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FOREWORD

I am pleased to put into the hands of readers Volume-8; Issue-10: October, 2021 of **"International Journal of Advanced Engineering Research and Science (IJAERS) (ISSN: 2349-6495(P) | 2456-1908(O)",** an international journal which publishes peer-reviewed quality research papers on a wide variety of topics related to Science, Technology, Management and Humanities. Looking to the keen interest shown by the authors and readers, the editorial board has decided to release print issue also, but this decision the journal issue will be available in various library also in print and online version. This will motivate authors for quick publication of their research papers. Even with these changes our objective remains the same, that is, to encourage young researchers and academicians to think innovatively and share their research findings with others for the betterment of mankind. This journal has DOI (Digital Object Identifier) also, this will improve citation of research papers. Now journal has also been indexed in **Qualis (Interdisciplinary Area) (Brazilian system for the evaluation of periodicals, maintained by CAPES).**

I thank all the authors of the research papers for contributing their scholarly articles. Despite many challenges, the entire editorial board has worked tirelessly and helped me to bring out this issue of the journal well in time. They all deserve my heartfelt thanks.

Finally, I hope the readers will make good use of this valuable research material and continue to contribute their research finding for publication in this journal. Constructive comments and suggestions from our readers are welcome for further improvement of the quality and usefulness of the journal.

With warm regards.

Dr. Swapnesh Taterh
Editor-in-Chief
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Smart City in Urban Innovation: Concept, Management, Policy and Technology

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***Keywords*— Smart City, Urban Innovation, Concept, Management, Policy, Technology.**

***Abstract*—** *This article defines a smart city not as a measure of how smart a city is but as an endeavor to become innovative. The meaning attached to A smart city is innovative in terms of administration, policy, and technology. Because each city's distinct setting influences its technical, organizational, and policy elements, we may think of smart cities as a contextualized interaction of technical, managerial, and policy innovation. However, there is a dearth of study on innovation in Management and policy, despite the abundant literature on technological innovation. After reviewing the public management literature, the author concluded that urban planning is a critical component of urban growth. Cities with sufficient intellectual resources, established institutions, and developed infrastructure are smart cities. The purpose of this exposition is to analyze the smart city's function in urban administration. The research establishes a link between coverage planning and investment pressure zones. The author's categorization of Medium-Size Cities is the primary outcome. The purpose of this article is to close a research gap by developing a complete framework for seeing the smart city movement as an invention that encompasses technology, Management, and policy. Additionally, we explore the inherent dangers of innovation, innovative techniques while avoiding risks, and the settings in which innovation and risks occur.*

I. INTRODUCTION

With the rapid advancement of information technology, the process of urban pattern transformation is accelerating as well. The Smart City, a new star in urban development, is highly sought after around the world. The creation of a smart city is like a roaring fire. Simultaneously, the management mode will shift. Security concerns, traffic congestion, food safety, medical resource limits, environmental pollution, public health emergencies, resource allocation, and job pressure become significant challenges in the setting of a rapidly rising urban population and expanding metropolis. It is critical for contemporary cities to be integrated into the whole spectrum of information management. A "smart city" and "smart city group" within the current city information platform will be a "sensible" choice for the construction. With the city's growth, contemporary city management and services tend to be digitized, and provinces are also actively developing intelligent transportation, smart grid, smart city management, energy conservation, and other areas of pilot applications. To avoid fast urbanization becoming a catastrophe, cities must be operated creatively. To that aim, intelligent city development represents a paradigm shift in urban development. The adage that "crisis breeds creativity" holds for smart cities as well. The smart city concept is gaining traction to resolve the complex and nasty challenges left behind by increasing urbanization. Because the wicked and complex challenges of urbanization are social, political, and organizational, smart city plans for innovation must take Management and policy into account in addition to technology. While critics

frequently focus on the technical aspects of smart cities, their organization and policy concerns have received little attention. In an urban or metropolitan setting, smartness employs cutting-edge information and communication technology (ICTs) and Management and policy problems. Additionally, technology adoption is not the final goal; what is critical is the intelligent use of the technology chosen, which demands intelligent Management and policy. A smart city, we define it, is fully committed to innovation in technology, administration, and policy. Innovation for a smart city presents both potential and hazards. There is a void in the available literature on smart cities. Most writers focus only on technology issues. The literature has considered a smart city as an expression of creative ideas, mainly ignoring the policy and management aspects of innovation. However, an examination of a diverse body of literature on government initiatives, information technology innovation, and urban innovation gives a prism through which to see a smart city as a management and policy innovation, as well as circumstances in which a smart city initiative is formed. We examine the non-technological aspects of a smart city as innovative yet inextricably linked to technology, drawing on a vast body of literature. Unambiguous and transparent urban planning should be the bedrock of smart city operation. While initiating this study, the author posed the following research questions, which were sought during the elaboration: To what extent does urban planning play a role in the notion of smart cities? What variables influence urban planning? What are the distinctions between cities in terms of spatial Management? How can local governments contribute to the reduction of urban sprawl? This collection of reservations was used to determine the elaboration's objectives. The elaboration's primary objective is to explore the relationship between coverage planning and investment pressure regions in terms of urban Management. The test technique included Pearson's linear correlation, Ward's analysis, and k-means analysis.

II. BACKGROUND OF THIS STUDY

Smart cities, according to territorial Management, are currently one of the most prevalent concepts. Numerous academic endeavors have been made to define and conceptualize a smart city intellectually. This has also been demonstrated in emerging contemporary theories of development management, most notably the industrial district, the network model, knowledge organization, intellectual capital, e-governance, new public Management, intelligent specialization, regional foresight, the cluster, the learning region and city, value-based Management, reengineering, innovative organization, and lean. [109, 115, 124, 120].

Smart City

is a global movement in urban policies focused on reclaiming urban residents' quality of life and utilizing innovation and advanced technology to address the challenging challenges that high population density generates. It contributes to resolving urbanization-related issues, notably pollution of the environment, land consumption, urban sprawl, transportation congestion, energy needs, and difficulties in accessing public services. It encompasses a diverse set of public initiatives, ranging from developing better transportation systems to the endorsement of creative innovation and knowledge for designing energy-saving policies [34].

