlighted, such as the development of department management and educational activities. In addition, some of the challenges faced by professionals can be identified. The nurse's role in the CME begins in the unit's planning phase, where he selects the physical and human resources based on the activities to be carried out in the sector. The nurse is responsible for selecting, training and adapting the team, taking into account the operations and activities to be performed in the unit (PEZZI & LEITE, 2010; SALES et al., 2016).

From the planning and organization stages to the execution of the work, the nurse has a fundamental role to guarantee the functioning of the systems that involve the storage, preservation, distribution, transport and handling of equipment and materials, with the objective of maintaining the integrity of equipment. and materials, products, and their effectiveness and quality to ensure patient safety in the care provided (SALES et al., 2016).

The research showed that the CME nurse's management involves multiple attributes, such as: coordinating the unit's work processes; supervise the activities carried out within the unit; define work schedules for each area of activity of the nursing team; supervise the execution of team activities; monitor the use of each work area equipment operation; inspect sterilization control documentation; monitor tests of products, supplies and equipment; confirm daily schedules for surgeries and check delivery of ordered materials; participate in administrative and managerial meetings of the units involved; monitor evaluation of CME quality indicators (COSTA & FUGULIN, 2011; GIL et al., 2013).

Management is one of the main responsibilities of nurses and includes many functions, such as planning and structuring services, developing administrative and operational tools, and managing human and material resources. The direct objective of the nurse's administrative behavior is to organize and control the work process, and the intermediate objective is to facilitate nursing and provide the patient with a chance of cure (GIL et al., 2013).

With regard to human resource management, it is worth noting that the nurse's work is challenging and demanding, involving humanistic values, personal and professional commitment, technical science and interpersonal knowledge, and dedication to indirect assistance to the health of individuals (SALES et al. , 2016). As team coordinators, nurses seek to integrate other professionals, fostering interpersonal relationships and enhancing teamwork, which contributes to effective practice and safe care at all stages of the CME work process. al., 2009; STRIEDER et al., 2019).

Activities related to the supervision of equipment operations, which constitute one of the duties of the nurse in the CME, appear from time to time in the study. It

requires understanding of the equipment and its proper functioning, as well as staff training to ensure the reliability and safety of CME patient care (COSTA & FUGULIN, 2011; GIL et al., 2013).

Nurses carry out educational activities, including: monitoring, planning and facilitating training, participation in programs, committees, courses and activities involving CME units and participation in team performance evaluations. The nurse is responsible for carrying out educational activities that, through continuing education, seek to train the team to perform their tasks in a coherent and qualified way, with the objective of minimizing possible failures during cleaning, preparation, disinfection, sterilization and storage (SOUZA & CERIBELLI, 2004; OURIQUES & MACHADO, 2013).

The challenges faced by nurses and their staff in the unit are the lack of recognition, devaluation, unpreparedness and long-term education, which contribute to low self-esteem, dissatisfaction, inadequate professional preparation and high turnover in the sector. In addition, there are conditions related to work flow and organizational characteristics, including physical, chemical, biological and ergonomic hazards, structural deficiencies, two or more jobs, excessive working hours, low wages, and physical stress and mental health, which can leave employees professionals who are vulnerable to illness and compromise their health and quality of life (PEZZI & LEITE, 2010; COSTA et al., 2015).

The literature does not address the reasons why nurses choose to work at CME or the historical evolution of nurses' work processes in this area of nursing, but suggests that the challenges and inability to provide direct care to patients may be important factors. Factors that prevent professionals from working in the unit (CAVALCANTE & BARROS, 2020).

It is also noteworthy that nurses recognize the importance of their work in the CME and are concerned with the social representation of the unit, mainly because they are not recognized as guided by the development of this live nursing process, light techniques. It is difficult to assist in direct care and ensure the safety of procedures and interventions provided to patients (BARTOLOMEI & LACERDA; 2006; TAUBE & MEIER, 2007).

Nurses find it difficult to define workflow elements in the CSSD, particularly in terms of work objects and end products. In this sense, the work process of nurses in this department permeates the dimensions of management, care, teaching and research, being able to act in different objects of work, namely, material resources and human resources, to transform. Indirect patient care, which makes it difficult to characterize this work process and measure the results obtained from it (BARTOLOMEI & LACERDA, 2006; CAVALCANTE & BARROS, 2020).

The performance of nurses in the CME has remained similar over the years, but with greater training of professionals in scientific evidence and management and the systematization of workflow tools, optimizing the operability of the assistance provided by the CME (CAVALCANTE & BARROS, 2020). This requires adequate instrumentation and working conditions, such as adequate physical structure, fair remuneration, quality equipment and materials, protocols and standards, effective communication skills, balanced scale, competent management and scientific knowledge (GIL et al., 2013; NAZARETH et al., 2018).

Given the above, it is important to emphasize that the role of nurses in the MSC, although challenging, is fundamental for the quality of care provided directly and indirectly. Nurses, therefore, need to be guided by the most recent skills and abilities, based on the human, ethical and technical sciences, seeking to contribute to the full potential of the nursing team in the most varied health practices (LUCON et al., 2017; GIL). et al., 2013).

IV. FINAL CONSIDERATIONS

The study made it possible to know the profile of nurses working in the CME and to assess the frequency with which the activities assigned to this professional were carried out in this professional unit, which is characterized as a sector of a health institution and whose work process includes knowledge and practices. specific, whose goals and objectives differ from the other units of the institution. Due to its characteristics, it is recognized by the nature of the work of indirect production of care, which instrumentalizes help in the field of health, providing the necessary support for the various care activities.

It was observed that the determination of the size of the CME staff is very important, because not always all professionals in the sector are from this branch of activity and are also not qualified to perform such functions, ignoring the chemical and biological risks in this branch of the body.

ACKNOWLEDGEMENTS

Thanking colleagues for their performance in the construction of the work and the advisor for their patience and tips

REFERENCES

[1] BARTOLOMEI SRT, LACERDA RA. O enfermeiro da central de material e esterilização e a percepção do seu papel social. Rev Gaúcha Enferm [Internet]. 2006 [acessado em 28 jun. 2019];27(2):258-65. Disponível em: https://seer.ufrgs.br/RevistaGauchadeEnfermagem/article/ view/4604/2524.

[2] BASU D, BAG SC, DAS A, RAZARIO D. The importance of paper records and their preservation period in a central sterile supply department: an experience from a oncology center in eastern India. J Infect Public Health. 2017;10(5):685-7. https://doi.org/10.1016/j.jiph.2016.10.004

[3] CAVALCANTE FML, BARROS LM. O trabalho do enfermeiro no centro de material e esterilização: Uma revisão integrativa. REV. SOBECC, SÃO PAULO. JUL./SET. 2020; 25(3): 171-178

[4] COSTA CCP, SOUZA NVDO, SILVA PAS, OLIVEIRA EB, VIEIRA MLC. O trabalho na central de material: repercussões para a saúde dos trabalhadores de enfermagem. Rev Enferm UERJ. 2015;23(4):533-9. https://doi. org/10.12957/reuerj.2015.15934

[5] COSTA JA, FUGULIN FMT. Nursing activities in central supply and sterilization: A contribution to personnel design. Acta Paul Enferm. 2011;24(2):249-56. https://doi.org/10.1590/S0103-21002011000200015

[6] GIL RF, CAMELO SH, LAUS AM. Nursing tasks in the material storage center of hospital institutions. Texto Contexto Enferm. 2013;22(4):927- 34. https://doi.org/10.1590/S0104-07072013000400008

[7] GOUVEIA MTO, OLIVEIRA VC, LIRA IMS. Riscos ergonômicos em um centro de material e esterilização. Rev Enferm UFPI. 2016;5(3):42- 7. https://doi.org/10.26694/reufpi.v5i3.5427

[8] HOYASHI CMT, RODRIGUES DCGA, OLIVEIRA MFA. Central de material e esterilização na formação do enfermeiro: proposta de um manual de práticas. Rev Práxis. 2015;7(14):35-45. https://doi.org/10.25119/praxis-7-14-761

[9] LUCON SMR, BRACCIALLI LAD, PILORO SM, MUNHOZ CC. Formação do enfermeiro para atuar na central de esterilização. Rev. SOBECC. 2017;22(2):90-7. https://doi.org/10.5327/Z1414-4425201700020006 BUGS TV, RIGO DFH, BOHRER CD, BORGES F, MARQUES LGS, VASCONCELOS RO, et al. Perfil da equipe de enfermagem e percepções do trabalho realizado em uma central de materiais. REME Rev Min Enferm. 2017;21:e-996. https://doi.org/10.5935/1415-2762.20170006

[10] MADEIRA MZA, SANTOS AMR, BATISTA OMA, RODRIGUES FTC. Processamento de produtos para saúde em centro de material e esterilização. Rev SOBECC. 2015;20(4):220-7. https://doi.org/10.5327/ Z1414-4425201500040006

[11] NAZARETH JCF, ALMEIDA NETO OP, SILVA MR, RODRIGUES LR, PEDROSA LAK. Quality of life related work of nursing professionals in sterilization material center. Biosci J 2018;34(4):1083-92. https://doi.org/10.14393/ BJ-v34n1a2018-38940

[12] OURIQUES CM, MACHADO ME. Nursing in the process of sterilization of materials. Texto Contexto Enferm. 2013;22(3):695-703. https:// doi.org/10.1590/S0104-07072013000300016

[13] PEZZI MCS, LEITE JL. Investigação em central de material e esterilização utilizando a Teoria Fundamentada em Dados. Rev Bras Enferm. 2010;63(3):391-6. https://doi.org/10.1590/S0034-71672010000300007

[14] SALES CRG, SABONGI ML, REIS VN, PIVATTI ASA, CAMISÃO AR, KANASHIRO Filho G. Logística de implementação de bloco cirúrgico na floresta: atuação do enfermeiro. Rev SOBECC. 2016;21(3):162-9. https://doi. org/10.5327/Z1414-4425201600030007

[15] SANCHEZ ML, SILVEIRA RS, FIGUEIREDO PP, MANCIA JR, SCHWONKE CRGB, GONÇALVES NGC. Strategies that contribute to nurses' work exposure in the material and sterilization central. Texto Contexto Enferm. 2018;27(1):2-9. https://doi.org/10.1590/0104-07072018006530015

[16] SOUZA MCB, CERIBELLI MIPF. Enfermagem no centro de material esterilizado: a prática da educação continuada. Rev Latino-Am Enfermagem. 2004;12(5):767-74. https://doi.org/10.1590/ S0104-11692004000500010

[17] STRIEDER AT, GRAUBE SL, DEZORDI CCM, STUMM EMF, MENEGHETE MC, BITTENCOURT VLL. Atuação do enfermeiro no processo de limpeza em um centro de material e esterilização. Rev SOBECC. 2019;24(1):50-3.

[18] TAUBE SAM, LABRONICI LM, MAFTUM MA, MÉIER MJ. Processo de trabalho do enfermeiro na central de material e esterilização: percepção de estudantes de graduação em enfermagem. Ciênc Cuid Saúde. 2009;7(4):558-64. https://doi.org/10.4025/cienccuidsaude.v7i4.6674

[19] TAUBE SAM, MEIER MJ. The nurse work process in the center of material and sterilization. Acta Paul Enferm. 2007;20(4):470-5. https://doi.org/10.1590/S0103-21002007000400014

[20] WANG L, CAI X, CHENG P. Application of a sub-specialties management model improves quality control in a central sterile supply department. BMC Health Serv Res. 2018;18(1):385. https://doi.org/10.1186/s12913-018-3214-7

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.40

Enrichment of multigrain cookies with tomato pomace powder

A.N. Kadam[1], K.A. Mane[2]

[1]MIT School of Food Technology, MIT-ADT University Loni Kalbhor, Pune, India
[2]Dept.of Food Process and Product Engineering, MIT School of Food Technology, MIT-ADT University Loni Kalbhor, Pune, India

Received: 01 May 2022,

Received in revised form: 17 May 2022,

Accepted: 24 May 2022,

Available online: 31 May 2022

***Keywords*— Tomato pomace powder, whole wheat flour, oats, finger millet, by-product, total phenolic content.**

Abstract *— Now a days baking industry is one of the large segments of food processing industries. Increased awareness of people led them change the eating pattern and choose healthy food including multigrain flour base products. Tomato pomace, a by-product from tomato processing is a source of valuable bioactive components and can be used in value added product preparation. The study was carried out to utilize tomato pomace powder in multigrain (wheat, finger millet and oats) cookies to assess the nutritive value and cost of prepared multigrain cookies. Multigrain cookies were prepared in four different proportions (whole wheat flour: tomato pomace powder as 31:2, 29:4, 27:6, and 25:8) by replacing the amount of whole wheat flour with the tomato pomace powder and subjected to quality evaluation (physical, sensorial, nutritional and functional) and production cost estimation. The results revealed highest acceptability of multigrain cookies prepared with 6% tomato pomace powder in terms of colour (8.1), taste (7.6), flavor (7.9), texture (7.6) and overall acceptability (7.9). The lycopene content (0.78-1.50mg/100g), beta carotene (30.14-124.15mcg/100g), total phenolic content (0.82-1.34mg GAE/g)and DPPH % inhibition (21.88-40.95%) exhibited increasing trend in developed cookies with increase in tomato pomace powder. The moisture, fat and carbohydrate content were decreased with increase in tomato pomace powder in multigrain cookies, whereas ash, protein and crude fibers showed increasing trend with increase in tomato pomace powder in cookies. The total cost of production for tomato pomace powder (6%) multigrain cookies was estimated as Rs. 200.55per kg.*

I. INTRODUCTION

Now a days, foods are envisioned not only to fulfil hunger and provide important nutrients for humans, but also to avoid nutrition-related illnesses and enhance overall health well-being. (Mudassir and Hafiza, 2015). Increasing consciousness and technical evidence indicate a strong link between health and diet leading to the generation of new concepts for food and nutrition science, research teams are focusing on the advancement of functional foods for the betterment of society (Carnes *et al.,* 2013). By-products from the food processing industry are a valuable source of bioactive components and colour pigments. These by-products can be used to develop nutraceuticals, functional foods, food ingredients, additives, and cosmetics. Functional foods and food elements are foods that give nutritional advantages in addition to fundamental nutrition (for the purposive community). Conventional foods, fortified, enriched, or enhanced foods, and dietary supplements are some examples of functional foods (Handa*et al.,* 2011).Bakery products are favoured segments of the food processing sector and can easily be enriched and fortified to meet a

variety of nutritive needs. Cookies are the most popular bakery product and are used by people of all ages because of their taste, aroma, and flavor. This is mainly due to its ready-to-eat nature and high nutrient content, accessibility in a wide range of flavors, and low cost. (Kishorgoliya*et al.*, 2018).In the present era, cookies are being transformed by varying or substituting different elements. The composite flour of whole grains (wheat, oats, and finger millet) improves the nutritive value of the products because it contains a high concentration of fiber, minerals, and antioxidants, all of which help to protect in case of cancer, diabetes mellitus, overweight, and cardiac disease. (Aggarwal*et al.*, 2016).

Tomato (*Lycopersicon esculentum* L.) is one of the most popular and widely cultivated vegetable crop all over the world. It contains a variety of nutritional components beneficial to physical health, including vit. C and E, minerals, antioxidants, and phenolic compounds. The processing of tomatoes generates massive amounts of waste materials such as pomace and seeds (Abdullah and Sheriful, 2018). Tomato pomace, an industrial by-product from the processing industry comprises about 4-7% of the full raw tomatoes processed into tomato products. Tomato pomace is composed of the skin, seeds, and vascular tissues of the tomato and contains up to 60% of the dietary fibers. It is a rich in antioxidants (lycopene and beta-carotene) and secondary metabolites like coumaric acids and flavanols (Jelena *et al.*, 2016). The world's annual tomato waste production reaches up to 11 million ton per year including 4 million tons of tomato pomace (Yasar and Tosun, 2020). The utilization of agro-industrial waste products in food or non-food base by-products projected great demand now a days on the basis of their environmental pollution causing effects. By-products of tomato processing industry usually represent an environmental problem and the extensive research work carried out by food and nutrition scientists provided an opportunity for potential utilization of tomato pomace for their addition in the human diet and animal feed. Tomato pomace utilization in food processed products will not only reduce industrial waste processing cost but also provide a viable solution to the pollution problem associated with food processing (Alaa *et al.*, 2015).

II. MATERIALS AND METHODS

Materials

The whole wheat flour, finger millet flour, oats, margarin, crystallized sugar, milk powder and baking powder required for formulation of multigrain cookies were procured from local market of Pune. Fresh and fully ripe tomatoes as a prerequisite for preparation of tomato pomace powder were also obtained from local market of Pune.

Preparation of tomato pomace powder

Fresh and fully ripe tomatoes were washed under tap water and subjected to cutting and grinding operations to obtain puree. Tomato puree was passed from muslin cloth and remaining mass containing peels, seeds and portion of flesh was collected as tomato pomace. Drying process of prepared pomace was carried out at 70^{o}C in tray dryer.Dried pomace was subjected to grinding process inhome scale grinder to obtain tomato pomace powder.

Preparation of multigrain cookies enriched with tomato pomace powder

The multigrain cookies were prepared by using traditional creaming method. Different formulations were prepared by replacing whole wheat flour with tomato pomace powder (Table 1). Sugar and margarine were blended continuously till it forms creamy consistency and all the sugar was uniformly mixed with margarine leaving behind no crystals or granules. Dry ingredients were sieved (Mesh no. 70 US) and mixed with cream and sufficient quantity of milk was added to form dough. The prepared dough was rolled and cookie cutter was used to cut rolled dough into uniform shapes. The cookies were rounded and placed in the baking tray splattered with fat and baked at 140-150^{o}C for 15-20min (Pal *et al.*, 2018) in rotary baking oven. The baked cookies were placed out of oven for cooling, for about 5-10 min. The cookies were weighed and packed in plastic containers. The packs were then stored in hygienic storage racks at room temperature.

Table 1. Formulation of tomato pomace enriched multigrain cookies (g/100g)

Sample code	Whole wheat flour	Finger milletflour	Oats	Tomato pomace powder	Margarine	Sugar	Milk	Baking powder
C	33	5	10	0	20	22	9.5	0.5
S_1	31	5	10	2	20	22	9.5	0.5
S_2	29	5	10	4	20	22	9.5	0.5
S_3	27	5	10	6	20	22	9.5	0.5
S_4	25	5	10	8	20	22	9.5	0.5

C: Control

S_1: 2% Tomato pomace powder with 31% wheat flour

S_2: 4% Tomato pomace powder with 29% wheat flour

S_3: 6% Tomato pomace powder with 27% wheat flour

S_4: 8% Tomato pomace powder with 25% wheat flour

Determination of physical properties

Three multigrain cookies enriched with tomato pomace powder were selected.The weight of each cookie was determined by using analytical scale. Diameter was measured using Vernier Calliper. Thickness of the cookies was measured by loading three cookies one above the other three times. Further, spread ratio of the cookies was measured and expressed as diameter/thickness.

Textural analysis

The texture of cookies was measured using a texture analyzer, with the following settings: aptitude test speed 141mm/s,speed 143mm/s, after test speed 1410mm/s, and activate force 14 auto. Each and everycookie was located in the centre of the plate, and the blade was dropped to break the cookie at a 5mm distance. The top force, which denoted the hardness of the cookies, was measured. The fracture forcewas reported as the peak force required to snap the cookies. Each sample was examined in three different ways.

Proximate composition

The proximate composition of prepared multigrain cookies including moisture, ash, fat, protein, crude fiber, and carbohydrate content of the cookies was determined using standard method of AOAC (2000) and Rangana's (2005).

Assessment of functional characteristics

Lycopene extraction was carried out by standard extraction procedure using acetone-petroleum ether method (Thimmaiah, 2016). The beta carotene content of lycopene enriched multigrain cookies was determined by protocol followed by (Biswas *et al.*, 2011).The total phenolic content of the ground cookies samples was estimatedbyFolin-Ciocalteu spectrophotometric method (Bhat*et al.*, 2020).

Sensory analysis

Cookies formulated from wheat flour, finger millet flour, oats and enriched with tomato pomace powder were evaluated for sensory properties, by10 semi-trained panelistsfrom MIT School of Food Technology. The cookies were evaluated for colour,flavor, texture, tasteand overall acceptability. The ratings were on a 9-point hedonic scale ranging from 9 (like extremely) to 1 (dislike extremely).

Statistical analysis

The data generated in the experiments was recorded and subjected to statistical analysis using standard procedure by using Completely Randomized Design (CRD), according to method by Panse and Sukhatme (1967).

III. RESULTS AND DISCUSSION

Proximate composition of tomato pomace enriched multigrain cookies

The proximate composition of tomato pomace enriched cookies was determined and depicted in table 2.The decreasing trend in moisture content (6.72%), fat (0.29%) and carbohydrate (1.19%) were recorded in cookies with increase in tomato pomace powder content. However, increasing trend in ash (54.93%), protein (8.88%) and crude fibers content (14.85%) was observed in cookies with increase in tomato pomace powder content. The moisture, protein and ash content were found to be in the range of 3.33-3.57%, 5.07-5.52% and 0.71-1.1%, respectively. The increase in ash content was attributed to addition of tomato pomace powder content. Similar results were observed in a study of tomato powder incorporation in cookies by Naseer and Ahsan (2020). The fat, crude fibers and carbohydrate content of tomato pomace enriched cookies were found to be 16.96-17.02%, 2.02-2.32% and 70.76-71.61%, respectively. The highest value of crude fibers content was observed for S_4 (8% tomato pomace powder) formulation, attributing to the increased amount of tomato pomace powder and presence of finger millet and oats.

Table 2. Proximate composition of tomato pomace enriched multigrain cookies

Sample	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Crude Fiber (%)	Carbohydrate (%)
C	3.57	0.71	17.02	5.07	2.02	71.61
S_1	3.47	0.82	17.00	5.16	2.11	71.44
S_2	3.42	0.91	16.99	5.28	2.23	71.17
S_3	3.39	1.02	16.96	5.41	2.26	70.96

S_4	3.33	1.10	16.97	5.52	2.32	70.76
Mean	3.44	0.91	16.99	5.29	2.19	71.33
SE ±	0.04	0.01	0.01	0.02	0.20	0.01
CD @5%	0.14	0.01	0.02	0.02	0.02	0.02

Physical properties of tomato pomace enriched multigrain cookies

Physical characteristics of cookies enriched with tomato pomace powder were evaluated and recorded in table 3. The results showed that the weight, diameter and thickness of tomato pomace powder enriched cookies were in the range of 11.42-12.62g, 5.48-5.53cm and 0.69-0.77cm, respectively (considering all five formulations). The thickness of cookies was found lowest in control and is observed to significantly higher in other formulations containing comparatively high content of tomato pomace powder.

The spread ratio was found to be in the range between 7.16 and 7.91, with the highest value of spread ratio in control formulation. Thus, decreased spread ratio and increased thickness of cookies could be attributed to addition of tomato pomace powder contributing to better rising ability. The volume of control (without tomato pomace powder) and S_4 formulation (8% tomato pomace powder with 25% wheat flour) was found to be 16.35 cm^3 and 18.59 cm^3, respectively. The density of enriched cookies showed to be in the range of 0.68-0.74 g/cm^3.

Table 3. Physical properties of tomato pomace enriched multigrain cookies

Sample	Weight (g)	Diameter (cm)	Thickness (cm)	Spread Ratio	Volume (cm^3)	Density (g/cm^3)
C	11.42	5.48	0.69	7.91	16.35	0.70
S_1	12.20	5.49	0.71	7.70	16.88	0.73
S_2	12.54	5.46	0.73	7.45	17.18	0.73
S_3	12.53	5.51	0.71	7.82	16.87	0.74
S_4	12.62	5.53	0.77	7.16	18.59	0.68
Mean	12.26	5.49	0.72	7.61	17.17	0.72
SE ±	0.01	0.01	0.02	0.07	0.23	0.01
CD @5%	0.02	0.02	0.02	0.25	0.72	0.14

Textural properties of tomato pomace enriched multigrain cookies

The textural properties of tomato pomace enriched (6%) cookies presented in table 4.depicted the hardness of cookies as 2619g, adhesiveness as 0.10mJ while cohesiveness as 0.74. The hardness of cookies could be attributed to development of gluten network during processing, as reported by Aslam *et al.* (2014). The springiness and springiness index, of developed cookies were recorded as 3.91mm and 0.98, respectively. Whereas chewiness and chewiness index were recorded as 4153g and 4070, respectively.

Table 4. Texture properties of tomato pomace enriched multigrain cookies

Parameters	Result
Hardness (g)	2619
Adhesiveness (mJ)	0.10
Springiness (mm)	3.91
Springiness Index	0.98
Chewiness (g)	4153.00
Chewiness Index	4070.00
Gumminess (g)	4153.00 g
Cohesiveness	0.74

Functional characteristics of tomato pomace enriched multigrain cookies

The lycopene and beta carotene content of control cookies were not detected, as control formulation is devoid of tomato pomace powder. Whereas, lycopene and beta carotene content of developed cookies formulations were in the range of 0.78-1.50mg/100 g and 30.14-124.15mcg/100 g, as depicted in table 5. It was observed that both above stated functional properties increased significantly and could be attributed to increase in tomato pomace powder content in developed cookies, due to the high carotenoids content of tomato. The total phenolic content was found in the range of 0.82-1.34mgGAE/g. Moreover, DPPH% inhibition in all formulations was recorded in the range of 21.88- 40.95%.

Table 5. Functional characteristicsof tomato pomace enriched multigrain cookies

Sample	Lycopene (mg/100g)	Beta Carotene (mcg/100g)	Total Phenolic Content (mg GAE/g)	DPPH Inhibition (%)
C	Nil	Nil	0.82 ± 0.03	21.88 ± 0.22
S_1	0.78 ± 0.05	30.14 ± 0.04	1.20 ± 0.04	28.50 ± 0.23
S_2	0.91 ± 0.05	62.29 ± 0.22	1.26 ± 0.08	32.00 ± 0.32
S_3	1.34 ± 0.08	93.26 ± 0.28	1.30 ± 0.08	37.46 ± 0.25
S_4	1.50 ± 0.04	124.15±0.16	1.34 ± 0.06	40.95 ± 0.75
Mean	1.15 ± 0.06	77.46 ± 0.18	1.184 ± 0.06	32.158 ± 0.35
SE	0.02	0.07	0.02	0.12
CD @5%	0.06	0.26	0.06	0.4

Sensory properties of tomato pomace enriched multigrain cookies

The results acquired from sensory evaluation of tomato pomace enriched multigrain cookiesevaluation are presented in table 6.The multigrain cookies prepared with 6% tomato pomace powder and 27% wheat flour recorded highest sensory score for colour (8.1), taste (7.6), flavor (7.9), texture (7.6) and overall acceptability (7.9) as compared to other samples, hence justified its status as standard cookies formulation with enrichment of tomato pomace powder.The effect of tomato pomace powder on sensory score of multigrain cookies was found statistically non-significant at 5%level of significance.

Table 6. Sensorial characteristics of tomato pomace enriched multigrain cookies

Sample	Colour	Taste	Flavor	Texture	Overall Acceptability
C	7.1	6.9	7.3	6.8	7.0
S_1	7.3	7.1	6.8	6.8	6.7
S_2	7.3	7.2	7.4	6.0	7.2
S_3	8.1	7.6	7.9	7.6	7.9
S_4	7.3	7.2	7.3	6.8	7.4
Mean	7.40	7.10	7.30	6.70	7.20
SE ±	0.13	0.12	0.12	0.14	0.11
CD @5%	0.39	0.34	0.37	0.42	0.34

IV. CONCLUSION

In present investigation, multigrain (wheat, finger millet and oats) cookies were enriched with tomato pomace powder in four different proportions by replacing the amount of whole wheat flour with the tomato pomace powder (31:2, 29:4, 27:6 and 25:8) and subjected for quality evaluation (physical, sensorial, nutritional and functional). The results revealed highest acceptability of

multigrain cookies prepared with 6% tomato pomace powder in terms of colour (8.1), taste (7.6), flavor (7.9), texture (7.6) and overall acceptability (7.9). The lycopene content (0.78-1.50mg/100g), beta carotene (30.14-124.15mcg/100g), total phenolic content (0.82-1.34mg GAE/g) and DPPH % inhibition (21.88-40.95%) exhibited increasing trend in developed cookies with increase in tomato pomace powder. The moisture, fat and carbohydrate content were decreased with increase in tomato pomace powder in multigrain cookies, whereas ash, protein and crude fibers showed increasing trend with increase in tomato pomace powder in cookies.

REFERENCES

[1] Abdullah A., Dr. Sheriful A. (2018). Utilization of Fruits and Vegetable Waste in Cereal Based Food (Cookies),*International Journal of Engineering Research & Technology*, ISSN: 2278-0181.

[2] Aggarwal D., Sabikhi L., Kumar S. (2016). Formulation of reduced-calorie biscuits using artificial sweeteners and fat replacer with dairymultigrain approach, *NFS Journal*, 2, 1-7.

[3] Alaa A. G., Mohsen S. A., Zeinab A. S., Bagato O., Ali MA (2015). In-vitro, Antiviral, Antimicrobial and Antioxidant Potential Activity of Tomato pomace,*Int. Journal. Pharm, Sci. Rev. Res.*, 32(2), 262-272.

[4] AOAC (2000). Association of Official Analytical Chemists. Official Methods of Analysis, 17th edition.

[5] Bhat N. A., Wani I. A., and Hamdani A. M. (2020). Tomato powder and crude lycopene as a source of natural antioxidants in whole wheat flour cookies, *Heliyon*,6 (e03042).

[6] Biswas, Sahoo A. K. J., andChatli, M. K. (2011). A simple UV-Vis spectrophotometric method for determination of β-carotene content in raw carrot, sweet potato and supplemented chicken meat nuggets, *Food Science and Technology*, 44(8), 1809–1813.

[7] Brand-WilliamsW., CuvelierM.E., BersetC. (1995). Use of a free radical method to evaluate antioxidant activity, *LebensmittelWissenschaft und- Technologie*, 28, 245-251.

[8] Carnes, J., Larramendi, C. H. D., Ferrer A., Huertas, A. J., Lripez M., PagrynM. A., NavarroJ. A., Garcra A L., VicarioJ. L.S. &Peia, M. (2013). Recently introduced foods as new allergenic sources: Sensitisation to goji berries (lyciumbarbarum),*Food Chemistry*, 137, 130-135.

[9] Handa C.,Goomer S. and Siddhu A. (2011). Physicochemical properties and sensory evaluation of fructoligosaccharide enriched cookies, *Journal Food Sci Technol*., 49(2),192–199.

[10] Jelena M. T., Miona M. B., Aleksandra M. Torbica, Biljana S. P., Ivana S. L., Jovana S. P., Aleksandar Z. F. (2016). The Influence of Addition of Dried Tomato Pomace on The Physical and Sensory Properties of Whole Grain Rye Flour Cookies, *Food and Feed Research*, 43(2), 145-152.

[11] Kishorgoliya N., Mehra M., and Goswami P. (2018). Nutritional quality of the developed multigrain flour and cookies, *Journal of Pharmacognosy and Phytochemistry*, SP1, 2886-2888.

[12] Mudasir A. B., and Hafiza A. (2015).Physico-Chemical Characteristics of Cookies Prepared with Tomato Pomace Powder,*Journal of Food J Processing & Technology*, 7,1 DOI: 10.4172/2157-7110.1000543.

[13] Pal V., Jacob T., Kumar., Binod K., Bharti and Neha P. (2018). Development and quality evaluation of multigrain cookies,*The Pharma Innovation Journal*, 7(7), 1002-1007.

[14] Panse V. G. and Sukhatme P. V. (1967). Statistical methods for agricultural workers 2nd edition, ICAR, New Delhi.

[15] Ranganna, S. (2005). Handbook of analysis and quality control for food products, 3rd edition.