Fig. 1: smart city

The term "smart city" first appeared in 1994. (Cocchia 2013). Since 2011, the number of publications on this subject has increased significantly. This is related to the rise of smart city initiatives and the European Union's backing. The concept "smart city" is commonly used in

literature. Nam and Pardo developed a three-dimensional concept of a smart city: technology, people, and institutions. The authors of all examined smart city models identified recurring social factors associated with technology to alter the economy, environment, and community (Nam, Pardo 2011). Caragliu and Nijkamp defined a city as smart when investments in human and social capital, as well as traditional and modern communication infrastructure, fueled balanced economic development and a high quality of life while also promoting responsible resource management through

participation in and commitment to natural resource management (Caragliu et al. 2011). Giffer compiled a rating of smart cities based on various urban characteristics (Giffinger et al. 2007). They classified governance, economics, mobility, people, environment, and lifestyle into six categories. The authors rated 70 European cities using a variety of ratios and indices. They proposed a Triple-Helix model of smart cities, with local governance, university leadership, and industry riches as pillars (Leydesdorff, Deakin 2011). Lombardi also discusses the Triple-Helix concept of smart cities and the importance of universities and research institutions in producing innovation and patents (Lombardi et al., 2012). At the same time, Sainz Pena described a smart city using information and communication technology to make critical infrastructure, components, and public services more interactive, efficient, and visible to residents (Sainz Pena 2011). Mandelson and Bradshaw, in turn, list eleven critical categories that a smart city must possess: health, resource efficiency, ICT literacy, public administration, regional economy, education, innovative services, culture and recreation, and public safety (Mandelson, Bradshaw 2009). Numerous writers define a smart city as an intelligent transportation system with a comprehensive urban plan based on several critical components such as technology, a sustainable economy and environment, everyday life digitalization, a decent governance style, and ICT (Simmie, Strambach 2005).

A smart city's distinguishing feature is its capacity for producing and consolidating knowledge and innovation (Sanchez 2013). This is why implementing smart initiatives enhances a city's social and economic attractiveness and competitiveness (Qi, Shaofu 2001). A smart city makes use of ICT to maximize the efficiency and efficacy of valuable and necessary municipal processes, activities, and services, generally by integrating disparate components and actors into a more or less fluidly interactive intelligent system (Yovanof, Hazapis 2009). These factors are considered in the context of broader ideas such as environmental preservation and energy production (Cozens 2008Mori, Christodoulou 2012). Today, each city needs indicators to assess its success. Generally, current indices are not standardized, interchangeable, or comparable throughout time.

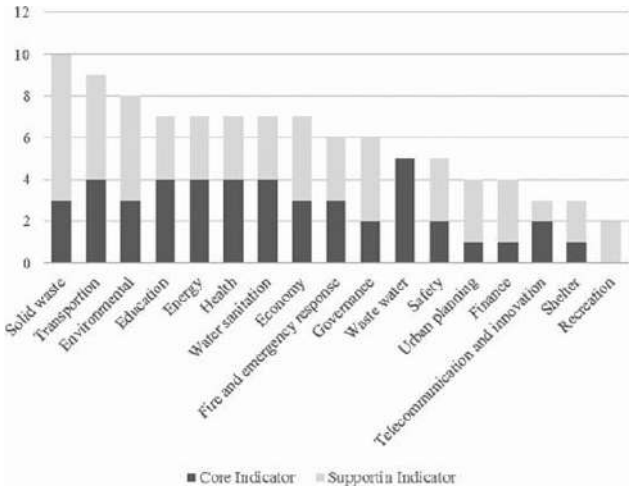

Fig. 1. Themes and the number of indicators

These indicators may be used to measure and monitor the sustainable development status of a city. Future requirements planning must consider the present efficacy of resource utilization. Certifies cities on a sliding scale based on the number of reported and confirmed indications.

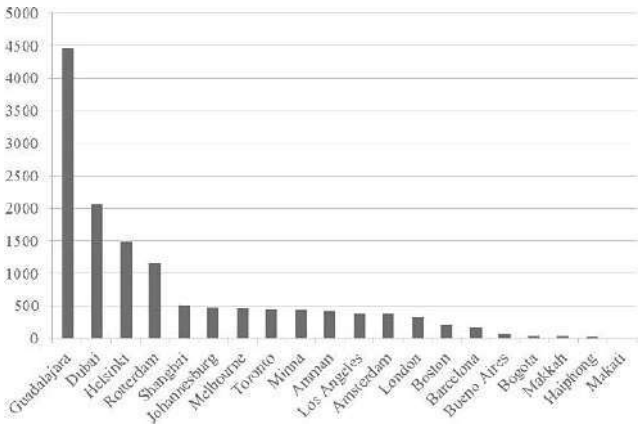

Fig. 2. Urban green space hectares/100000 people (source: self-elaboration based on WCCD 2014)

A city planning indicator's goal is to give data on the quantity of green space and trees planted per person, the size of informal settlements, and the employment/housing ratio (McCarney 2014). A green area is more expansive than a recreational place and is accessible to the general public. The World Health Organization recommends that all cities have at least 9 square meters of green space per resident. The most acceptable quantity is considered to be between 10 and 15 m2 per inhabitant. At 446 m2, Guadalajara, Mexico, has the highest green space per inhabitant. Dubai and Helsinki may be used interchangeably in the following instances. Integrating

substantial green spaces into highly crowded areas is a challenging task that Rotterdam and Shanghai have achieved.

Smart City Innovation

Simply said, innovation is "novelty in motion" [5] and "new ideas that work" [77]. These succinct formulations frequently stress not only a novel concept but also a novel behavior. When we define a smart city as an attempt by a city to become smart rather than a status, the connotation of a smart city reflects municipal innovation. The term "smart city" refers to technological advancements in addressing urban agglomeration-related difficulties [18].

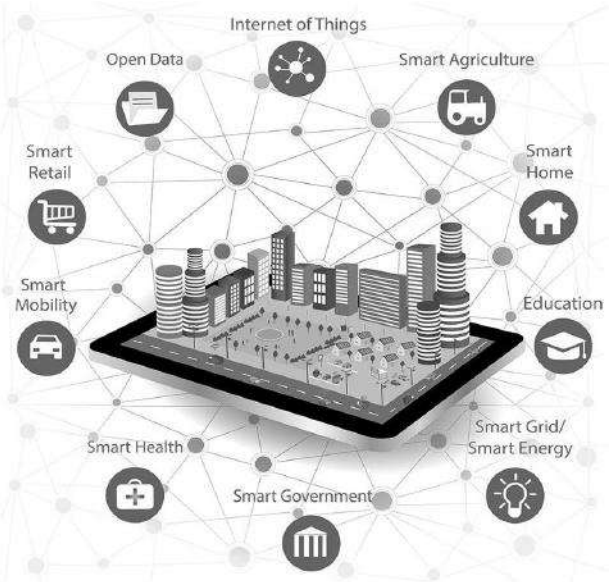

Fig. 2. Smart City Innovation

A smart city is an urban environment that has embraced ICT-enabled public sector innovation. It promotes long-standing methods for increasing operational and managerial efficiency and overall quality of life by capitalizing on improvements in information and communication technologies and infrastructures [53]. Innovation establishes connections between the definitional components of a smart city. Innovation in smart cities occurs at the infrastructural and process levels to fulfill ambitions. The prior literature on public sector and urban innovation define or categorizes innovation. According to Amanpour's [26] typology, innovations are classified as technical or administrative/organizational. Smith and Table [93] defined innovation in municipal government bureaucracies in three dimensions: Management, technology, and administration. According to Hartley [54], innovation can occur in the following areas: product, service, process (new ways of designing organizational processes and administrative reorganization into front- and back-office processes), position, strategy (new goals or purposes), governance (new forms of citizen engagement and democratic institutions), and rhetoric (new language and concepts). Elements of a Smart City Concept Before delving into the intricacies of a smart city as an invention, it is necessary to grasp its fundamental conceptual aspects. The notion of the smart city is still developing, and work on defining and conceiving it is ongoing [13,57].