[16] Thimmaiah S. K. (2016). Standard methods of biochemical analysis reference book, 2nd edition.

[17] Yasar S. and Tosun R.(2020). Improving Nutritional Qualities of Tomato Pomace by Pleurotusostreatus and Phanerochaetechrysosporium Fermentation, KSU *J. Agric Nat*., 23 (2), 527-534.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.41

Perceptions of Quality of Life in the Context of Telework in Public Organizations in Brazil: An Integrative Review

Thyago Ferreira da Silva[1], João Carlos Hipólito Bernardes do Nascimento[2], Maurício Mendes Boavista de Castro[3]

[1]Programa de Pós-Graduação em Gestão Pública – PPGP/UFPI). Address: Universidade Federal do Piauí - UFPI, Campus Ministro Petrônio Portella, Av. Petrônio Portella - Ininga, Teresina – PI. ZIP CODE: 64049-550. Identifiers (ID): Lattes: http://lattes.cnpq.br/5658846653921493. Email: thyagopi@gmail.com

[2]Programa de Pós-Graduação em Gestão Pública – PPGP/UFPI). Address: Universidade Federal do Piauí - UFPI, Campus Ministro Petrônio Portella, Av. Petrônio Portella - Ininga, Teresina – PI. ZIP CODE: 64049-550. Identifiers (ID): Lattes: http://lattes.cnpq.br/7222237836912088;

ORCID: http://orcid.org/0000-0003-3505-372X; Web of Science ResearcherID: F-8868-2018; Research Gate: https://www.researchgate.net/profile/Joao_Nascimento10. Email: joaohipolito@ufpi.edu.br

[3]Programa de Pós-Graduação em Gestão Pública – PPGP/UFPI). Address: Universidade Federal do Piauí - UFPI, Campus Ministro Petrônio Portella, Av. Petrônio Portella - Ininga, Teresina – PI. ZIP CODE: 64049-550. Identifiers (ID): Lattes: http://lattes.cnpq.br/2780744627192313; ORCID: https://orcid.org/0000-0002-8463-1197. E-mail: mauricioboavista@ufpi.edu.br.

Received: 29 Apr 2022,

Received in revised form: 19 May 2022,

Accepted: 25 May 2022,

Available online: 31 May 2022

***Keywords*— Quality Of Work Life, Telework, Public organizations.**

***Palabras clave*— Calidad de vida en el trabajo, teletrabajo, Organismos públicos.**

Abstract *— This article sought to identify the current panorama of the study of Quality Of Work Life (QWL) applied to telework in Public Organizations in Brazil. In methodological terms, it is an integrative literature review based on publications from the data platforms: CAPES, SPELL, SciELO and ENAP, delimited by the time frame from 2010 to 2021. By applying search descriptors and parameters for acceptance and rejection, 23 articles composed the corpus and supported the analyses. From the review it was found that, although there are still few researches in the area, a majority of teleworkers positively evaluate the QWL aspects in the telework modality, within the scope of public administration. The flexibility of the workday, the reduction of displacements and the reduction of costs, among other factors were cited as advantages. Despite this, issues such as the weakening of the bond with the company and co-workers and technical adaptation difficulties appear as compromising the QWL. The results achieved have the potential to support future research that addresses the quality of life of teleworkers within the scope of public administration. In addition, the present research can allow the reflection of governments and public managers on the benefits and challenges pointed out by the findings of the study.*

Resumen *— Este artículo buscó identificar el panorama actual del estudio de la Calidad de Vida en el Trabajo (CVL) aplicado al teletrabajo en Organizaciones Públicas en Brasil. En términos metodológicos, se trata de*

una revisión integrativa de la literatura a partir de publicaciones de las plataformas de datos: CAPES, SPELL, SciELO y ENAP, delimitada por el marco temporal de 2010 a 2021. Mediante la aplicación de descriptores de búsqueda y parámetros de aceptación y rechazo, se compusieron 23 artículos el corpus y apoyó los análisis. De la revisión se encontró que, aunque todavía existen pocas investigaciones en el área, la mayoría de los teletrabajadores evalúan positivamente los aspectos de la CVT en la modalidad de teletrabajo, en el ámbito de la administración pública. Se citaron como ventajas la flexibilidad de la jornada laboral, la reducción de desplazamientos y la reducción de costos, entre otros factores. A pesar de ello, cuestiones como el debilitamiento del vínculo con la empresa y los compañeros de trabajo y las dificultades de adaptación técnica aparecen como comprometedoras de la CVT. Los resultados alcanzados tienen el potencial de sustentar futuras investigaciones que aborden la calidad de vida de los teletrabajadores en el ámbito de la administración pública. Además, la presente investigación puede permitir la reflexión de gobiernos y gestores públicos sobre los beneficios y desafíos señalados por los hallazgos del estudio.

I. INTRODUCTION

In recent years, the world has been facing an extremely challenging scenario. Governments and society in general have been faced with several problems from the exponential increase in hunger and misery, the explosion of wars and conflicts, terrorism, global warming and especially the emergence of what can be considered the most devastating of all in the contemporary era, the COVID-19 pandemic (UN, 2021).

In this highly challenging scenario with scarce resources, society increasingly demands public services and consequently requires governments and public administration to find ways to provide permanent service delivery with maximum aggregate quality (Cavalcante, 2017) . Thus, in the face of this environment of continuous changes, the public sector incorporated the type of employment called “teleworking”, a type of service provision that had existed for decades and gained notoriety with the advent of the COVID-19 pandemic.

Remote work has advanced as it presents itself as one of the alternatives to the problems of displacement and infrastructure in large urban centers. In the Brazilian context, it has been consolidated in the private environment, especially with regard to companies in the information technology area. With regard to the public sector, the pioneering initiatives of the Federal Service for Data Processing (SERPRO), Superior Labor Court (TST) and Federal Audit Court (TCU), for example, stand out. It is noted that this is a remarkably contemporary theme, which has recently had a great boost with the restrictions of the pandemic environment.

Regarding the issue of quality of life at work (QWL), this is an area of study, which despite its name having been coined only in the 1970s by Louis Davis (Amâncio, Mendes, & Martins, 2021). It is pointed out that its development has taken place over several years, having as an embryonic milestone, in the 1927s, with the psychologist Elton Mayo when he studied social factors as potential influencers in the exercise of work activities. In addition, its emergence is also associated with the union movements caused by the 1930s crisis, as well as by the studies of Eric Trist, at the Tavistock Institute, England in the 1950s (Fernandes, 2017; Limongi-France, & Arellano, 2002).

In the 1980s, with the advancement of market globalization and the intensification of competitiveness between companies globally, as well as the economic, social and political challenges, QVT gained a competitive differential condition and its application in the work environment became seen as a way to increase organizational profits (Amâncio et al., 2021). From this, there was a broad incentive to QWL through the promotion of well-being in the work environment and through initiatives to improve working conditions, in addition to expanding assistance benefits related to work safety and worker health. In Brazil, this period coincided with the redemocratization process, with the opening of the economy and, among other aspects, the elaboration of the Federal Constitution of 1988 (Fernandes, 2017; Amorim, 2010; Silva, 2010; Limongi-França, & Arellano, 2002).

When analyzing the research environment on QWL, it is observed the wide application in the private sector, which seek to diagnose the Quality of Life at Work of the most diverse professionals, or to analyze and

evaluate programs developed by organizations, and in the public service, Quality of Work Life Management is still an embryonic phenomenon (Amorim, 2010).

In a brief observation of the historical contextualization of the QWL theme and the advent of telework, something in common is observed: the fact that both stand out in a more expressive way in the private organizational environment and the appearance of public organizations in the protagonism of development of these themes under study.

In view of the context presented, the objective of this article sought to identify the current panorama of the study of quality of life at work (QWL) applied to telework in Public Organizations in Brazil. Through a bibliographic review, we sought to determine the panorama of scientific productions published in the period from 2010 to 2021, which deal with the perceptions of the theme Quality of Life at Work in the Context of Telework of the Brazilian public administration from the theoretical-methodological paths adopted. and the established discussions. In this way, specific objectives were established in the interface: i) to identify studies that correlate QWL and Telework in public organizations; ii) verify the theoretical-methodological approaches; iii) analyze the evolution of the theme of the pre-pandemic and pandemic period; and iv) demonstrate the main aspects of QWL addressed within the scope of teleworking in the public sector.

In view of the above, the result of the present study has the potential to assist and support future research that addresses the correlation of QWL and Telework within the scope of public administration. The results obtained can also contribute to possible reflections by governments and public managers on the importance of QWL and Telework themes and their benefits for the provision of public services to society, as well as they can stimulate initiatives aimed at the development of more efficient work policies. that promote effective improvements in the well-being and commitment of public servants.

In this scenario, this article was structured in sections, starting with this introduction, followed by the theoretical foundation, right after the methodology adopted in the research. Subsequently, the analyzes of the scientific productions are presented, and finally, the final considerations to the study.

II. FUNDAMENTAÇÃO TEÓRICA

2.1 QUALIDADE DE VIDA NO TRABALHO (QVT)

Since the remote times that gave rise to human civilization, it has been observed that man has sought to develop tools and techniques that minimize the efforts and wear and tear caused by labor in the activities of his daily livelihood, in order to make the work less painful or even less painful. more pleasurable (Ferrari, 2014). In remote periods, this type of attitude was carried out intuitively and was not even imagined in studies and conceptualization of quality of life at work, which only came to have greater meaning and reach in discussions and research through the context of organizations, more specifically, when they started studies on behavioral, psychosocial and motivational aspects of workers (Coutinho, 2009; Sant'anna et al., 2011; Feitosa, 2014; Meneses, 2019).

In the context of general administration and its theories, it is observed that several studies address intrinsic characteristics of the quality of life at work and consequently may have contributed to the development of this theme, among which it is important to highlight: Elton Mayo in 1927 with a study from Hawthorne; the presentation of human needs in a hierarchical way through Maslow's Pyramid, in 1979; McGregor in 1980 with theories X and Y; Herzberg with the Hygienic and Motivating factors, which deal with job satisfaction or dissatisfaction, and; McClelland with the theory of Contingency of Motivation in which he approaches the needs for achievement, power and affiliation (Pereira et al., 2021).

Despite the various studies on aspects of quality of life at work carried out until then, it was only from the 1970s onwards that the term QWL was used and with that, several authors stood out in carrying out more advanced studies on the subject, including the presentation of models and methodologies used to this day. Authors such as Walton (1973) who related productivity to employee satisfaction and motivation, Hackman and Oldham (1975) who were the first to quantify QWL assessment instruments, Westley (1979) dealing with problems arising from the work environment, Huse and Cummings (1985) focusing on workers' participation in work decisions and problems, Peter and Waterman (1983), Davis and Werther (1983), and Limongi-França (1996) focusing on worker health, among others (Coutinho, 2009).

Something that draws attention and should be highlighted is the fact that much of the doctrinal framework on the subject focuses and develops in the private environment, and the collection is still quite small in the context of public administration. In the public sector, especially in Brazil, it is clear that the keynote of QWL is faced with several challenges inherent to the adaptability of the theme to this area. In addition, factors such as “demanding society for better use of resources and better results, and for transparency in the use of financial

resources" (Klein et al, 2019, p.03).

In this way, it is observed that the study of the quality of life at work is a subject in the development phase and that it has a vast field of study in front of it for deepening, mainly in the public area. It is noticed that this theme has constantly evolved, starting with the need to improve the execution of work activities, passing through studies related to well-being at work when there was no defined concept, advancing with the name QVT and developing with the new forms of institutions, markets and technological innovations. Therefore, presenting itself also propitious to correlate with the new modalities of labor employment such as Telework.

2.2 TELEWORK

To understand the conceptualization of the nomenclature "Telework", a brief explanation of its emergence is necessary. The idea of remote work emerged as a proposition in the 1970s, to face the oil industry crisis, the growth of vehicle traffic in large cities and, also, with the greater presence of women in the labor market. However, the theme gained scope and prominence from the 1990s onwards, directly linked to technology companies and professionals, mainly with advances in information technology and telecommunications (Costa, 2007).

The terminology telework comes from the English word (teleworking) which basically can be understood as work carried out remotely in relation to the work environment, which can be at home or anywhere else, making use of the structure and tools of telephony and information technology. . There is no single and precise definition in the literature, and different concepts can be found on the subject. Anyway, regardless of the concept presented, it is possible to verify that teleworking is based on pillars such as flexibility, autonomy, responsibility, quality of life, among others.

In view of the various concepts that are presented on the subject and in order to organize the understanding, it is worth highlighting the classification that takes into account the place where teleworking is carried out, by which teleworking is listed in at least 04 (four) categories, of which: "(1) Home office work; (2) Mobile work, without a fixed location; (3) Work in a satellite office; and (4) Work in telecenters (coworking)". According to this classification, both these categories are species and the term telework is the genus that encompasses them (Abreu, 2016; Silva; 2014).

In Brazil, despite teleworking being a relatively contemporary topic, it is possible to identify several studies on the subject, mainly within the scope of private organizations, and it appears that there are results and authors with different opinions. There are studies that address from the advantages and disadvantages of telework, such as Barros e Silva (2010) and Filardi (2018), through those that address teleworkers' perceptions of QWL, in addition to those that analyze whether the worker's profile is compatible with this type of work such as Nogueira and Patini (2012), among others.

In the Brazilian public administration, it is important to highlight the pioneering spirit of some public entities in the implementation of telework, among which are: Federal Data Processing Service (SERPRO) which adopted telework through a pilot project in 2005, the Court of Accounts of the Union (TCU) that regulated the work carried out outside its premises through ordinances nº 139/2009 and 99/2010 and the case of the Superior Labor Court (TST) from 2012. the Federal Revenue Service of Brazil (2012), Attorney General of the Union - AGU (2011), among others (FILARDI et al, 2018).

When it comes to the regulation of the subject in the Brazilian state, it is observed that only in 2011 the first attempt to regulate this modality took place with the change, through Law n. 12,551/2011, of the Consolidation of Labor Laws (CLT). Through this change, teleworkers were given the same rights as employees who work face-to-face. However, it is worth noting that this law left many points that are not clearly presented, compromising its execution. Thus, on July 13, 2017, Law No. 13,467 was published with more significant and detailed changes on the service performed under telework.

III. RESEARCH METHODOLOGY AND PROCEDURES

For the development of this study, a systematic literature review was used. This research methodology consists of "a synthesis of primary studies that contain objectives, materials and methods clearly explained and that was conducted according to a clear and reproducible methodology" (Greenhalgh, 1997, p. 672).

It should be noted that the systematic literature review is divided into four different methods: meta-analysis, systematic review, qualitative review and integrative review. As it is a methodology that absorbs and integrates other different methods from the scientific field in its execution, the systematic literature review is also known as an "umbrella" methodology (Botelho et al, 2011; Rother, 2007).

This research specifically adopted the integrative review method. The choice to use this type of research was due to the fact that this procedure uses a data source on a delimited and specific theme and for having its

development with strict observance of methodological rigors, thus being characterized as original studies for the scientific research environment . Therefore, it can offer contributions to the literature surrounding the subject and serve as a guide for new researchers (Rother, 2007).

The work was carried out guided by the phases defined according to (Botelho et al, 2011). Initially, the theme was identified, which deals with the perceptions of Quality of Life in the Context of Telework in Public Organizations in Brazil and the guiding questions of the study were defined.

In the first stage, the databases in which the queries would be carried out were established, as well as the search terms to be used to carry out the bibliographic survey. It was decided to use, in a conjugated way, the following keywords: "telework" or "home office", "AND" "public" or "public" and "quality of life" or "QVT" or "quality of life" ".

It is noteworthy that the in-depth verification of aspects of quality of life at work occurs later through the analysis and detailed reading of the results obtained with the filter determined above. In addition, the platforms were chosen considering their "reasonable representation" in the national scientific scope and based on the availability of access to content – CAPES Journals, Portal Spell, Scientific Electronic Library Online (SciELO), ENAP Repository; and the period of publications to be examined was delimited – from January 2010 to November 2021.