Table 1. Definitions Provisional of the Term "Smart City

Definition
A city that excels in a forward-thinking manner across a range of qualities, founded on a clever mix of endowments and the actions of self-decisive, autonomous, and informed inhabitants.
A city that continuously analyses and combines the health of all of its essential facilities.
A city that "connects the physical infrastructure, the information technology infrastructure, the social infrastructure, and the economic infrastructure to maximize the city's collective intelligence.
A city "that integrates ICT and Web 2.0 technology with other organizational, design, and planning efforts to de-materialize and accelerate bureaucratic processes, as well as contribute to the identification of novel, innovative solutions to city management complexity, to improve sustainability and livability.
application of Smart Computing technologies to enhance the intelligence, connectivity, and efficiency of a city's essential infrastructure components and services, including municipal administration, education, healthcare, public safety, real estate, transportation, and utilities.
[45,50,52,54]

Table 1 summarizes some commonly used working definitions. Three fundamental elements emerge from such definitions. To begin, infrastructure is critical to the notion of a smart city. While technology enables a smart city, it is not always an essential aspect [79]. Combining, connecting, and integrating technologies and infrastructures is critical to the smart city's success]. Core systems are not discrete entities; they evolve into a complex multi-dimensional network of various systems that operate in synergy to achieve optimum performance [34,96]. Second, processes—how a city becomes smart—are critical in the working definitions. A critical

component of a smart city is a fundamental shift in the way services are delivered. Achieving the smart city is mainly about service transformation and improvement, not technology [21]. Finally, dreams for a brighter future are critical. A smart city should include the following elements: smart economics, competent government, smart transportation, smart environment, smart people, and smart lifestyle [,72,96].

Risk of Smart City

Every invention has some level of risk. When a smart city is defined as innovative, it transforms into a living laboratory for experimentation [17], which always includes inevitable dangers (generated by new, untested trials). A smart city program is a catalyst for innovation and an attempt to control the risks associated with innovation. The risks associated with smart city innovation are relevant in this article, as prior research has grossly underestimated the potential negative consequences of developing the new technical and networked infrastructures required to make a city smart [18,57]. As an innovation, a smart city programmed may introduce a new degree of complexity. The project goes beyond technology, combining technology, people, capacity, and global reach into sufficiently complex systems to allow for the emergence of unanticipated emergent characteristics [62]. Collapse to manage high risks effectively results in the complete failure of technology-driven public sector initiatives. Of IT initiatives fail because of non-technical elements of innovation—risks associated with policy, organization, and Management [41]. Poor planning, a weak business case, a lack of top management support, a lack of leadership, a lack of professional skills, a misalignment between organizational and project objectives, vulnerability to policy swings, too much technology-driven enthusiasm, and political hyper-activism are all common reasons [15,19,25].

Additionally, public sector innovation may be an oxymoron [11], as public sector innovation programs operate under less favorable conditions for invention. Government agencies are monopolies that lack competitive motivation to innovate and bureaucracies organized to execute essential functions reliably and consistently and to oppose change or disruption of those functions. The public sector cannot readily absorb the many expenses associated with learning, experimentation, and improvisation. Avoiding failure is a top organizational objective in the public sector, where responsibility is strongly valued [29,85]. Short-term achievement of objectives and results, and a lack of a long-term plan for service innovation [24].

Framework

A holistic vision of smart city innovation encompasses technological, Management, and policy advancements. The two non-technical aspects of a smart city (administration and policy) warrant additional attention. Fig. 2 summarizes the multidimensional framework for smart city innovation, emphasizing the relevance of technology, organization, policy.[127,128,129]

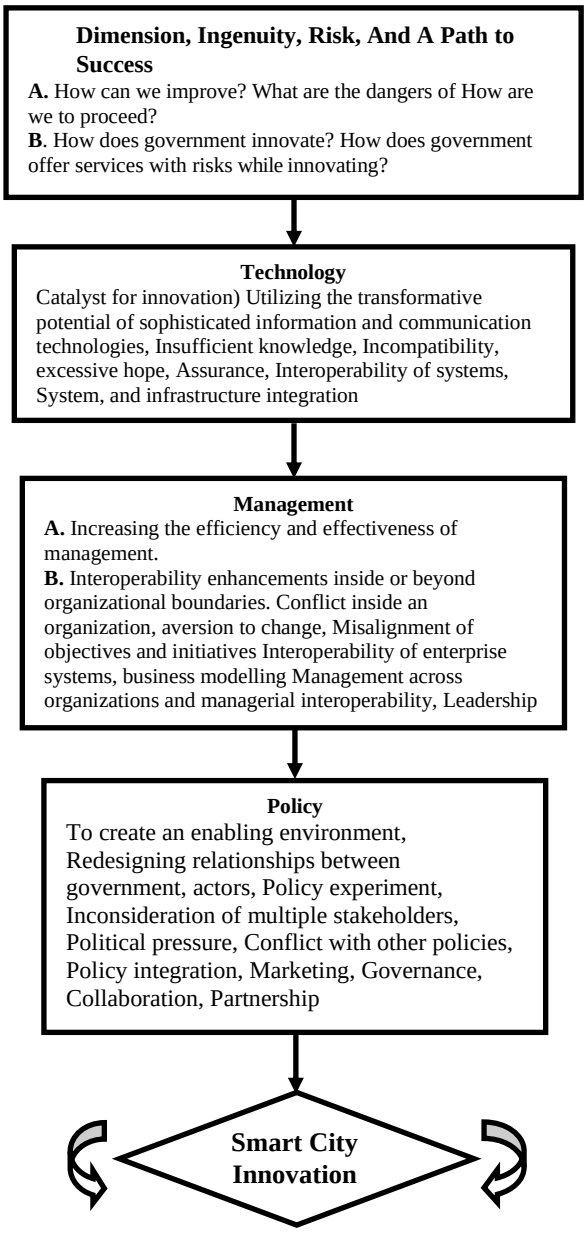

Fig. 3. The Framework of Smart City Innovation

As an innovation, a smart city capitalizes on the transformative potential of smart technologies (for example, instrumentation with intelligent sensors), mobile technologies, virtual technologies, cloud computing, and digital networks such as mobile wireless and Metropolitan