In the next step, the definition of including and excluding parameters for data selection took place. In addition to indicating the criteria, it was also established that the acceptance of the article would be conditioned to the simultaneous presence of all studies in all inclusion criteria. On the other hand, those texts that belonged to some exclusion factor were rejected.

Table 1: Inclusion and exclusion parameters

Inclusion	Exclusion
Studies dealing with telecommuting	Studies that do not address telecommuting
Studies that demonstrate aspects of QWL	Studies that do not demonstrate aspects of QWL
Studies that address the Brazilian context	Studies that do not address the context of Brazil
Studies related to the public sector	Studies that are not related to the sector público
Studies published from January 2010	Studies published prior to January 2010

Source: adapted from Amâncio et al. (2021).

Soon after, in the third phase, a scheme was constituted formed by the following elements of the textual composition: authorship, year of publication, title, objective and area.

Based on the reading of these schematized items, adding to the previously defined acceptance/rejection parameters, the selection of studies was undertaken. In the fourth phase, the categorization step was performed. For Botelho, Cunha and Macedo (2011, p.131), this stage "aims to summarize and document the information extracted from the scientific articles found in the previous phases". Then, the fifth phase began, which consisted of discussing the research findings. Finally, the terminative stage was implemented, in which the study was consolidated, describing the course of the integrative review, ending with an overview of the results found, which are presented in the following section.

IV. DATA ANALYSIS AND DISCUSSION

Data collection consisted, initially, of carrying out a search for keywords, in predetermined databases, using the application of the following search descriptors: "Telework" OR "Home office" AND "public" " AND" "Quality of Life". Thus, a large amount of raw data (188 papers) was obtained, as shown in Table 02 below:

Table 2: Amount of raw data obtained in the previous selection of articles

PERÍOD O	ENAP	CAPES	SCIELO	SPELL
2010 a 2019	**9**	**62**	**5**	**16**
2020 a 2021	**11**	**45**	**24**	**16**
TOTAL	**20**	**107**	**29**	**32**
188				

Source: research data.

Next, the inclusion and exclusion criteria determined in phase 2 were applied, seeking to refine the research and the following result was obtained: 146 manuscripts were discarded because they fit into any of the rejection parameters listed in Table 1 ; 13 were rejected for being in duplicate; and another 06 were excluded after an in-depth reading and identification that, despite addressing telework in the public sector, they did not directly address QWL aspects.

Table 3, presented below, shows the summary detailing the year of publication, title, author, area and the main results of the studies found about the object studied. In this way, it makes it possible to carry out an analysis and make it possible to obtain timely answers to the questions raised by the text.

Table 3: Aspects of the selected studies

YEAR	TITLE	RESULTS	AUTHORS	AREA
2016	Implementation of Telework Pilot Project in the General Coordination of Information Technology of the Social Security Department	As a result, a viable project of interim intervention is proposed, aiming to measure the expected positive results in terms of improving the quality of life and productivity of servers, to support a future decision regarding the definitive institutionalization of the practice in the unit.	Henry Mross	Secretary of Social Security / DF
2018	Advantages and Disadvantages of Telework in Public Administration - Analysis of the Experiences of Serpro and the Federal Revenue	Advantages: improved quality of life; greater balance in the work x family relationship; greater productivity; flexibility; creating metrics; cost reduction; stress; travel time; exposure to violence; and knowledge of job demand. Disadvantages were: no adaptation; lack of communication; loss of relationship with the company; psychological problems; infrastructure; and telecommuter control.	Fernando Filardi; Rachel Mercedes P. de Castro; Marco Tulio Fundão Zanini	Federal Data Processing Service – DF
2018	The Adoption of Telework by the Regional Electoral Court of the Federal District - TRE-DF- A Study on the Possible Impacts on the Quality of Life at Work of Servers	Adoption of telework by TRE/DF would impact the QVT of servers by providing a reduction in stress, flexibility in working hours, independence in performing tasks and strengthening the family.	Mariane Cássia Rodrigues Alves	Justice/DF
2018	Attitudes to the Change in Telework in the Federal District Attorney's Office	The results obtained showed a high rate of attitudes of acceptance on the part of the servers regarding the practice of teleworking. And yet, low skepticism and attitudes of fear regarding the referred modality of work in the agency.	Edie Paulo Assis Peixoto Alves	Justice/DF
2018	Pilot Project Implementation Telework at the Benefits Board of the National Social Security Institute	Concluding, then, the feasibility of implementing the pilot project, which can be submitted to the sponsoring authority so that, if agreed, it authorizes the start of this project.	Bruno Baranda Cardoso	INSS/DF

2018	Telework - A study of the perception of the quality of work life of teleworkers and on-site workers	The study answered the general objective, pointing out that increasing the performance goal does not affect the QWL of teleworkers. Among the results found, two drew attention: the dissatisfaction of the teleworker and the great dissatisfaction of the face-to-face worker with the prospect of salary advancement and professional growth; and dissatisfaction with the lack of free time of the on-site worker.	Rodolfo Lemos Medeiro	Federal Public Administratio n/DF
2020	Telework in the context of the Covid-19 Pandemic - The Perception of Public Servants of the Brazilian Judiciary and MPU	The biggest highlight of the work/family scope was the difficulty of reconciling different roles in the routine at home. Despite this, the flexibility of schedules was often cited as a positive point. On the other hand, in professional relationships, it was noted that the lack of contact with colleagues to solve problems and coexistence was the most apparent aspect in the responses. In general, saving resources was also relevant in the analyzed contexts. The research findings emphasize that adapting teleworking to the pandemic has positive and negative points with the potential to expand the initiative and also adapt to the service in the way it was already provided.	Lunara Stollmeier PANDINI; Eliana dos Santos PEREIRA	Judiciary and MPU/Brazil
2020	Telework During the Pandemic - The Experience of the Technical Staff of the State University of Santa Catarina – Udesc	Most servers have rated their current remote work experience as satisfactory or very satisfactory (73.7%). However, 40 servers have evaluated it regularly, while 13 servers have not evaluated this experience positively. Even in unstable times due to Covid-19, 139 servers felt an improvement in their quality of life. The improvement of the balance between personal and professional life, in turn, was verified by a little less than half of the sample.	Ana Luiza Leite; Dannyela da Cunha Lemos	State University of Santa Catarina – Udesc
2020	Telework as an inducer of increases in productivity and cost rationalization - An empirical application in the Ministry of Justice and Public Security	Preliminary results indicate that teleworking contributes to the optimization of the use of physical spaces, enabling the rationalization of the institution's common costs; in the significant increase in the average productivity of teleworking servers. Therefore, it can be seen that the results of this research corroborate the findings in the literature, especially with regard to the benefits perceived by the organization, since the adoption of telework evidenced the increase in productivity and real possibilities of cost rationalization in the aforementioned ministry.	José de Albuquerque Nogueira Filho;Míriam Aparecida Mesquita Oliveira;Fabian o Pereira Corrêa Sämy;André Nunes	Ministry of Justice and Public Security/DF
2020	Today's Telework – What Are the Impacts on Professional Performance, Well-Being and Work Context?	Among the positive aspects of teleworking, the increase in productivity and improvements in the teleworker's quality of life stand out. Among the negative points, technical and social difficulties stand out. As for the comparison, teleworkers perceive their work context, their professional performance and their well-being at work more positively.	Karina Pereira Bastos Vilarinho;Tatia n e Paschoal; Gisela Demo	Federal Data Processing Service/DF

2020	Perspectives and Challenges of Telework in the Federal Public Administration in the Face of the Covid-19 Pandemic	Regulatory agencies have shown a good level of maturity. Ministries have successful experiences in a few units and suffered most from the urgent measure. Serpro and TCU already had good experience and did not have great difficulties in the face of the pandemic. Finally, remote work is well supported by most employees, who reported improved quality of life after experiencing this way of working.	Juliane Zatelli de Souza	Federal Public Administration/DF
2021	Skills for Teleworking from Home - Construction and Validity Evidence of the Scale	The instrument has a two-factor empirical structure that assesses skills for balancing work and other activities (soft skills) and for using digital resources in work interactions (hard skills). The EHTC can be used to identify adaptation and readiness for teleworking from home and to investigate associations between these skills and other indicators.	Gardenia da Silva Abbad,Luciana Mourão, Russen cleyton Barros Costa,Lara Barros Martins, Juliana Legentil, Lisa Miranda	Federal/Judicial/District Public Administration – DF
2021	The Public Service and Telework in the Brazilian Federal Public Administration in Times of Covid-19	The survey revealed that 95.13% of respondents are performing their activities remotely, either partially (n=107) or fully (n=322). Among the advantages pointed out by the practice of teleworking, there is no need to travel (88.50%) as the main advantage of exercising this practice, followed by flexible working hours (69.79%) and quality of life (60 .43%)	André Luiz Trajano dos Santos; Augusto da Cunha Reis	Federal public administration/Brazil
2021	Telework During the Covid-19 Pandemic - Indicators of Intensification of Teaching Work	It was possible to conclude about the consequences of the junction between paid and unpaid work in the same time and space: the work overload, intensification - indicated by the lengthening of the working day, by the accumulation of activities and management of results with the self-responsibility on the teaching and learning processes influenced by the current dynamics of educational policies.	Danyela Martins Medeiros	Basic Education of the Department of Education of the - DF
2021	Telework and Quality of Life - Case Study of the Judiciary in a State in Northern Brazil	The results showed an average of 4.107 in the General Satisfaction Level, showing that 88.5% of TJAP servers are satisfied or very satisfied with the participation in the telework regime. However, the low Coefficient of Tolerable Variation (30%) shows that variables related to Information and Communication Technologies (ICT's) are challenges to be overcome regarding this work model, considering the peculiarities involved in the context of Amapá.	Luis de Jesus Pereira;Ananias Costa Oliveira;Leiliane Penafort da Silva;Cláudio Márcio Campos de Mendonça	Court of Justice of Amapá
2021	Telework Pilot Project for Technical Servers at the State University of Santa Catarina	Most servers did not report improvement in quality of life and job satisfaction. Furthermore, there was no resistance from servers, as predicted in the literature. This may have occurred due to the project involving few servers and who already had the propensity to try this type of work	Ana Luiza Leite;Dannyela da Cunha Lemos	Santa Catarina State University

2021	People Management and Telework - Challenges and Possibilities	The results showed that there is similarity in the objectives, in the legislation, in the availability of information technologies, in the sensitization and in the means of communication. However, there are different perspectives regarding the centralization or not of the remote work program in certain sectors, distinction in the frequency of goals, in the request for increased productivity and in the available modalities.	Ana Luiza Leite Dannyela da Cunha Lemos	Justice/State of Santa Catarina
2021	Denasus Performance Evaluation in the Context of Telework	It was found that it is possible to develop an individual performance assessment instrument capable of evaluating the performance of servers in remote work, however, preliminary studies must be carried out on the nature of the activities carried out in the department, in order to identify those susceptible to remote realization, contributing to the achievement of Denasus' institutional objectives and improving the health services provided by it to society	Paula Bittencourt Gomes	Ministry of Health/DF
2021	Main Impacts of the Return to Face-to-Face Work in a Pandemic Scenario – The Experience of Ebserh Headquarters	The first feeling perceived by employees when performing remote work obtained 21.65% of indication as being comfortable, followed by the same percentage for the feeling of being productive. The survey also showed other points favorable to QWL, of which 17.07% of those surveyed felt motivated, 15.85% indicated a feeling of security and 14.63% realized they were engaged. The dimension of the survey on QVT confirmed that EBSERH Headquarters employees embraced the cause of remote work	Euysderson Aragão Borges;Flávio Coelho	EBSERH/DF
2021	Quality of Life of Workers with Disabilities in Compulsory Telework - A Study in Brazilian Public Organizations	The results indicated that the averages of the Compulsory e-QVT dimensions were concentrated in the optimal and good rating ranges, with the most critical points falling on the dimension of Overload resulting from Compulsory Telework.	Jayne da Silva Bezerra	Person with Disabilities
2021	Quality of Life in Compulsory Telework in the Context of Covid-19 - Perceptions Between Genders in Public Organizations	The results showed satisfactory and good levels in almost all e-QWL dimensions, with the exception of the overload factor. It was also possible to verify the existence of significant differences between women and men in the management dimension of telework; and between women and men with and without children, indicating that in families with children, workers perceive that there is more interruption during the performance of activities and less balance between work, rest and leisure. When comparing the perceptions of women with and without children, lower averages and greater dispersion of responses were found in the group of women with children and a significant difference in the dimension teleworker activities	Simone Maria Vieira de Velasco	Miscellaneous / Brazil

2021	Quality of Life in Mandatory Telework in Public Administration -Individual predictors	The results showed, in general, the predominance of representations of well-being and quality of life in telework, also showing possible sources of discomfort regarding the overload resulting from mandatory telework. It was also possible to observe that individual and functional characteristics influence the perception of technological support and the levels of quality of life in telework. These results confirm the need for a careful selection of teleworkers, a clear and fair definition of goals and the right to disconnect from work.	Míriam Aparecida Mesquita Oliveira;Maria Júlia Pantoja	Miscellaneous / Brazil
2021	Quality of Life in Compulsory Telework in the Context of Covid-19 - Comparative Analysis of Workers and Managers of a Public Institution of the Federal Judiciary Power	The workers' ability to self-manage, organize their own activities (self-discipline) and adapt to teleworking is positively highlighted. On the other hand, critical levels related to the overload resulting from compulsory teleworking, especially among those occupying managerial positions, involving the perception of an increase in the workload and a greater demand for commitment	Marcelo Guimarães de Carvalho;Maria Júlia Pantoja	Justice/DF

Source: Own elaboration (2021).

The information collected made it possible to identify some interesting findings. First, it was found that the research that sought to relate telework in public institutions with the issue of worker's quality of life is extremely recent, since approximately 73.91% of the results found were made in the period from 2020 to 2021, being that 52.17% of the total represents studies carried out in the year 2021. In addition, he observed that most of these studies directed their research to the analysis of the quality of life of public servants in the face of the COVID-19 problem and the compulsory adoption of telework in public bodies.

It should be noted that despite the studies on the quality of life of public teleworkers, being a relatively recent issue, it was observed that several public entities have been using the telework regime for a long time, as for example, in the cases of SERPRO, TCU and Federal Revenue (RFB), making this type of service provision already consolidated in the scope of many state entities. Thus, it appears that the adoption of teleworking in many institutions of the federal public administration is institutionalized (Alves, 2018). This can help to understand some of the findings of this research, which showed that the QWL studies of the public teleworker are quite concentrated in the federal district, with about 60.86% of the results obtained, mostly within the scope of the federal public administration, encompassing bodies of the executive, judiciary, public prosecutor and court of accounts of the union. On the other hand, at the state level, the state of Santa Catarina stands out with about 13.04% of the findings. The rest of the results are dispersed among the other entities of the federation, with much lower percentages.

In addition, when it comes to the perspective of identifying studies by public administration sphere, it is important to highlight that, among the analyzed findings, there was no research that addresses the quality of life in telework in the municipal administration. Therefore, the fact that municipal institutions were not observed in the results resulting from the research design can be considered a limitation for the study of the topic (Oliveira, 2021). Therefore, considering the absence of municipal data within the literary frame studied, it is not possible to make inferences or conclusions about teleworking and quality of life in Brazilian municipalities.

When observing the concentration of research by areas of public administration, the judiciary stands out clearly with about 34.78% of participation, distributed by state and federal courts. However, areas with great representation in the provision of services to society, such as health and education, appear with tiny percentages of approximately 8.6% each. With regard to inter-institutional research, which involves employees from several different agencies, a percentage of around 30% of the universe studied was involved. In addition, it is worth mentioning the identification of findings that investigate the perceptions of QWL in teleworkers with disabilities and also that analyze the impacts of telework on QWL by gender, one for each in absolute numbers.

Regarding the perceptions about the quality of life of teleworking servers, there was a predominant support

for this type of service, with a high acceptance rate (Alves, 2018; Souza, 2020). One of the points that stood out most, in a positive way, being mentioned repeatedly by teleworkers, was the flexibility of working hours and schedules (Filardi et al, 2018; Santos, 2021; Pereira, 2021; Alves, 2018). In addition, among the aspects that confirm the approval of teleworking in the public sector, factors such as reduced travel, cost reduction, reduced stress, ability to organize one's own activities (self-discipline) and others were also mentioned.

On the other hand, among the negative aspects that compromise the quality of life of teleworkers in public organizations, the following stand out: the loss or weakening of the bond with the company and with co-workers, difficulties in technical adaptation, especially with new technologies. In addition, it is worth emphasizing that the overload resulting from compulsory teleworking stands out, appearing with great frequency, among the negative factors in the findings of several researchers (Carvalho, 2021; Oliveira, 2021; Velasco, 2021; Bezerra, 2021; Medeiros, 2021) . In this way, it was noticed that despite the acceptance of teleworking by most of the surveyed servers, disadvantages were still pointed out with the adoption of this type of service provision.

In terms of methodology approaches, there was a great diversity of methodological procedures and tools used to collect data, it was also verified the predominance in the use of the quantitative approach, although it was found the occurrence of some qualiquantitative situations. Furthermore, the questionnaire, with a percentage of approximately 60%, was the main instrument used to collect information. In addition, several other investigation methods were identified, including exploratory, documentary research, surveys and interviews. It is also important to highlight the use of the Mandatory e-QWL theoretical model proposed by Pantoja and composed of five dimensions as well as the conceptual categories and factors that influence Walton's QWL.

The findings of this integrative review made it possible to verify that the study of the topic addressed, quality of life of public teleworkers, still happens in an incipient way. This can be confirmed not only by the small number of selected studies but also by the other results found, among which they can be listed: most of the papers were carried out between 2020 and 2021, poor geographical distribution, little representation of state agencies, absence of municipal institutions, few areas of public service were studied and so on. Given this scenario, it is possible to point out some guidelines and directions for future research, such as: expansion of the scope of work so that it encompasses the analysis and investigation of the theme at the levels of state and mainly municipal administration; diversification of the areas studied, seeking to explore areas of greater impact in the direct provision of public services; and expansion of methodological approaches, diversifying the study models used.

V. CONCLUSIONS

The present research shows that, despite the debates on the quality of life of teleworkers in the private environment are widespread, such discussions still manifest themselves in an embryonic way in public organizations. In view of the time frame delimited by the study that encompasses the period (2010 - 2021), in general, it was observed that there was a significant increase in studies on the quality of life of teleworkers from 2020 to 2021, which may have be justified by the emergence of the coronavirus pandemic in that time interval. In addition, some limitations were identified in the study of the quality of life of public teleworkers, such as: Studies concentrated geographically, mostly in the country's capital, small state representation and complete absence of research within the municipal administration, among others. In addition, the results showed a great approval of teleworking by public servants despite the allegation of some difficulties.

Regarding its relevance, this study has the potential to provide both academic and practical benefits in the work environment. In academic contributions, for example, it can support future research that addresses the quality of life of teleworkers within the scope of public administration through the knowledge of the main limitations found, as well as the observance of the exposed recommendations. As for the practical contributions, they can be demonstrated both by allowing public managers to reflect on the benefits pointed out by servers in teleworking as well as by bringing to the light of management the challenges and difficulties faced in the teleworking environment, allowing adjustments and adaptations to be promoted. in the implementation of this type of service provision in the public sector.

As observed in the analysis of the results, the current article found limitations that did not allow the exhaustion of discussions on the subject studied. For recommendations for future research, it is recommended that some guidelines be followed in order to enrich the work of future researchers, such as: starting with the observation of the context of private institutions in order to expand the scope of the study, as well as the use of new data platforms enabling a greater robustness of the information capture base. In addition, it is recommended that the geographic expansion be carried out, by the state and municipal spheres and other areas of action of the

public administration, among other aspects.

REFERENCES

[1] Abbad, G. D. S., Mourão, L., Costa, R. B., Martins, L. B., Legentil, J., & Miranda, L. (2021). Habilidades para teletrabalho em casa: construção e evidências de validade da escala. *Revista Psicologia Organizações e Trabalho*, 21(3), 1655-1664.

[2] Abreu, E. V. X. de. (2016). *A adoção do teletrabalho: uma análise da aceitação do uso do trabalho a distância com jovens trabalhadores.* 2016. 106 f. Dissertação (Mestrado) - Curso de Administração, Universidade Fumec, Belo Horizonte.

[3] Alves, E. P. A. P. (2018). Atitudes frente à mudança do teletrabalho na Procuradoria da República no Distrito Federal. Trabalho de Conclusão de Curso (Especialização em Gestão Pública) – *Escola Nacional de Administração Pública.* Brasília: ENAP.

[4] Alves, M. C. R. (2018). A adoção do teletrabalho pelo Tribunal Regional Eleitoral do Distrito Federal–TRE/DF: um estudo acerca dos possíveis impactos na qualidade de vida no trabalho dos servidores. Trabalho de Conclusão de Curso (Especialização em Gestão Pública) – *Escola Nacional de Administração Pública*. Brasília: ENAP.

[5] Amâncio, D. L. P., Mendes, D. C., & Martins, S. (2021). Qualidade de Vida no Trabalho nas Organizações Públicas Brasileiras: uma Revisão Integrativa da Literatura. *Teoria e Prática em Administração*, 1-15.

[6] Amorim, T. G. F. N. (2010). Qualidade de vida no trabalho: preocupação também para servidores públicos?. *Revista Eletrônica de Ciência Administrativa*, 9(1), 35-48.

[7] Andrade, S. M., Limongi-França, A. C., & Stefano, S. R. (2019). Dimensões da qualidade de vida no trabalho e justiça organizacional: um estudo com servidores públicos municipais Dimensions of quality work life and organizational justice: a case with municipal public servants. *Revista Capital Científico-Eletrônica* (RCCe)-ISSN 2177-4153, 17(3), 93-108.

[8] Antunes, E. D., & Fischer, F. M. (2020). Can't justice stop?! The COVID-19 impact on the Brazilian Federal Judiciary teleworking policy. Revista Brasileira de Saúde Ocupacional, 45.

[9] Barros, A. M., & Silva, J. R. G. D. (2010). Percepções dos indivíduos sobre as consequências do teletrabalho na configuração home-office: estudo de caso na Shell Brasil. *CADERNOS Ebape.br*, 8(1), 71-91.

[10] Bezerra, J. D. S. (2021). Qualidade de vida de trabalhadores com deficiência no teletrabalho compulsório: um estudo em organizações públicas brasileiras. Trabalho de Conclusão de Curso (Especialização em Gestão de Pessoas, Inovação e Resultados) – *Escola Nacional de Administração Pública.* Brasília: ENAP, 2021.

[11] Borges, E. A. (2021). Principais impactos do retorno ao trabalho presencial em cenário de pandemia–a experiência da EBSERH sede.

[12] Botelho, L. L. R., de Almeida Cunha, C. C., & Macedo, M. (2011). O método da revisão integrativa nos estudos organizacionais. *Gestão e sociedade*, 5(11), 121-136.

[13] Brasil (1988). *Constituição Federal Brasileira de 1988*. Saraiva, São Paulo.

[14] Brasil (2011). Lei Nº 12.551, de 15 de Dezembro de 2011. *Equipara o teletrabalho ao trabalho presencial*. Brasília, DF, 15 dez. 2011.

[15] Brasil (2017). Lei Nº 13.467, de 13 de Julho de 2017. *Adequa a legislação às novas relações de trabalho*. Brasília, DF, 13 jul. 2017.

[16] Cardoso, B. B. (2018). Implantação de projeto-piloto de teletrabalho na diretoria de benefícios do instituto nacional do seguro social. Trabalho de Conclusão de Curso (Especialização em Gestão Pública) – *Escola Nacional de Administração Pública.* Brasília: ENAP, 2018.

[17] Carvalho, M. G. (2021). Qualidade De Vida No Teletrabalho Compulsório no Contexto Da Covid-19 - Análises Comparadas De Trabalhadores E Gestores De Uma Instituição Pública Do Poder Judiciário Federal. Trabalho de Conclusão de Curso (Especialização em Pessoas, Inovação e Resultados) - *Escola Nacional de Administração Pública.* Brasília: ENAP.

[18] Cavalcante, P.; Cunha, B. Q. (2017). É preciso inovar no governo, mas por quê? In.: *Inovação no Setor Público:* teoria, tendências e casos no Brasil. Brasília: Enap: Ipea.

[19] Cavalcante, R. M. F., Pontes, K. V., Bandeira, A. A., & Rocha, A. L. (2018). Qualidade de Vida e Qulidade de Vida no Trabalho: Uma Revisão Bibliográfica. ID on line *Revista de Psicologia*, 12(40), 21-31.

[20] Costa, I. D. S. A. D. (2007). Teletrabalho: subjugação e construção de subjetividades. *Revista de Administração Pública*, 41, 105-124.

[21] Coutinho, M. L. G. (2009). *Práticas de gestão de projetos em programas de qualidade de vida no trabalho*. Dissertação (Mestrado em Administração) - Faculdade de Economia, Administração e Contabilidade, Universidade de São Paulo, São Paulo, 2009.

[22] Feitosa, T. V. N. (2014). *Qualidade de Vida no Trabalho em Condições Extremas.* Dissertação (Mestrado Acadêmico em Administração) – Centro de Estudo Sociais Aplicados, Universidade Estadual do Ceará, Fortaleza, CE, 2014. Disponível em: <http://repositorio.unifametro.edu.br/handle/123456789/879>. Acesso em: 08 dez 2021.

[23] Fernandes, D. F. B. (2017). Políticas Públicas de RH e a QVT de Servidores Públicos: Um Caso em Pernambuco. *RAUnP - Revista Eletrônica do Mestrado Profissional em Administração da Universidade Potiguar*, 9(2), 21-33.

[24] Ferrari, M. D. (2014). *Qualidade de vida no ambiente de trabalho: UTFPR - Curitiba e o desenvolvimento de pessoas.* 165 f. Dissertação (Mestrado em Tecnologia) – Universidade Tecnológica Federal do Paraná, Curitiba, 2014.

[25] Filardi, F., Castro, R. M. P. D., & Zanini, M. T. F. (2020). Vantagens e desvantagens do teletrabalho na administração pública: análise das experiências do Serpro e da Receita Federal. *Cadernos Ebape*.br, 18(1), 28-46. . Brasília: ENAP, 2021

[26] França, A. C. L. (1996). Indicadores empresariais de qualidade de vida no trabalho: esforço empresarial e

satisfação dos empregados no ambiente de manufaturas com certificação ISO 9000 (Doctoral dissertation, Universidade de São Paulo).

[27] Gil, A. C. (2010). *Como elaborar um projeto de pesquisa.* Quinta edição. Atlas. São Paulo.

[28] Gomes, P. B. (2021). Avaliação de desempenho do DENASUS no contexto de teletrabalho. Trabalho de Conclusão de Curso (Especialização em Gestão de Pessoas, Inovação e Resultados) – *Escola Nacional de Administração Pública*. Brasília: ENAP, 2021.

[29] Greenhalgh, T. (1997). How to read a paper: Papers that summarise other papers (systematic reviews and meta-analyses). *Bmj*, 315(7109), 672-675.

[30] Hackman, J. R.; & Oldham, G. R. (1975). Development of the job diagnostic survey. *Journal of Applied Psychology*, 60(2), 159-70.

[31] Huse, E. F.; & Cummings, T. G. (1985). *Organization development and change*. Minnesota: West Publishing Co.

[32] Junior, E. P., & Caetano, M. E. S. (2009). Implicações do teletrabalho: um estudo sobre a percepção dos trabalhadores de uma região metropolitana. *Revista Psicologia: Organizações e Trabalho*, 9(2), 22-31.

[33] Klein, L. L., Lemos, R. B., Pereira, B. A. D., & Beltrame, G. (2017). QUALIDADE DE VIDA NO SERVIÇO PÚBLICO: UMA AVALIAÇÃO EM UMA INSTITUIÇÃO DE ENSINO SUPERIOR1. REAd. *Revista Eletrônica de Administração*, 23, 317-344.

[34] Klein, L. L., Pereira, B. A., & Lemos, R. B. (2019). Quality of working life: Parameters and evaluation in the public service. *Revista de Administração Mackenzie*, 20(3). Doi: https://10.1590/1678-6971/eRAMG190134.

[35] Leite, A. L., & da Cunha Lemos, D. (2021). Projeto-piloto de teletrabalho para servidores técnicos da Universidade do Estado de Santa Catarina. *Revista Expectativa*, 20(1), 73-96.

[36] Leite, A. L., & Lemos, D. D. C. (2020). Teletrabalho durante a pandemia: experiência do corpo técnico da universidade do estado de Santa Catarina–UDESC. *Pensamento & Realidade*, 35(3), 87-109.

[37] Leite, A. L., & Lemos, D. D. C. (2021). Gestão de pessoas e o teletrabalho: desafios e possibilidades. Revista do Serviço Público, 72(2), 330-359.

[38] Limongi-França, A. C., & Arellano, E. B. (2002). Qualidade de vida no trabalho. In: Fleury, M.T. L. (Org.). *As pessoas na organização.* São Paulo: Editora Gente, v. 1, 295-306.

[39] Medeiro, R. L. (2018). Teletrabalho: um estudo da percepção sobre a qualidade de vida no trabalho dos teletrabalhadores e dos trabalhadores presencias. Trabalho de Conclusão de Curso (Especialização em Gestão Estratégica de Pessoas) – Escola Nacional de Administração Pública. Brasília: ENAP.

[40] Medeiros, D. M. (2021). O teletrabalho durante a pandemia da covid-19: indicadores da intensificação do trabalho docente. *Revista Educação e Políticas em Debate*, 10(3), 1158-1171. DOI: https://doi.org/10.14393/REPOD-v10n3a2021

[41] Meneses, J.S. (2019). Qualidade de vida no trabalho: na percepção dos servidores Técnico-administrativos do Campus Binacional – Oiapoque – AP, na Universidade Federal do Amapá (UNIFAP). Dissertação (Mestrado Profissional em Políticas Públicas) – Centro de Estudo Sociais Aplicados, Universidade Estadual do Ceará.

[42] Mross, H. (2016). Implantação de projeto-piloto de teletrabalho na Coordenação-Geral de Informática da Secretaria da Previdência.

[43] Nogueira Filho, J. A., Oliveira, M. A. M., & Sämy, F. P. C. (2020). aumentos de produtividade e da racionalização de custos: uma aplicação empírica no Ministério da Justiça e Segurança Pública. *Revista do Serviço Público*, v. 71, n. 2, p. 274-296.

[44] Nogueira, A. M.; & Patini, A. C. (2012)Trabalho remoto e desafios dos gestores. *Innovation and Management Review*, 9(4), 121-152.

[45] Oliveira, M. A. M. (2021). Qualidade de vida no teletrabalho obrigatório na administração pública: preditores individuais. Trabalho de Conclusão de Curso (Especialização em Pessoas, Inovação e Resultados) – *Escola Nacional de Administração Pública*. Brasília: ENAP.

[46] Oliveira, M. A. M., & Pantoja, M. J. (2021). Desafios e Perspectivas do Teletrabalho nas Organizações: Cenário da Produção Nacional e Agenda de Pesquisa. Revista Ciências Administrativas, 26(3). https://doi.org/10.5020/2318-0722.2020.26.3.9538

[47] Organização Das Nações Unidas Brasil (2021). *Relatório da ONU: ano pandêmico marcado por aumento da fome no mundo*. Disponível em: https://www.unicef.org/brazil/comunicados-de-imprensa/relatorio-da-onu-ano-pandemico-marcado-por-aumento-da-fome-no-mundo. Acesso em: 05 dez. 2021.

[48] Pandini, L. S., & dos Santos Pereira, E. (2020). O teletrabalho no contexto de pandemia de covid-19: a percepção de servidores públicos do judiciário brasileiro e MPU. Caderno de Administração, 28(2), 55-81.