Area Networks. These technical advancements introduce dangers associated with technology, such as incompatibility between old and new systems, a lack of technological expertise, and excessive optimism on technological capability [29]. Interoperability is critical for technical innovation in the context of a smart city. A smart city delivers interoperable services that enable pervasive connection to alter internal and external government operations to people and companies [24]. To intelligent cities, technology must be easily linked across systems and organizations [15]. Technical performance should not be assumed to follow naturally from technological innovation; instead, performance is contingent on the successful management of technical systems and infrastructure. Not all communities are intelligent.

In terms of technology, management, and policy, we describe smart city innovation:

A. Management OF Organizational, Technology innovation is changing and upgrading technical tools to improve services and create circumstances for the instruments to be used more effectively. It is a process that develops Management and organizational competencies necessary for the efficient use of technology tools and environments.

B. Policy innovation is a tool for addressing institutional and non-technical urban issues and establishing the circumstances necessary to develop a smart city.

This study does not re-emphasize the importance of technology compared to the past literature, which has already explored technical innovation for a smart city enough. Rather than that, we will contribute to a balanced picture by bridging a research gap between widely discussed and less-addressed topics by taking Management, policy, and context into account. Fig 2 illustrates a framework for comprehending smart city activities in terms of the four dimensions. The following sections discuss the organizational Management, policy, and contextual aspects of a smart city.

III. MANAGEMENT INNOVATION

This section discusses the organizational and administrative techniques that may be used to advance smart city innovation. According to Moon and Norris [76], the most compelling motivation for municipal governments to incorporate new ICTs in their core tasks is management innovation. Managerial innovation influences the extent to which technological and administrative innovation occurs [100]. Successful organizational change management is critical in the public sector [42]. A smart city is one in which intelligence is applied to municipal administration [12]. Numerous strategic techniques may be used to advance smart city innovation.

Architectures of Businesses

Smart city innovation can be thought of as a business-to-business initiative. Enterprise architecture, as defined by Ross, Weill, and Robertson [90], is "the organizing logic for core business processes and IT infrastructure that reflects the standardization and integration of a business's operating model" (p. viii). Enterprise architecture, they believe, can be reduced to two concepts: business process integration and business process standardization. Thus, enterprise architecture is a business issue, not an IT one. Enterprise architecture is not just for businesses; governments also use it. Enterprise architecture and business process modeling are a means of innovating organizational and managerial processes to transform traditional bureaucracy. The term enterprise refers to the architectural scope, denoting a distinct, interdependent group composed of multiple agencies cooperating and a defined network of those organizations sharing a policy area to provide services that no single agency can provide alone [81]. It is regarded as a necessary condition for cross-government collaboration [20,31,61]. Ibrahim [38] defines e-government architecture as "the standards, infrastructure components, applications, technologies, business model, and guidelines for electronic commerce among and between organizations that facilitate government interaction and increases group productivity (p. 591)." Enterprise architecture is critical for designing and developing systems aligned with business process management, which is defined in the enterprise architecture as enterprise-wide rather than project-specific [38,60,89,91,92]. Thus, business model and enterprise architecture readiness [23] is a critical capability for innovation in the direction of a smart city.

Management at the Inter-organizational

Smart city innovation requires advanced levels of information and knowledge sharing, and integration. To that end, managerial interoperability across organizations and applications is critical for the cross-organizational integration of information and knowledge required for ICTs to fulfill their promise of government transformation [80]. Governments are increasingly relying on inter-organizational collaboration to maximize the value of information. Interoperability's growing popularity transcends political partisanship and cuts across policy areas and institutions. Interoperability across agencies and levels of government requires leadership that can operate in cross-border settings, networks, and governance.

Leadership Roles

Support from top management and commitment to organizational change is critical to the success of innovation [1,16,30,42,64,107]. Both executive and managerial leaders have a critical role in championing the cause of innovation, establishing detailed justifications for change, identifying and encouraging champions, and developing a unified set of goals to which people can commit [21,42]. Chief Information Officers (CIOs) are identified as enablers of a smart city in metropolises [101]. Leadership in cross-organizational settings entails a variety of leadership and management capabilities. Not only does leadership apply to a single agency, department, or team, but also a network and enterprise of organizations. This is not to say that central leadership is irrelevant; instead, ICT-driven organizational and structural changes such as network-based collaboration encourage coordination among diverse actors rather than hierarchical command and control [56]. As a result, leaders should hone their network leadership abilities. A strong leader is required to ensure the successful implementation of a smart city initiative [21]. City leaders can create a social infrastructure for collaboration that enables multiple organizations to work together across jurisdictional and sectoral boundaries [65].

IV. POLICY INNOVATION

While technology is a tool, policy innovation can result in the tool being used intelligently. An innovative government places a premium on policy changes, as the government cannot innovate without a normative imperative [40]. While technological innovation can be observed and broadly agreed upon, policy innovation is ambiguous [54]. Three critical policy directions for smart city innovation are proposed. Integration Urban policy is critical in shaping and changing cities' regional, national, and even global connections [9]. Coordination of policies across multiple spatial scales, organizational practices, and levels of governance—is critical to a city's innovation [70,84]. Metropolitan areas receive a plethora of policies from various bodies, but policies from various levels of government are frequently poorly coordinated, fragmented, overlapping, or even conflicting, resulting in perverse outcomes. Not only are technologies, systems, infrastructure, services, and information integrated, but also policies. Successful innovation requires "packages of policies," not single-targeted interventions [63,73,99]. Van Winden [99] proposed three distinct types of policy integration: sectoral, horizontal, and vertical integration. Sectoral integration is concerned with coordinating various policy areas and sectors, for example, economic policy, transportation policy, and housing policy. Horizontal integration refers to the alignment of policies among urban actors [82]. The majority of metropolitan areas are governed by a network of municipalities that interact and share resources. Vertical integration is concerned with the coordination of activities between various levels of government—typically the federal (central or national), state (provincial or regional), local (or municipal), and international.

Developing a holistic vision for a metropolitan region can be a critical first step toward greater policy integration. While various visions for a smart city may conflict, thriving modern cities integrate multiple visions [73]. For example, increasing transportation accessibility may be detrimental to the urban environment, whereas improving air quality may necessitate reducing accessibility. A challenge for that city is maintaining economic growth while remaining accessible and improving the overall quality of life. A situation in which one stone kills two birds is possible. The term "decoupling" [10] refers to a set of policies that reduce the transport intensity of activities while maintaining economic growth. In this case, policymakers must priorities decoupling economic growth from negative externalities associated with transportation. Integration of policies is required for this approach. By connecting health and transportation policies through references to healthy lifestyles and related issues, it is possible to persuade citizens to change their mode of transportation. Transport policies, in this way, integrate other policy areas such as health care, public safety, and economic development.

Brand Promotion

City marketing requires policy rhetoric [7]. In the policy realm, innovation necessitates a branding strategy [69]. Additionally, a brand is a public promise made by a city government to urban residents and external individuals or organizations. Image creation is not a trivial matter; it is critical to the transition to a smart city, as a well-known brand makes a city well-known to the outside world [58]. Cities, not nations, are increasingly competing for people, ideas, and capital, and a city's smartness is becoming a central selling point. City marketing is critical for cities that serve as magnets for new talent, resources, and investment. A city brand should communicate its unique selling points [33-35]. Labeling a city as "smart" or using an alternative equivalent nickname risks being interpreted as hype, illusion, fad, or empty rhetoric [22]. By contrast, there are several instructive examples of where abrasive rhetoric underpins positive policy developments. Hospers [58] provided three examples of a result-driven and broadly supported branding strategy used to promote a city's sustainable growth and differentiation

from competitors: "Austin: The Live Music Capital of the United States," "The resund: The Human Capital," and "Manchester: The Original and Modern." Austin, the state capital of Texas, is home to the domestic pop and rock scene. The resund, the Danish-Swedish border city, has developed a reputation for being a desirable place to live, work, and play. Manchester's nickname implies a repetition of the city's glorious past as a historical cradle of the Industrial Revolution, thereby establishing the city as a modern and classic industrial metropolis.

Initiative Concentrated on Demand

Prosperous smart cities have demand-driven policies rather than supply-driven, or that are well balanced between the two. The difference between demand and supply reflects economic activity and a contrast between the government's push for a smart city initiative and the engagement of non-governmental parties in the initiative. At its most fundamental level, more innovative government entails truly citizen-centric operations and services [59]. Supply-side (government-led) policies are insufficient on their own and must be supplemented by demand-side initiatives. Policies for smart cities must be balanced with an emphasis on demand and must promote diversity, social networks, and cross-sector innovation. Often, successful innovation occurs due to the involvement of key stakeholders [49-51,54]. Demand-driven policies may result in improved governance. Governance is a collective action of multiple actors and the ability to accomplish goals in the face of complexity, conflict, and social change [99]. ICT-enabled governance, in particular, is the interaction of ICTs and governance processes [74,75]. Digital networks-enabled governance reflects a shift away from established and increasingly ineffective hierarchical structures toward better-understood frameworks regarding the negotiated involvement of multiple public and private stakeholders operating at varying scales [43,56,84,86,97,98]. Policies governing a brilliant city initiative should promote collaboration and partnership to overcome fragmentation through the involvement of key stakeholders. A smart city serves as a laboratory for collaboration between disparate functional sectors and jurisdictions [39]. Demand-side policies also encourage and facilitate active citizenship and network governance that is centered on citizens. A smart city initiative must foster an environment conducive to citizen engagement that is convenient and effective [21,83]. Citizen engagement has the potential to increase citizens' sense of ownership over their city, heighten local governments' awareness of their needs, and ultimately reshape the citizen-government relationship [67,97]. Governments now have more opportunities to engage the public in a transparent learning environment that provides input into governance through Web 2.0 [24]. Donovan et al. [37] drew attention to a large-scale municipal e-government initiative in Ireland called Innovative Cities for the Next Generation (ICING). Its central principle, "the thin-skinned city," refers to a city becoming more sensitive and responsive to the needs of its residents.

V. CONCLUSION

Any claim about the future of cities that is normative is necessarily contextual [13]. "Context significantly defines and influences innovation," according to [54]. Each city faces unique challenges in innovation for a smart city, and each city's strategy may be unique as well [96]. Both innovation and risk must be contextualized. A detailed description of the likely risks associated with a particular initiative should accompany the presentation of strategies [47]. The author noted in the public management literature that urban planning is a critical factor in urban development. Cities with sufficient intellectual resources, established institutions, and developed infrastructure are called smart cities. According to the author, those cities should implement proper local spatial development plans. Critical areas of the city, such as technology parks, research and development companies, business incubators, technology transfer centers, and industrial complexes, should undoubtedly be included in these plans. The most practical way to assess a city's performance is through standardization. The level of investment pressure is the determining factor in determining whether special Management is necessary. If this indicator decreases, the area is no longer required to be included in local spatial development plans. Applying taxonomic methods to ten medium-sized urban centers in Europe revealed a strong correlation between coverage planning, investment pressure, and green space. Cities that have been analyzed have been classified into distinct categories. The first category of urban centers included cities in need of coverage planning enhancements. It will undoubtedly have a positive effect on these cities' levels of innovation. The author's suggested and recommended methods may play a critical role in supervising planning coverage across various territorial units. This type of surveillance may benefit local governments, public institutions, and organizations affiliated with those entities. The technologies of today are referred to as "space-shrinking technologies" [32], and they have enabled the development of a knowledge society and a global community. One could argue that location is irrelevant, and that all that is required is a reliable cable connection to bring the entire world within easy reach. Nonetheless, the hyperbolic assertion that distance is dead conceals a significant paradox [108]. Geographical concepts such as distance,

location, location, place, and space continue to be important for a city's innovation [14,63,68,84]. Individuals' face-to-face interactions continue to be critical. People's proximity remains a necessary condition for intensive communication and knowledge exchange.

There are numerous reasons why the physical dimension is significant in this digital era. A progressive reason is the feasibility of a hybrid (physical and virtual) city, which is a sensory fusion of cyberspace and physical space [108]. The ambiguous relationship between the ostensible place lessness of cyberspaces and the pervasive importance of place underscores a critical concern for smart cities [13]. Additionally, the context of urban proximity remains significant for a variety of compelling reasons. Cities' economic and technological attractiveness is a result of their agglomeration economies [8]. Innovative organizations and individuals will continue to cluster in specific locations such as financial districts, industrial districts, and cultural districts [6]. Urbanization fosters innovation; the more concentrated the talent pool, the more innovative the output [105]. Spatial concentration, in turn, generates pernicious urban problems. According to poverty researchers, negative neighborhood effects such as increasing income polarization and deteriorating community infrastructure are occurring [14]. Neighborhoods within the same city are frequently not equally accessible or usable in terms of transportation systems, digital infrastructure, and other services. For instance, in some urban areas, the digital divide becomes a neighborhood-specific spatial divide.

issue. Certain aspects of location context are advantageous while others are disadvantageous.