[49] Pereira, L. J., Oliveira, A. C., da Silva, L. P., & de Mendonça, C. M. C. (2021). TELETRABALHO E QUALIDADE DE VIDA: ESTUDO DE CASO DO PODER JUDICIÁRIO EM UM ESTADO DO NORTE DO BRASIL. *Revista Gestão e Desenvolvimento*, 18(1), 222-245.

[50] Pereira, L. J., Oliveira, A. C., da Silva, L. P., & de Mendonça, C. M. C. (2021). TELETRABALHO E QUALIDADE DE VIDA: ESTUDO DE CASO DO PODER JUDICIÁRIO EM UM ESTADO DO NORTE DO BRASIL. *Revista Gestão e Desenvolvimento*, *18*(1), 222-245.

[51] Peters, T. J.; & Waterman Jr., R. H. (1983). *Vencendo a Crise: Como o Bom Senso Empresarial Pode Superá-la*. São Paulo: Harper & Row do Brasil.

[52] Rother, E. T. (2007). Revisão sistemática X revisão narrativa. *Acta paulista de enfermagem*, 20(2), v-vi.

[53] Sant´anna, A.S.; Kilimnik, Z.M.; & Moraes, L.F. (2011). Antecedentes, origens e evolução do movimento em torno da qualidade de vida no trabalho. Cap. 1. In:SANT´ANNA, A.S.; KILIMNIK, Z.M.; MORAES, L.F. *Qualidade de vida no trabalho: abordagens e fundamentos.* Rio de Janeiro: Elsevier; Belo Horizonte/MG: Fundação Dom Cabral.

[54] Santos, A. L. T., & da Cunha Reis, A. (2021). O Serviço Público e o Teletrabalho na Administração Pública Federal Brasileira em Tempos de Covid-19/The Public Service and

Teleworking in the Brazilian Federal Public Administration in Covid-19 Times. *Revista FSA*, 18(3), 29-48. DOI: https://10.12819/2021.18.03.2

[55] SILVA, G. D. F. F. D. (2014). Perspectivas sobre o teletrabalho no contexto da administração pública brasileira: um anteprojeto. 88 f. *Dissertação (Mestrado) - Curso de Administração Pública*, Escola Brasileira de Administração Pública e de Empresas**,** Fundação Getúlio Vargas, Brasília, 2014.

[56] Silva, T. T. R. (2010) Considerações sobre os aspectos relacionados à promoção à saúde e bem estar no local de trabalho nos últimos 20 anos. In Vilarta, R., Gutierrez, G. L., & Monteiro, M. I. (Orgs.). *Qualidade de vida: evolução dos conceitos e práticas no século XXI*. Campinas: Ipes, 179-185.

[57] Souza, J. Z. (2020). Perspectivas e desafios do teletrabalho na administração pública federal diante da pandemia da covid-19. Trabalho de Conclusão de Curso (Especialização em Gestão Pública) – *Escola Nacional de Administração Pública*. Brasília: ENAP.

[58] Souza, J. Z. D. (2020). Perspectivas e desafios do teletrabalho na administração pública federal diante da pandemia da covid-19.

[59] Velasco, S. M. V. D. (2021). Qualidade de vida no teletrabalho compulsório no contexto da covid-19: percepções entre os gêneros em organizações públicas.. *Gt 3 Gestão De Organizações Públicas*, 2021. Disponível em: <https://sbap.org.br/ebap/index.php/home/article/view/134/42>Acesso em: 10 dez 2021.

[60] Vilarinho, K. P. B., Paschoal, T., & Demo, G. (2021). Teletrabalho na atualidade:: quais são os impactos no desempenho profissional, bem-estar e contexto de trabalho?. *Revista do Serviço Público*, 72(01), 133-162.

[61] Walton, R. E. (1973). Quality of working life: what is it? USA: *Slow Management Review*, 15(1), 11-21.

[62] Werther, B. W; & Davis, K. (1983). *Administração de Pessoal e Recursos Humanos: A Qualidade De Vida No Trabalho*. São Paulo: MC-Graw-HIll do Brasil.

[63] Westley, W. A. (1979). Problems And Solutions In The Quality Of Working Life. *Humans Relations*, 32(2), 111-123.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.42

Evaluation of the antifungal effect of oleoresin and essential oil of *Pterodon emarginatus* Vogel (Sucupira), *Anacardium occidentale* L. (Caju) and *Anacardium humile* (cajuzinho-do-cerrado)

Nadilane do Bonfim Ferreira da Costa[1], Aloisio Freitas Chagas Junior[2], Olavo da Costa Leite[3], Gessiel Newton Scheidt[4], Jader Nunes Cachoeira[5], Augustus Caeser Franke Portella[6]

[1]Student in the Agronomy Engineering course at the Federal University of Tocantins,Gurupi Campus-TO, Brazil
https://orcid.org/0000-0002-1178-8281
[2]PhD in Agronomy Engineering at the Federal University of Tocantins, GurupiCampus-TO, Brazil
https://orcid.org/0000-0002-7489-8701
[3]PhD in Vegetables Production at the Federal University of Tocantins, Gurupi Campus-TO, Brazil;
https://orcid.org/0000-00002-8959-0064
[4]PhD in Biotechnological Engineering at the Federal University of Tocantins, Gurupi-Campus-TO, Brazil
https://orcid.org/0000-0002-4729-3416
[5]PhD in Forest Engineering at the Federal University of Tocantins, Gurupi-Campus-TO, Brazil
https://orcid.org/0000-0001-9150-5431
[6]PhD in Biotechnological Engineering at the Federal University of Tocantins, GurupiCampus-TO, Brazil
https://orcid.org/0000-0001-5178-9257

Received: 30 Apr 2022,

Received in revised form: 21 May 2022,

Accepted: 26 May 2022,

Available online: 31 May 2022

Keywords *— **Essential oil; antifungal activity, inhibitory power.***

Abstract *— Oil from **Pterodon emarginatus Vogel (or Sucupira), Anacardium occidentale L. (Caju) and Anacardium humile (cajuzinho-do-cerrado)** in natura and their fractions wereevaluated for fungitoxic activities, against two species of filamentous fungi of the genus**Fusarium sp and Rhizopus previously identified by their macroscopic (photographic records) and microscopic (microcultivation) characteristics in Petri dishes**. Resin oil andessential oil concentrations in the range of 10 to 50% were used for qualitative and quantitative analyses. The samples were placed on 5 mm diameter paper disks and distributed on potato, dextrose, and agar (BDA) medium in Petri plates, inoculated with spores of the microorganisms, and incubated at 28°C for 10 days. Only the BDA mediumwas used on the plate as a positive control. The qualitative results showed that the oil showed good activity, but one of the fractions of the essential oil of cajuzinho-do-cerradowas highly effective against the Fusarium fungus at the concentration of 10% in 24 h. presenting halo of inhibition of 0.05 ± 0.01 mm, and 0.06 ± 0.01 mm at the concentrationof 50% in 24 h. For the Rhizopus fungus, the cashew oil was the one that showed the best performance compared to the control in all concentrations studied during 48 hours, and in the 50% concentration had a maximum growth rate $(\mu(t))$ of 7.76 ± 0.01 mm, about 41% lower than the control.*

I. INTRODUCTION

One of the largest biomes in South America, known as the Brazilian savannah, possesses a large biodiversity yet is vaguely exploited for the amount of its natural resources. Its abundant vegetation has predominant characteristics, such as trees with thick and twisted trunks, as well as grasses and bushes. The Cerrado is characterized by the presence of dry winters and rainy summers, a climate classified as Aw by Kôppen (rainy tropical) (WALTER, 2006). The threat of man in this biome is characterized by expansion of agricultural frontiers that advance in the Cerrado biome and compromising the native fauna and flora, also using, indiscriminately, the water resources(RIOS et al., 2013).

The Cerrado offers its populations a wide variety of products, which can be important allies in the promotion of sustainable livelihoods, where income generation andquality of life are in line with the conservation of natural resources (SAWER, et al. 1999).Essential oils, which can be extracted from various parts of plants, have different biological activities. The Brazilian Cerrado has a wide variety of plants that produce essential oils, although many have not yet been studied (ALVES, v. 80, n. 2, p. 290-294, 2020). Fungi of the genus *Rhizopus*, considered to cause great losses of grains under storage conditions, were the main responsible for the unviability of a great part of storedseeds, because they are located preferentially in the embryo (DHINGRA, 1985), while contaminations by *Fusarium* sp. occur during the formation or maturation of the fruit (MACHADO, 1988). The importance of using healthy seeds and good sanitary quality will have a good positive result on the crop.

The control of diseases and plagues in agriculture has intensified, being basicallyperformed through the use of synthetic chemicals. However, the use of pesticides has proven inefficient, since several organisms have shown increasing resistance to such products, requiring the use of increasingly larger quantities (SANTOS et al., 2004). The production of food with a minimum degradation of natural resources has become a demand of society, and there is a growing concern of the population to consumehealthy food with a production associated with the preservation of the environment, which has made the use of chemical agents a questionable practice. Thus, several alternative methods of disease control have been studied. Such alternative methods may provide biological control of phytopathogens and induction of resistance in plants. Among these, the use of essential oils and chitosan wrapping are highlighted (STANGARLIN et al., 1999; SCHWAN ESTRADA & STANGARLIN, 2005; CAPDEVILLE et al., 2002).

II. MATERIALS AND METHODS

Essential Oil Prospecting

To verify the potential of essential oils as fungicides, a selection of plants presents in the Cerrado biome, in the southern region of Tocantins in the city of Gurupi, was carried out. Among them, *Pterodon emarginatus Vogel* (or Sucupira), *Anacardium occidentale L*. (Caju) and *Anacardium humile* (cajuzinho-do-cerrado).

The seeds and cashew nuts were ground manually to increase the surface area of contact, seed-water, and then submitted to extraction. The seeds were weighed 200g, 1000 mL of water were added and placed in a round bottom flask and left to boil for 4 hours, controlling the temperature in approximately 100ºC. The extraction of the essential oil was performed in the CEMAF Laboratory of the Federal University of Tocantins in October 2020. The extraction method chosen was maceration, using acetone to obtain the acetonic extract.

Bioassays for fungicidal activity of essential oils

The fungal species evaluated in this study belonged to the mycoteca of the Bioactive Compounds Laboratory of the UFT, Gurupi Campus and were kept in Petri plates containing agar, potato dextrose (BDA) medium, stored at 4°C, with replication every 2 months and reactivated to perform the bioassays along with the essential oils of the species *Pterodon emarginatus Vogel* (or Sucupira), *Anacardium occidentale L*. (Caju) and Anacardium humile (cajuzinho-do-cerrado) as fungicide agents. (Caju) and *Anacardium humile* (cajuzinho-do-cerrado) as fungicide agents.

For this experiment pure oil was used at concentrations: 10, 20, 30 and 50%. Asa control, BDA (Potato-Dextrose-Agar) medium without the addition of supplements wasused. Aliquots of oil were added to the melted BDA medium poured into Petri dishes. Inthe center of each plate, after medium solidification, a mycelium disk of *Fusarium sp* and*Rhizopus* fungi grown on BDA medium was placed individually, previously identified by their macroscopic (photographic records) and microscopic (microcultivation) characteristics on Petri plates, and the plates were incubated at 22 ± 2°C under a 12-hour photoperiod. The area of the irregular polygons formed by mycelial growth was calculated using Pick's theorem (Murty & Thaim, 2007), according to Equation

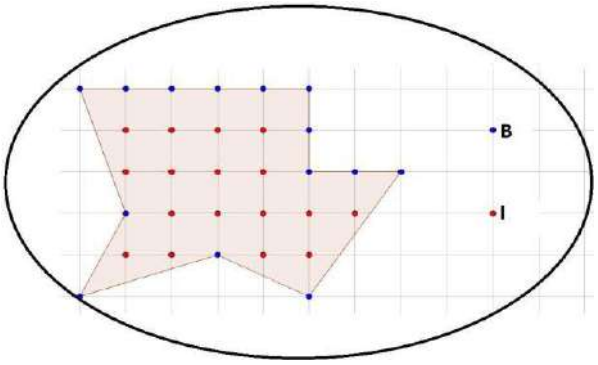
$$1.Pick(P) = \frac{1}{2}B + I - 1 \quad (1)$$

Where:

Pick(P) is the area of the irregular polygon formed by mycelial growth;

B is the number of points formed by the border image of a checkered grid overlaid on theplate containing the growing fungus;

I is the number of points inside this mesh.



The mycelial diameter of the irregularly formed colonies were calculated usingEquation 2.

$$D = 2\sqrt{\frac{A}{\Pi}} \quad (2)$$

Where:

D is the diameter of the colony;

A is the area formed by the mycelial growth of the fungus;

Π is the value of the PI constant.

The experiment was performed in 3 repetitions for each concentration of essential oil in each strain and the specific growth rate was evaluated for each fungus in their respective media according to Equation 3, in an entirely randomized manner.

$$\mu(t) = \frac{Dd}{Ddt} \quad (3)$$

Where:

$\mu(t)$ is the specific growth velocity (h^{-1}); t is the time (h) and D is the colony diameter (mm). The results of the specific growth velocities of each fungus and medium were subjected to analysis of variance (ANOVA) and Tukey's test at the 5% significance level for comparison of means. The radial and kinetic growth profile of each fungus was evaluated for the concentrations of essential oil in the culture medium.

III. RESULTS AND DISCUSSION

The effect of the concentrations of the essential oils in this study (sucupira, caju and Cajuzinho-do-Cerrado) on the mycelial growth of the Fusarium fungus was evaluated from the experiments in Petri dishes and the kinetics of the specific microbial growth speed was obtained. The tested concentrations are determinant factors in the growth, causing significant changes in the diameter of the colonies.

The results of the specific growth speed relative to the *Fusarium* microorganism within 96 hours are shown in Table 1, presented with the respective concentrations of the oils in the BDA culture medium, to be compared with the WITNESS, without the addition of oils. Significant differences (p-value<0.05) were detected by ANOVA and the comparison between the means of maximum growth rates by Tukey's test. Sucupira oil after 96 hours of observation showed significant difference only at 50% concentration compared to the control. The cashew and cajuzinho-do-Cerrado oils showed a significant reduction in the specific growth speed of the *Fusarium* fungus at the concentration of 50% immediately after 24 hours of inoculation, and also at the concentrations of 10, 20, 30 and 50% after 96 hours. This data is important to help establish the minimum growth time of the fungus after fungicide application.

Table 1 - Maximum specific speed of growth ($\mu(t)$) for Fusarium species at the different concentrations of the essential oils evaluated.

	Sucupira			Cashew			Cajuzinho-do-Cerrado		
Concentration	24h	48h	96h	24h	48h	96h	24h	48h	96h
10%	0.196[a]	0.13[a]	0.08[a]	0.28[a]	0.16[a]	0.10[a]	0.05[a]	0.15[a]	0.09[a]
20%	0.218[b]	0.13[a]	0.08[a]	0.28[a]	0.16[a]	0.10[a]	0.13[b]	0.16[b]	0.10[b]
30%	0.063[c]	0.13[a]	0.08[a]	0.25[b]	0.16[b]	0.09[b]	0.14[b]	0.16[b]	0.09[a]
50%	0.229[d]	0.12[a]	0.07[b]	0.28[a]	0.15[a]	0.10[a]	0.06[a]	0.16[b]	0.09[a]
Witness	0.072[e]	0.04[b]	0.09[a]	0.16[c]	0.16[a]	0.17[c]	0.10[c]	0.10[c]	0.10[b]

The same letters in the column do not differ significantly by Tukey's test at 5% significance level.

The *Rhizopus* fungus reached maximum growth in 48 hours, totally colonizing the Petri dishes. The cashew essential oil had the best performance already in the concentration of 10% with significant differences (p-value <0.05) in relation to the control. COUTINHO et al. (1999) evaluated in their studies with hydroalcoholic extracts of cashew (*Anacardium occidentale L.*) and mastic (*Astronium urundeuva* Engl.) the fungicide efficiency in comparison to the chemical fungicides Benomyl® and Captan®, finding a higher efficiency for the chemical fungicides alone or in

mixture, for the controlof the microflora associated to the bean seeds. They also concluded that the vegetal extracts only exercised a partial control of the fungus found; however with interference in the process of seed germination.