Urban policies are inextricably linked to and shaped by the broader environmental context (social, political, economic, cultural, and demographic) [47]. Odendaal [78] compared smart city initiatives in Brisbane and Durban against a backdrop of broader environmental issues. The success of the two cities is contingent on contextual differences in the relationships between key actors and the political and economic environment. Eger [39] asserted that, given the changing geopolitical context, there is no one-size-fits-all approach to city innovation. Thus, the city government's imperative is to establish a set of well-articulated strategies that are contextually appropriate.

The broader environmental context's challenges reflect the growing exclusion of certain segments of the population due to socioeconomic disparities [72]. There is also a clear demographic divide in terms of access to online tools. Numerous cities are concerned about the ageing society's impact on technology diffusion. In comparison, the proportion of Digital Natives, Digital Immigrants, or Net Generation [94]—individuals born into and familiar with new technologies—creates an important urban context worthy of our attention, as the technology-savvy generation is likely to benefit from smart city innovation. Another environmental context is the international pressure on urban competitiveness. The level of competition among global cities may influence the policy suite for a smart city. Numerous metrics exist for ranking and rating smart cities and their innovation initiatives. European Smart Cities Ranking is a representative evaluation that could be an effective tool for positioning, benchmarking, and branding cities. However, the metrics introduce some risks, such as overlooking complex interrelationships, overlooking the long term, and promoting current initiatives as stereotypes [45,46].

Innovation is significantly influenced by the complexity of the process and the uncertainty of the environment [95]. The degree of complexity varies according to the nature of the interactions. Intergovernmental, interorganizational, or intraorganizational smart city initiatives are possible, as are program-specific or enterprise-wide initiatives [80]. Smart city initiatives can span multiple jurisdictions. Data, information, and knowledge are all examples of objects of interaction. Interactions can take the form of sharing, communication, or integration. Numerous possible combinations result in a range of complexity levels. Smart city initiatives involving a greater number of actors and at a higher level would be more complex. Success in smart city innovation requires an understanding of the complexity's level and nature.

The discussion thus far has been explicitly focused on smart city initiatives as managerial and policy innovations to provide a balanced perspective on already-heavily debated technological issues and relatively little-discussed managerial and policy issues. We observe that most smart city studies are optimistic about the future of smart city initiatives. Their conclusions are not incorrect in and of themselves but are circumscribed. and insufficient, we provide a more complete picture of the smart city phenomenon. This review of the extensive literature on e-government projects, public sector innovation, and urban innovation suggests counterclaims to commonly held (and sometimes erroneous) beliefs about smart cities. To summaries, the following propositions represent our message to government practitioners and smart city researchers.

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The role of state attorney in the duty of coherence in Public Administration

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***Abstract*—** *This article deals with the role of state attorney in the implementation of the duty of coherence of the Public Administration. The Postmodern State, strongly marked by complexity, plurality and uncertainty, causes the public manager the task of reducing legal uncertainty and dispensing with isonomic treatment to the administered. The effectiveness of the principle of legal certainty and the guarantee of state coherence depends on the improvement of public management, but also on the organization and autonomy of public advocacy. Highlighted in the constitutional text as an essential function of Justice, public advocacy is responsible for internal control and defense of the legality of state acts, guaranteeing the public administration a management within the parameters set in the legal system. The coherent and isonomic action of the Public Administration, avoiding the publication of contradictory acts and the unequal treatment between persons inserted in similar contexts, depends, to a large extent, on the performance of the state attorney that, for that reason, must have ensured the functional independence. In the exercise of its institutional mission, public advocacy must ensure administrative coherence, which reveals the need for issuing opinions and other forms of legal expression, including in the judicial sphere, that guarantee respect for judicial and administrative precedents.*

I. INTRODUCTION

This study aims to analyze the role played by state attorney in guaranteeing the duty of state coherence.

With the intense technological transformations, the pluralism of interests enshrined in the legal system, the excess of information and the increase in uncertainties and risks, the coherent performance of public managers is challenging. State coherence is a requirement that automatically follows from the principles of legal certainty, good faith, protection of legitimate expectations and equality.

The challenge is the search for coherence in an environment of chaos. It is not a question of demanding, purely and simply, the petrification of state action, since coherence does not mean immutability.

In fact, the path is state action consistent with firm promises, interpretations and past acts themselves, in order to generate predictability for citizens and, in this way, protect the legitimate expectations generated, without, however, prohibiting the changes, adaptations and evolutions that are necessary for the Law to remain connected with the needs of society.

In this context, it is convenient to investigate the role of state attorney in implementing the duty of coherence in public management.

II. THE CHALLENGES OF PUBLIC MANAGEMENT IN THE POSTMODERN STATE

Currently, Public Administration faces enormous challenges, with emphasis on the difficulty of reconciling diverse interests, typical of a plural society, in the context of uncertainties and constant technological changes.

The challenges presented by post-modernity (CHEVALIER, 2009, p. 17 e 182), especially the increase in risk, the speed of information, new technologies and the complexity of the interests that must be satisfied by the State, demonstrate the insufficiency of traditional models of organization, action and control of the Administration Public, guided by excessive formalities and by the lack of concern with state efficiency. Likewise, globalization imposes the revaluation of markets and the need for transnational dialogues, relativizing the legal borders of States.

In this complex scenario, André-Jean Arnaud (2007, p. 307) demonstrates the distancing of some positivist traps, such as: “determinism (everything can be explained independently of the observer), excluded third principle (everything that is not true is false) and reductionism (everything is reducible to simple elements)”.

In the same way, Paolo Grossi (2007, p. 64 e 69.), professor of the History of Law at the University of Florence, will criticize the “mythologies of modernity”, especially the reductionism of Law which, by intending to make the legal landscape simple and harmonious, generated abstraction and artifice. In his view, the legal system presupposes the ordered reality and cannot do without, therefore, respect for complexity and social plurality.

There is a clear tendency to decentralize power within and beyond the administrative organization, making it possible to diagnose, as demonstrated by Santi Romano, a plurality of legal systems (ROMANO, 2008).

Public managers cannot ignore social, political and legal changes, and must adapt to the new demands of the globalized and complex world. For this reason, in the Brazilian scenario, the Public Administration must reinforce the legitimacy and efficiency of its actions.