Table 2 - Maximum Specific Speed of Growth (μ(t)) for the Rhizopus fungus atdifferent concentrations of the essential oils evaluated in 48 hours.

	Oil Concentration in BDA medium			
Species	10%	20%	30%	50%
Sucupira	14.33[a]	14.45[a]	13.12[a]	13.29[a]
Caju	9.20[b]	8.05[b]	10.03[b]	7.76[b]
Cajuzinho-do-Cerrado	14.33[a]	14.45[a]	14.45[c]	13.10[a]
witness	12.74[c]	12.59[c]	13.11[a]	13.11[a]

The same letters in the column do not differ significantly by Tukey's test at 5%significance level.

IV. CONCLUSION

The essential oils Sucupira, Caju, and Cajuzinho-do-Cerrado have the potential toinhibit the development "in vitro" of *Fusarium* and *Rhizopus* fungi, being important to reduce the production losses by fungal activities in stored grains, enabling new alternatives to mitigate the ecological impacts and suggesting a new path for food production.

ACKNOWLEDGMENT

Thanks to PIBIC/CNPq for the support through the Scientific Initiation Scholarship.

REFERENCES

[1] ALVES, C. C. F. et al. Antiproliferative activity of essential oils from three plants of the Brazilian Cerrado: Campomanesia adamantium (Myrtaceae), Protium ovatum (Burseraceae) and Cardiopetalum calophyllum (Annonaceae). Brazilian Journal of Biology, v. 80, n. 2, p. 290-294, 2020.

[2] COUTINHO, W.M.; ARAÚJO, E.; MAGALHÃES, F.H.L. Efeito de extratos de plantasanacardiáceas e dos fungicidas químicos Benomyl e Captan sobre a micoflora e qualidade fisiológica de sementes de feijão (Phaseolus vulgaris L.). Ciência e Agrotecnologia, Lavras, v.23, n.3, p.560-568, 1999.

[3] CAPDEVILLE, G.; DE WILSON, C.L.; BEER, S.V.; AIST, J.R. Alternative disease

[4] control agents induce resistance to blue mold in harvested Red Delicious apple fruit. Phytopathology, n. 92, p. 900-908, 2002.

[5] DHINGRA, O. D.; MUCHOVEJ, J. J.; CRUZ FILHO, J. Tratamento de sementes(Controle de Patógenos). Viçosa: UFV, University Press, 1980. 121p. D

[6] MACHADO, J. C. Patologia de sementes: fundamentos e aplicações. Brasília: MEC-ESAL-FAEPE, 1988. 106p.

[7] MURTY, M.R. and THAIM, N., Pick's Theorem via Minkowski's Theorem. Amer. Math. Monthly 114 (2007) no. 8, 732-736.

[8] RIOS, Eloci Peres; THOMPSON, Miguel. **Biomas brasileiros**. Editora Melhoramentos,2013.

[9] SANTOS, A. S.; ALVES, S. de M.; BAKER, D.; ROCHA NETO, O. Descrição de

[10] sistema e métodos de extração de óleos essenciais e determinação de umidade de biomassa em laboratório. Belém: Embrapa Amazônia Oriental, 2004. 6p. (Embrapa Amazônia Oriental. Technical Communication, 99)

[11] SAWERS, G. The aerobic/anaerobic interface. Curr Opin Microbiol 2, 181-187. 1999.

[12] SCHWAN-ESTRADA, K.R.F.; STANGARLIN, J.R. Extratos e óleos essenciais de plantas medicinais na indução de resistência. In: CAVALCANTI, L.S. et al. Indução de resistência em plantas a patógenos e insetos. Piracicaba: Fealq, 2005. p.125-32.

[13] STANGARLIN, J.R. et al. Plantas medicinais e controle alternativo de fitopatógenos. Biotecnologia Ciência & Desenvolvimento, v.2, n.11, p.16-24, 1999.

[14] WALTER, Bruno Machado Teles. Phytophysiognomies of the Cerrado biome: terminological synthesis and floristic relations. **Embrapa Recursos Genéticos e Biotecnologia-Thesis/dissertation (ALICE)**, 2006.

International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.43

Effect of Low Power Laser on Postoperative Pain in Endodontic treatment: Literature Review

Diana Rodrigues Leão Frota[1], Sávio Martins de Araújo Dias[2]

[1]Lutheran University Center of Palmas, Brazil
E-mail: diana_rodrigues996@hotmail.com
[2]Lutheran University Center of Palmas, Brazil
E-mail: saviodias13@rede.ulbra.br

Received: 29 Apr 2022,

Received in revised form: 20 May 2022,

Accepted: 25 May 2022,

Available online: 31 May 2022

***Keywords*— Pain; Low Power Laser; endodontics**

***Abstract*—** *Pain after endodontic treatment is common in cases where treatment is performed, due to factors such as extrusion of debris to the apical region, extravasation of irrigators and intracanal medications, amount of sessions that the element is exposed, complex anatomy that makes it difficult to clean and disinfect the channel system, among others. The use of low-power laser was positive in pain remission, with benefits from its biological effects through biostimulation that has analgesic, anti-inflammatory and healing character. The present study aimed to review the literature on the effect of low-power laser on the control of post-endodontic pain. For this, searches were performed in the following databases: Scielo, Google Scholar, Pubmed, Journal of endodontics and Journal of dental lasers where 24 articles were selected after inclusion and exclusion criteria. The articles included in the research were in the period 2000 and 2021 in three languages (Portuguese, English and Spanish). This study concludes that the literature and experiments related to this theme clearly show the occurrence of a variety of biological stimuli including analgesia in the affected area, stimulation of endorphin release and inhibition of nociceptors in pain control. As limited as studies are limited, further studies on the subject should be researched for a definitive conclusion.*

I. INTRODUCTION

Pain is one of the five signs of inflammation, it can be a real or potential damage of tissues. It differs from person to person, since each one has its own pain threshold, which is diversified in quality and sensory intensity (SOUZA, 2002). Endodontic treatment is performed when the dental pulp suffers, in some way, some trauma or is exposed to bacteria that came due to the progression of caries, these bacteria can invade the root canal system causing pain and other disorders to the patient, which can be solved with a good endodontic treatment. According to Alí *et al.,* (2016) post-endodontic pain "is linked to a secondary periapical inflammatory response and mechanical, chemical and/or microbial injury of periradicular tissues". Studies also show that post-endodontic pain can also be caused by over instrumentation, extrusion of irrigators and medication (GAMA *et al.,* 2008).

Low-power lasers have specific wavelength, and aim to accelerate tissue repair processes, as they act as biomodulators, biostimulators, minimize painful symptomatology, healing, etc. These biomodulatory phenomena promote the therapeutic effects of cell morpho differentiation and proliferation, tissue neoformation, revascularization, edema reduction, increased cell regeneration, increased local microcirculation and vascular permeability (HENRIQUES; CAZAL; CASTRO., 2010).

The laser device produces a beam of light (red in color) that becomes visible when they receive a wavelength energy range of 632.8nm which leave helium-neon particles (He-Ne) excited and produce this particular beam of light. The

laser provides a multitude of benefits to the body such as a better response to inflammation, minimization of painful symptomatology and cellular biostimulation, it is worth mentioning that the therapeutic laser has no curative effect, but acts as an important analgesia agent which makes a better anti-inflammatory response, reduction of edema and pain minimization , which is of paramount importance for the patient to have a better clinical experience, because it will reduce painful symptomatology bringing more comfort to the patient and greater convenience (LINS et al,. 2010).

Pain control when using low-power laser is due to its action of modulation of inflammation, release of endogenous opioids, increases serotonin, excitation and nerve conduction of peripheral neurons, vasodilation, and that it can act in other places because of substances that it releases into the circulation (PELEGRINI; VENANCIO PROVINCE; LIEBANO., 2012).

Therefore, the present study aimed to analyze the effect of low-power laser on postoperative pain in endodontic treatment.

II. METHODOLOGY

A literature review was conducted using the following databases: SciELO, Google Scholar, Pubmed, Journal of endodontics and Journal of dental lasers. Theses and articles published in Portuguese, Spanish and English were included between 2000 and 2021, so these include: literature review, human research, randomized studies, placebo-controlled clinical trial, prospective study and clinical case. Articles that presented duplicity and were not related to the theme were excluded.

Initially, to verify if there was a relationship with the theme of the present study, the articles were previously selected from the reading of the titles and abstracts. After further analysis of the content of the research, publications that were in agreement with the guideline and predefined inclusion and exclusion criteria were inserted in this literature review. Thus, a total of 8925 included in this literature review were generated, published from 2000 to 2021.

Twenty-four articles were selected in the databases using the keywords in the search: pain in endodontics; postoperative pain; low power laser; laser therapy.

III. RESULTS

The crosses of the descriptors allowed the achievement of a total found in the databases, 3685 in PubMed, 132 in SciELO, 50 in the Journal of endodontics, 10 in the Journal of laser in medical Sciences, 03 in the Journal of Biological Medical Sciences and 5000 in Google Scholar.

In the initial screening of PubMed, 3685 articles were found that, first, were evaluated according to the reading of titles and abstracts, and later those that presented duplicity and/or irrelevance were discarded. The final screening was performed through the careful reading of the texts, selecting 10 articles that were on the proposed theme. In the SciELO platform, 132 articles were initially found, but 09 were selected. In the Journal of endodontic platform initially 50 articles were found, however only 02 articles were selected. In the Journal of laser in medical Science platform, 10 articles were initially found, but only 01 articles were selected. In the Journal of Biological Sciences platform, 03 articles were found, however only 01 was selected. In Google Scholar, 5000 studies related to the theme searched were found, however, after passing the same inclusion and exclusion criteria, only 24 were selected.

IV. DISCUSSION

This study reviewed in the literature ways to reduce post-endodontic pain with the use of low-power laser, in which, after inclusion and exclusion criteria, 24 studies were selected that were used among them: literature reviews, human research, randomized studies, placebo-controlled clinical trials, prospective studies and clinical cases. Among the symptoms we feel, pain is one that we remember from early childhood, and ste may be linked to a potential or real damage to the tissues, and can be reported both in terms of these damages and by both characteristics, in which this pain is also considered as a genuinely subjective and personal experience as stated by Souza, et al., (2002). These studies corroborate the studies by Valerio et al., (2019), where he states that pain is recognized as the fifth vital sign since 1996 and that it is a unique, subjective and individual experience, which makes it difficult to include it as the fifth vital sign.

After bacteria invade the dental pulp there is an aggression to the root canal system causing in addition to pain, disorders to the patient. As the goal of endodontic treatment is to relieve the pain of the patient it should not relaps, but for a number of factors this can occur. In the reported studies, it is proven that post-endodontic pain is present when there is existence of this symptom even before the performance of this intervention Ali et al., (2016), these studies agree with the studies of El Mubarak, Abu-Bakr and Ibrahi., (2010) who also state that patients who presented pain before treatment, revealed pain in the post-treatment period, regardless of whether it was performed in one or multiple sessions, where, what determined post-endodontic pain was the presence of pain before endodontic treatment, which also corroborate the literature review of Oliveira and Rocha., (2018) which states that the patient is susceptible to postoperative pain when presenting preoperative pain and

that with the use of medications can relieve symptomatology.

Other causes may influence post-treatment pain, such as the type of intracanal medication used during operative practice. The study reported that patients had significant differences in the use of two types of intracanal medications used Gama et al., (2008), so these studies are correlated with the studies by Singh et al., (2013) who conducted a study using two different intracanal medications proving that one stand out over the other, showing that intracanal medications have differences in pain control.

Also known as soft lasers, low-power lasers are those that have a wavelength ranging from 635 to 950 nm and are used for therapeutic purposes, i.e. they are used to treat diseases because of what their properties cause when they come into contact with cells, as its analgesic, anti-inflammatory and biostimulation effects BARROS et al.,(2008) these studies corroborate the studies by LINS et al., (2010) that also add how the laser effect is present in the scar tissue and affirm that this occurs because the f absorbed ontones are transformed into photochemical, photophysical and/or photobiological effects and the anti-inflammatory effect was due to interacting with cells and tissues at the appropriate dose , certain cellular functions can be stimulated, such as stimulation of lymphocytes, the activation of mast cells, the increase in mitochondrial ATP production and the proliferation of various types of cells, thus promoting anti-inflammatory effects, which also corroborate the studies by ANDRADE, CLARK E FERREIRA et al., (2014) that also add what effects can be achieved through wavelengths between 600 and 1000nm and powers from 1mW to 5W/cm^2. The authors also point out that very low (2.5 W/cm$^{2)}$ ^{or} very high (25 W/cm$^{2)}$potencies may cause inverse effects, which corroborate the studies by BRAMANTE et al., (2015) that state that the anti-inflammatory and analgesic effects of LBP can reduce edema and prevent infections.

The low-power laser is widely introduced in the health area for pain control, which in dentistry has been widely used in the specialty of endodontics to reduce this symptom. The use of laser as a tool for pain control, comparing it with people who did not use it, was significantly higher because of the properties that the laser has Asnaashari, Mohebi and Paymanpour., (2011), these results agree with those of Coelho, Vilas-Boas and Tawil (2019) where the difference was that these authors used unirradicular teeth that resulted in the group that was used the LLLT experienced only mild pain in 24 hours after treatment and that in 72 hours they did not feel any pain. Patients who had exposure to LLLT on the first day had low levels of pain, and also agree with the findings of Morsy et al., (2018) who compared the conventional endodontic treatment with the endodontic treatment using the 980nm diode laser in the intervention of teeth with conical periapic lesions that obtained similar results, demonstrating that the group that used the laser presented considerably lower levels of pain in relation to the group that did not apply it, they also agree with the studies by Doganay and Arslan., (2018) where they observed that the use of laser for pain control in molars with symptomatic apical periodontitis was beneficial in reducing postoperative pain in endodontics and diswinding from the prospective clinical study of Payer et al. , (2005)who state that there was no significant effect on the inflammatory response or healing process in conventional LLLT during endodontic surgery, and also disagree with the studies by Yoshinari et al., (2019) who stated that there were no post-treatment pain so much with the use of LBP and without the use of laser, that is, there was no difference between the groups because of the elements being asymptomatic.

In the randomized clinical study of Guerreiro et al., (2021) the authors state that the properties of laser therapy instill the synthesis of inflammatory processes, decrease the activity of C fibers and exert regenerative effects on injured tissues, having as laser wavelength the main factor for the depth of light penetration of the same, stating that it has the anti-inflammatory and analgesia properties and that everything depends on the dose applied. These studies agree with the studies by Abtahi et al., (2013) where the difference was that he used orthodontic apparatus for an induced separation of dental elements, from which it was observed that the group that was applied the laser pain level was lower than in the placebo group, thus showing its beneficial effects on pain control.

V. CONCLUSION

In view of the above, it was concluded that for the low-power laser to promote a biological effect, it is necessary to absorb its beam of light by the target tissue. The literature pertinent to the theme and the experiments clearly indicate the occurrence of multiple biostimulant effects, including analgesia of the affected region stimulating the release of endorphins, inhibiting nocepceptor signs and controlling pain mediators. This makes its application after a treatment that can occur tissue injury, such as endodontic treatment, a good option for patient comfort and accelerated repair of perirradicular tissue.

ACKNOWLEDGEMENT

First I thank God, for without him I believe that nothing in the world would exist and because he would be there together accompanying me in all my moments whether they are of anguish, sorrow and happiness.

I thank my family, because without their support I don't think it would be possible to be here today, for all the support they've given me and that I've never been missed. I thank my grandmother Maria Melania for being the foundation we need, for advising us and never, but never leaving us forsawed at any time, to my father Alcenor Dias who despite all the difficulties he did not measure efforts to contribute and support me when I made the choice of my course, I thank my brother Alcenor and David for all the companionship and brotherhood during all these years in my walk , I thank my aunts Auridéa, Auricéa and Ana Socorro for always taking care of me in the most difficult moments and always supporting me, so I always say that I have 4 mothers, I thank my uncles and cousins Cicero, Alcides, Marciel, Vanessa, Beatriz and Ana Alice for always being by my side and never let me miss anything and I still thank all my family members who contributed For my course and for my personal life, directly or indirectly, I love you very much.

I thank my advisor Diana Leão Rodrigues Frota, for all patience and for having accepted to be my advisor in this period, person who has deep admiration and professional inspiration I want to arrive one day on the same level as you, you were of great importance for the completion of this work and I hope to have reached your expectations during it.

To the evaluators my thank you for agreeing to participate, you were a fundamental part for me know that I have kept you with great affection and I hope one day to be 10% of the professional you are.

I wanted to thank my friend Ludimila who helped me so much in carrying out this work, you were also of paramount importance for the conclusion of it, I leave here my thank you very much.

I wanted to thank my college class that despite the regrets were my companions during this journey, and what journey in my friends? There were so many moments lived, so many things that they couldn't be left out. I leave my thanks here.

I also want to thank those who have always hoped for my success, know that you have a space stored in my heart and I hope that we can all walk a path of success regardless of our trail, I leave here my thank you very much

REFERENCES

[1] ABTAHI SM, MOUSAVI SA, SHAFAEE H, TANBAKUCHI B. Effect of low-level laser therapy on separator force-induced dental pain in orthodontic treatment. **Dent Res J (**Isfahan). 2013 Sep;10(5):647-51. 24348624; PMCID: PMC3858741.

[2] ALÍ A, OLIVIERI JG, DURAN-SINDREU F, ABELLA F, ROIG M, GARCÍA-FONT M. Influence of preoperative pain intensity on postoperative pain after root canal treatment: A prospective clinical study**. J Dent.** 2016 Feb;45:39-42. doi: 10.1016/j.jdent.2015.12.002. Epub 2015 Dec 8. PMID: 26678517.

[3] ANDRADE, Fabiana do Socorro da Silva Dias, CLARK, Rosana Maria de Oliveira and FERREIRA, Manoel LuizEffects of low-level laser therapy on wound healing. **Magazine of the Brazilian College of Surgeons [online].** 2014, v. 41, n. 02 [Accessed 20 June 2021] , pp. 129-133. Available in: <https://doi.org/10.1590/S0100-69912014000200010>. ISSN 1809-4546. https://doi.org/10.1590/S0100-69912014000200010.

[4] ASNAASHARI, M.; MOHEBI, S.; PAYMANPOUR, P. Pain Reduction Using Low Level Laser Irradiation in Single-Visit Endodontic Treatment. **Journal of Lasers in Medical Sciences**, v. 2, n. 4, p. 139-143, 1 Nov. 2011.

[5] BARROS FC, ANTUNES SA, FIGUEREDO CMS, FISCHER RG. Low intensity laser in periodontal healing. **Ci Med Biol R.** 2008;

[6] BRAMANTE CM, DUQUE JA, CAVENAGO BC, VIVAN RR, BRAMANTE AS, de ANDRADE FB, DUARTE MA. Use of a 660 nm laser to aid in the healing of necrotic Alveolar Mucosa caused by extruded sodium hypochlorite: a case report. **J Endod**. 2015 Nov;41(11):1899-902. doi: 10.1016/j.joen.2015.07.011. Epub 2015 Sep 11. 26371982.

[7] COELHO MS, VILAS-BOAS L, TAWIL PZ. The effects of photodynamic therapy on postoperative pain in teeth with necrotic pulps. **Photodiagnosis Photodyn Ther**. 2019 Sep;27:396-401. doi: 10.1016/j.pdpdt.2019.07.002. Epub 2019 Jul 10. PMID: 31301436.

[8] DOĞANAY Yıldız E, ARSLAN H. Effect of Low-level Laser Therapy on Postoperative Pain in Molars with Symptomatic Apical Periodontitis: A Randomized Placebo-controlled Clinical Trial. **J Endod**. 2018 Nov;44(11):1610-1615. doi: 10.1016/j.joen.2018.07.002. Epub 2018 Ago 23. 30144985.

[9] EL MUBARAK AH, ABU-BAKR NH, IBRAHIM YE. Postoperative pain in multiple-visit and single-visit root canal treatment. **J Endod.** 2010 Jan;36(1):36-9. doi: 10.1016/j.joen.2009.09.003. PMID: 20003932.

[10] GAMA TG, de OLIVEIRA JC, ABAD EC, RÔÇAS IN, SIQUEIRA JF Jr. Postoperative pain following the use of two different intracanal medications. **Clin Oral Investig**. 2008 Dec;12(4):325-30. doi: 10.1007/s00784-008-0199-3. Epub 2008 Apr 10. PMID: 18401602.

[11] GUERREIRO MYR, MONTEIRO LPB, de CASTRO RF, MAGNO MB, MAIA LC, da SILVA BRANDÃO JM. Effect of low-level laser therapy on postoperative endodontic pain: An updated systematic review. Complement **Ther Med.** 2021 Mar;57:102638. doi: 10.1016/j.ctim.2020.102638. Epub 2020 Dec 8. 33307205.

[12] HENRIQUES, Águida Cristina Gomes; CAZAL, Claudia; CASTRO, Jurema Freire Lisboa de. Action of laser therapy in the process of cell proliferation and differentiation: literature review. **Rev. Col. Bras. Cir.** , Rio de Janeiro , v. 37, n. 4, p. 295-302, Aug. 2010 . Available from

<http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-69912010000400011&lng=en&nrm=iso>. access on 25 Sept. 2020.

[13] LINS, Ruthinéia Diogenes Alves Uchôa et al. Biostimulant effects of low-power laser in the repair process. **Brazilian Anais of Dermatology [online**]. 2010, v. 85, n. 6 [Accessed 18 June 2021] , pp. 849-855. Available in: <https://doi.org/10.1590/S0365-05962010000600011>.

[14] MORSY DA, NEGM M, DIAB A, AHMED G. Postoperative pain and antibacterial effect of 980 nm diode laser versus conventional endodontic treatment in necrotic teeth with chronic periapical lesions: A randomized control trial. **F1000Res.** 2018 Nov 15;7:1795. doi: 10.12688/f1000research.16794.1. PMID: 31372210; PMCID: PMC6659763.

[15] NEVES, Leniana Santos et al . The use of laser in orthodontics. **Rev. Dent. Ortodon Press. Ortop. Facial**, Maringá , v. 10, n. 5, p. 149-156, Oct. 2005 . Available from <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1415-54192005000500015&lng=en&nrm=iso>. access on 29 Oct. 2020.

[16] OLIVEIRA, R. K. F.; ROCHA, M. P. Painful symptomatology after endodontic treatment: Literature review. Id on Line **Multidisciplinary and Psychology Journal**, v. 12, n. 42, 2018, p. 696-703.

[17] PAYER M, JAKSE N, PERTL C, TRUSCHNEGG A, LECHNER E, ESKICI A. The clinical effect of LLLT in endodontic surgery: a prospective study on 72 cases. **Oral Surg Oral Med Oral Pathol Oral Radiol Endod.** 2005 Sep;100(3):375-9. doi: 10.1016/j.tripleo.2004.10.006. PMID: 16122669.

[18] PELEGRINI, Stella; VENANCIO, Roberta Ceila; LIEBANO, Richard Eloin(Local and systemic effects of low-power laser on the pressure pain threshold in healthy individuals. **Physioter. Pesqui.** , São Paulo , v. 19, n. 4, p. 345-350, Dec. 2012 . Available from <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1809-29502012000400009&lng=en&nrm=iso>. access on 28 Sept. 2020.

[19] SILVA, Daniela Calumby da et al . Treatment of Riga-Fede disease using laser therapy: clinical case report. **RGO, Rev. Gaúch. Odontol.** , Campinas , v. 65, n. 1, p. 87-91, Mar. 2017 . Available from <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1981-86372017000100087&lng=en&nrm=iso>. access on 06 Dec. 2020.

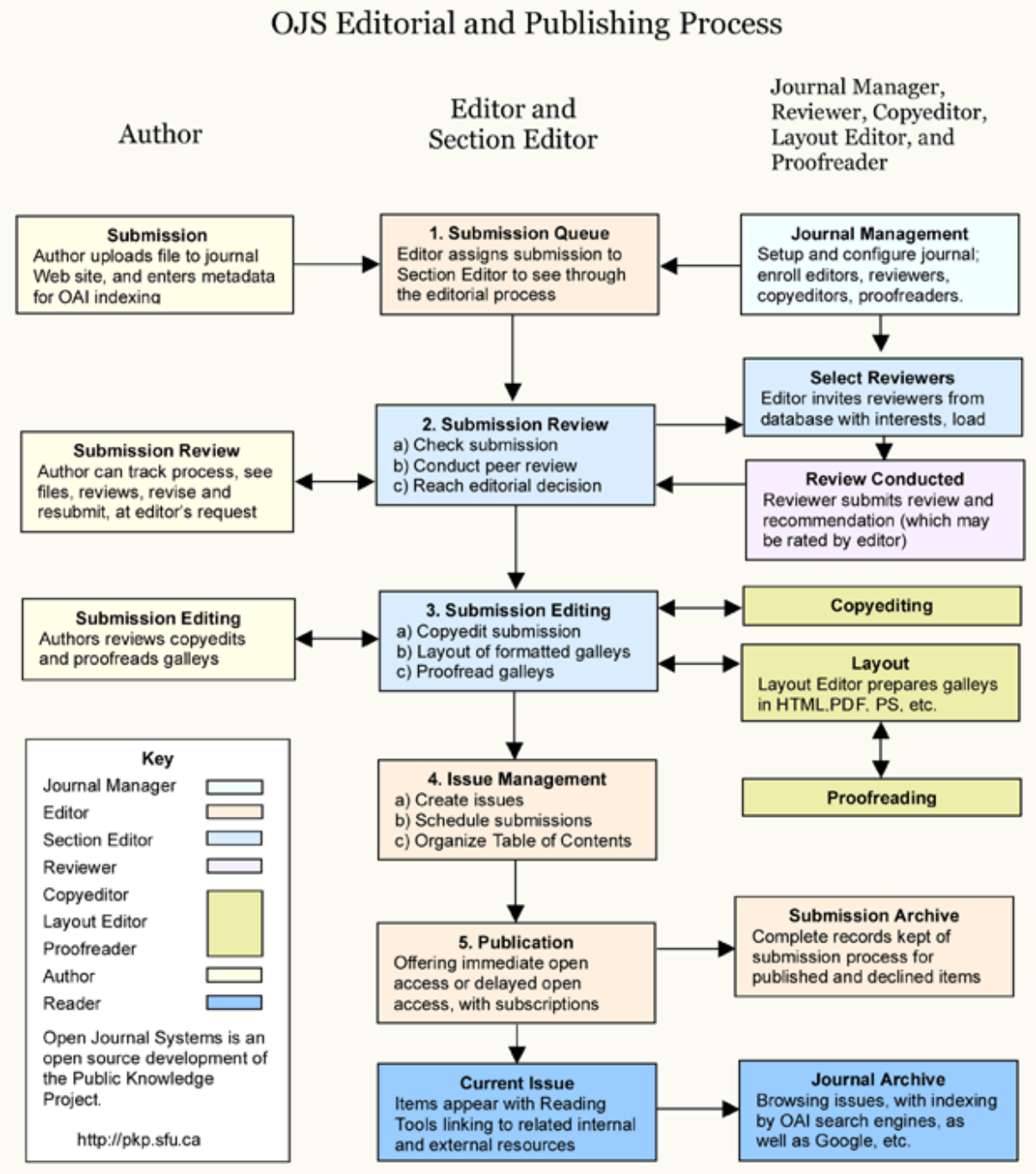
[20] SILVA EM, GOMES SP, ULBRICH LM, GIOVANINI AF. Histological evaluation of low intensity laser therapy in epithelial, connective and bone tissue healing: experimental study in rats. **Rev Sul-Bras Odontol**. 2007;

[21] SINGH, Ripu Daman et al. Intracanal medications versus placebo in reducing postoperative endodontic pain – a double – blind randomized clinical trial. **Brazilian Dental Journal [online].** 2013, v. 24, n. 1 [Accessed 5 June 2021] , pp. 25-29. Available from: <https://doi.org/10.1590/0103-6440201302039>. ISSN 1806-4760. https://doi.org/10.1590/0103-6440201302039.

[22] SOUSA, Fatima Aparecida Emm Faleiros. Pain: the fifth vital sign. **Rev. Latino-Am. Nursing**, Ribeirão Preto , v. 10, n. 3, p. 446-447, June 2002 . Available from <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0104-11692002000300020&lng=en&nrm=iso>. access on 24 Sept. 2020.

[23] VALÉRIO, Allana Fernandes et al. Difficulties faced by nurses to use pain as the fifth vital sign and the mechanisms/actions adopted: an integrative review. **BrJP [online].** 2019, v. 2, n. 1 [Acessado 4 Junho 2021] , pp. 67-71. Disponível em: <https://doi.org/10.5935/2595-0118.20190013>. ISSN 2595-3192. https://doi.org/10.5935/2595-0118.20190013

[24] YOSHINARI, Franciely Mariani Silva et al . Influence of Photodynamic Therapy in the Control of Postoperative Pain in Endodontic Treatment: A Cross-Sectional Randomized Clinical Trial. **Pesqui. Bras. Odontopediatria Clín. Integr.** , João Pessoa, v. 19, e4369, 2019. Available from <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1983-46322019000100343&lng=en&nrm=iso>. access on 09 nov. 2020.



~IJAERS Workflow~

Important links:

Paper Submission Link:
https://ijaers.com/submit-paper/
Editorial Team:
https://ijaers.com/editorial-board/
Peer Review Process:
https://ijaers.com/peer-review-process/
Publication Ethics:
https://ijaers.com/publication-ethics-and-publication-malpractice-statement/
Author Guidelines:
https://ijaers.com/instruction-to-author/
Reviewer Guidelines:
https://ijaers.com/review-guidelines/

Journal Indexed and Abstracted in:

- Qualis-CAPES (A2)-Brazil
- Normatiza (Under Review-Ref.020191511)
- NAAS Score: 3.18
- Bielefeld Academic Search Engine(BASE)
- Aalborg University Library (Denmark)
- WorldCat: The World's Largest Library Catalog
- Semantic Scholar
- J-Gate
- Open J-Gate
- CORE-The world’s largest collection of open access research papers
- JURN
- Microsoft Academic Search
- Google Scholar
- Kopernio - powered by Web of Science
- Pol-Index
- PBN(Polish Scholarly Bibliography) Nauka Polaska
- Scilit, MDPI AG (Basel, Switzerland)
- Tyndale University College & Seminary
- Indiana Library WorldCat
- CrossRef DOI-10.22161/ijaers
- Neliti - Indonesia's Research Repository
- Journal TOC
- WIKI-CFP
- Scinapse- Academic Search Engine
- Mendeley-Reference Management Software & Researcher Network
- Dimensions.ai: Re-imagining discovery and access to research
- Index Copernicus Value(ICV): 81.49
- Citeseerx
- Massachusetts Institute of Technology (USA)
- Simpson University (USA)
- University of Louisville (USA)
- Biola University (USA)
- IE Library (Spain)
- Mount Saint Vincent University Library (Halifax, Nova Scotia Canada)
- University Of Arizona (USA)
- INDIANA UNIVERSITY-PURDUE UNIVERSITY INDIANAPOLIS (USA)
- Roderic Bowen Library and Archives (United Kingdom)
- University Library of Skövde (Sweden)
- Indiana University East (campuslibrary (USA))
- Tilburg University (The Netherlands)
- Williams College (USA)
- University of Connecticut (USA)
- Brandeis University (USA)
- Tufts University (USA)
- Boston University (USA)
- McGill University (Canada)
- Northeastern University (USA)
- BibSonomy-The blue social bookmark and publication sharing system
- Slide Share
- Academia
- Archive
- Scribd
- ISRJIF
- Cite Factor
- SJIF-InnoSpace
- ISSUU
- Research Bib
- infobaseindex
- I2OR
- DRJI journal-repository

AI Publication
International Journal of Advanced Engineering Research and Science (IJAERS)
104/108, Sector-10, Pratap Nagar, Jaipur, India