In the context of the plural order, characterized by complexity and, eventually, by the antagonism of interests that must be pursued by the State, administrative action must intensify its concern with planning, with transparency, openness to society's participation, with the provision of accounts and with effective control instruments based on results.

Here, the need to establish consistency in administrative action is highlighted, with the aim of reducing legal uncertainty and providing equal treatment to those administered.

Unfortunately, the concern with the coherence of state action, although it presents some normative advances, has not yet been internalized in the practice of various bodies, including within the scope of the Judiciary.

It is not an easy task to decide in a scenario of complexity, plurality and uncertainty.

Public managers face intensified difficulties due to the need to decide quickly and efficiently, taking into account the context presented.

In addition to the difficulty of finding the best possible decision in view of the numerous alternatives presented at the time of decision, the manager is also concerned about not being held responsible later to the control bodies.

Administrative decisions are frequently questioned by the control bodies which, unfortunately, intend to impose the controller's view as the only correct one, without considering the reasonableness of the administrative interpretations placed on the manager at the time of decision making.

The confusion between the "administrative error", inherent to any human activity, including that developed within the Public Administration, and the configuration of the "administrative misconduct", which presupposes the intentional or, exceptionally, culpable action of the dishonest agent, it has been undertaken by members of the control bodies in bringing lawsuits and applying sanctions.

It is inherent to the Democratic State of Law the exercise of control of the Public Administration, with the guarantee of institutional autonomy of the internal and external controlling bodies.

What should be avoided – and the challenge is to fix the balance point – is the formalistic, decontextualized, disproportionate and substitutive look of the controlling body on the decision of the public manager, otherwise the punitive vision will generate the so-called "Public Administration of the fear”, with administrative paralysis, violating the constitutional principle of efficiency, due to the fear of public agents inserted in the positions and management functions of the Public Administration.

The increase in legal norms with an open texture, especially the legal principles and rules that enshrine indeterminate legal concepts, fosters the manager's

freedom (regulated discretion) to take administrative decisions.

The path, however, is two-way: while there is a clear increase in the prestige of the activity carried out by the Public Administration in the implementation of constitutional norms, the principle of legality naturally generates more sensitive restrictions on the performance of the administrator and expands the external control of administrative acts.

It is, therefore, fundamental that the public manager, on the one hand, has incentives or, at the very least, is not afraid to make decisions, with the concern to maintain consistency with those under management, which preserves legal certainty and isonomy in dealing with similar issues.

In order to ensure greater legal certainty in the application of the rules of Public Law, Law 13.655/2018 inserted important normative provisions in the Law of Introduction to the Rules of Brazilian Law (LINDB), which can be divided into at least four pillars:

a) reinforcement of the motivation of the state decision with an emphasis on legal pragmatism (articles 20 to 24 of LINDB): in order to take reality seriously, the context and consequences of the decision must be considered by managers and control bodies;

b) protection of honest public agents (articles 22 and 28 of the LINDB): in the interpretation of norms on public management, the real obstacles and difficulties of the manager and the requirements of public policies in his charge will be considered, restricting the personal accountability of the public agent for their decisions or technical opinions in cases of intent or gross error;

c) consensuality and participation (articles 26, 27 and 29 of LINDB): feasibility of entering into administrative commitments (agreements) and the possibility of holding public consultations to issue normative acts;

d) administrative coherence (art. 30 of the LINDB): public authorities must act to increase legal certainty in the application of the rules, including through regulations, administrative summaries and responses to queries. The instruments provided for in the caput of art. 30 will be binding in relation to the body or entity to which they are intended, until further revision.

It is verified, especially in the last pillar mentioned above, that the administrative coherence, inherent to the Democratic State of Law, is reinforced with the alteration promoted in the LINDB.

In addition to ensuring legal certainty and equality in the interpretation and application of Law, the coherent action of the public manager, with the application of the same legal solutions to similar cases, constitutes an important instrument of personal protection against possible subsequent liability to the control bodies.

III. THE DUTY OF COHERENCE IN PUBLIC ADMINISTRATION

In the Democratic State of Law, Public Administration is subordinated not only to laws, but also to legal principles, in what is conventionally called the principle of Juridicity (principle of legality in the broad sense). It is currently possible to affirm that the foundation of Administrative Law is the realization of fundamental rights, which demonstrates the impossibility of completely free, capricious and authoritarian administrative actions.

The binding of the Public Administration is not only related to external acts, originating from other Powers (laws and judicial decisions), but also with its own administrative acts (individual and normative) and administrative practices.

Based on the criterion of origin, administrative binding can be divided into two types (OTERO, 2003, p. 381-382):

a) external binding: this results from acts external to the Public Administration (Constitution, laws and court decisions); and

b) self-binding: this results from the Administration's own acts and conduct (individual administrative acts and regulations, administrative practice, administrative promises, contracts).

In Brazil, the concept of administrative external binding is widely accepted, notably due to the enshrinement of the constitutional principles of legality and separation of powers (or functions), with the provision of checks and balances.

The assertion that administrative action is subject to the law is nothing new, which is why any illegal administrative activity must, as a rule, be invalidated. It is true, however, that the nineteenth-century conception of legality, typical of the post-revolutionary Liberal State, has undergone changes in recent years to adapt to the new reality imposed by neo constitutionalism and post-positivism (OLIVEIRA, 2010).

Thus, administrative action is subject to the control of legality (legality) exercised by the Judiciary (art. 5, XXXV, of the Brazilian Federal Constitution) and by the Legislative Power (art. 49, V, of the Brazilian Federal Constitution), including with the assistance of the Courts of Auditors (art. 70 of the Brazilian Federal Constitution).

On the other hand, the study of administrative self-binding has not received, with honorable exceptions, the

necessary attention from doctrine and jurisprudence in Brazil.

Therefore, it's necessary to develop this topic, since the idea that people cannot act in a contradictory and incoherent way must be applied not only to the private sector, but also to the public sector.

It's is unreasonable to conceive that the Public Administration carries out its activities randomly and irrationally, which would lead to legal uncertainty and risk of ineffectiveness of fundamental rights. The predictability generated by coherent administrative action is a requirement of the Democratic State of Law, as well as of the principles of legal certainty, reasonableness and isonomy.

The idea of administrative self-binding (Selbstbindung) emerged in Germany in the 19th century, initially linked to the principle of equality in the administrative application of the law, with the aim of avoiding arbitrary acts in the exercise of administrative discretion (MAURER, 2006, p. 706).

Subsequently, the idea of administrative self-binding was also connected with the principle of protection of legitimate trust, defending citizens against whims and arbitrariness of the Public Power, notably in the field of broken state promises or the arbitrary revocation of administrative acts (OLIVEIRA, 2013, p. 163-189).

Administrative self-binding does not only bring benefits to individuals. The Public Administration itself benefits from its coherent and non-contradictory action, such as: the speed of response to repetitive demands; the reduction of litigation; the reduction of uncertainties, risks and costs of legal-administrative relations; and greater acceptance by individuals of their decisions and, consequently, the reinforcement of the legitimacy of their actions (MODESTO, 2010, p. 7).

Administrative self-binding may result from activities or from different administrative conduct, such as normative administrative acts, internal acts, continued administrative practices, individual acts, administrative promises, etc.

Traditionally, self-binding maintains an intense relationship with administrative discretion, functioning as a containment of any discretion on the part of public agents who exercise administrative choices and valuations based on legislation (DÍEZ SASTRE, 2008, p. 203-206).

The main function of self-binding is to limit administrative discretion based on the principles of equality, good faith and the protection of legitimate expectations. The margin of freedom recognized by the legislator to the public administrator to choose the best administrative path in satisfying the public interest does not mean a blank check for the adoption of disproportionate, unequal and contrary to good faith measures. It is necessary to ensure that administrative action is coherent and not contradictory in the Democratic State of Law.

Despite its initial connection with discretionary administrative action, the idea of self-binding was later extended to encompass, not free from doctrinal controversies, linked actions, installment activities and special subjection relationships involving the Public Administration and citizens.

It should be noted that self-binding does not mean administrative immobilization and must be conceived in a relative (and not absolute) way (PIELOW, 1997, p. 51). This is because self-binding involves the tension between the search for continuity and predictability of administrative action, on the one hand, and the need for innovation and flexibility on the part of the Administration to meet social, technological, political, economic and cultural changes.

In duly motivated cases, the Administration may change its interpretation of certain legal rules, applying, as a rule, the new guidance to similar future cases, with the aim of safeguarding the legal certainty and good faith of citizens.

In short, in the Democratic State of Law presupposes coherence in state action, with contradictory conduct in legal relations with citizens appearing to be undesirable.

Consequently, in administrative proceedings or similar legal relationships, even if they involve different individuals, the Administration must apply equal and consistent treatment.

It is possible to affirm that the duty of administrative coherence is based, at least, on the following constitutional principles:

a) principle of equality: similar cases involving different individuals must be treated on an equal basis, with disproportionate discrimination between persons in similar factual and legal situations being prohibited;

b) principles of legal certainty, good faith and protection of legitimate expectations: predictability, loyalty and consistency of administrative action, with the exemption of uniform treatment to similar cases, guarantees legal certainty and protects good faith and expectations legitimate rights of individuals;

c) principles of reasonableness and proportionality: respect for its own precedents avoids the practice of administrative arbitrariness;

d) principle of efficiency: the consistent action of the Administration has the potential to discourage administrative litigation and the judicialization of the matter decided, as well as making the administrative activity more agile.

In addition to constitutional arguments, the need for consistency and predictability in administrative activities is an imposition of infra-constitutional legislation.

In this sense, for example, at the federal level, art. 2, single paragraph, XIII, of Law 9.784/1999 provides that the interpretation of the administrative rule must be carried out in the way that best guarantees the fulfillment of the public purpose to which it is addressed, "retroactive application of a new interpretation prohibited".

From the rule in question, it is possible to see the concern of the federal legislator with respect to administrative interpretations that were implemented to resolve past cases, preventing the retroactivity of new interpretations, safeguarding the authority of precedents already edited.

Based on the systematic interpretation of the legal system, the prohibition of retroactivity of the new administrative interpretation is based on the need to protect the good faith and legitimate trust of the administrator, who cannot be surprised by the change in the interpretation of the Administration. For this reason, we understand that nothing prevents the retroactivity of the new administrative interpretation as long as it is favorable to those administered.

The concern with consistency in administrative action, avoiding sudden and successive changes in interpretation, can also be found in art. 50, VII of Law 9.784/1999, which requires the motivation, indicating the facts and legal grounds, of administrative acts that "fail to apply established jurisprudence on the issue or disagree with opinions, reports, proposals and official reports".

Furthermore, the Brazilian Code of Civil Procedure (CPC/2015) which established the theory of judicial precedents, with adaptations of its original model of Common Law, as well as the need for uniform jurisprudence, which even impacts administrative proceedings. This is because art. 15 of CPC/2015 provides that "in the absence of rules governing electoral, labor or administrative processes, the provisions of this Code shall be applied to them on a supplementary and subsidiary basis".

The requirement for administrative coherence was reinforced with art. 30 of LINDB, inserted by Law 13.655/2018, which requires state action aimed at increasing legal certainty in the application of rules, including through regulations, administrative summaries and responses to queries, which will have a binding nature in relation to the body or entity for which they are intended, until further revision.

The duty of administrative coherence reveals the importance of studying administrative precedents, which traditionally did not receive greater attention from traditional doctrine, making it possible to include them in the list of Administrative Law sources (OLIVEIRA, 2018, p. 95).

The effectiveness of the principle of legal security and the guarantee of state coherence depends, as well as the respect of the legal order in its entirety, on the improvement of public management, but also on the organization and autonomy of state attorney.

As will be shown below, state attorneys represent society's first shields against arbitrary actions by managers.

IV. THE ROLE OF STATE ATTORNEY IN THE EFFECTIVENESS OS STATE COHERENCE

State attorneys, who perform public functions essential to Justice (articles 131 and 132 of the Brazilian Federal Constitution), are responsible for the internal control and defense of the legality of state acts, guaranteeing individuals a public management within the parameters established in the legal system.

The activities are varied, involving, for example, the defense of state entities in lawsuits, the filing of lawsuits, the analysis of draft administrative contracts, the issuing of opinions on controversial matters and legal guidance for public managers.

The quality of the performance of the state attorney and his characterization as a state attorney – and not a government one – depends on a number of factors, but, primarily, on the technical, administrative and financial autonomy of the legal body itself, essential characteristics for the defense impartial acts and public contracts.

In this context, it is possible to affirm the essentiality of state attorney for the preservation of the Democratic State of Law, with emphasis on the implementation of the principles of legal certainty, equality and efficiency.

The coherent and isonomic performance of the Public Administration, avoiding the issue of contradictory acts and the unequal treatment between people inserted in similar factual and legal contexts, depends on the independent action of state attorney.

Only independent state attorneys are able to guide public managers, issuing technical and impartial opinions. It is not a question here, it should be emphasized, of binary

action in defining the state decision to be adopted in a given concrete case, but, above all, of the demonstration of risks and possible decision-making pathways made available to the public manager.

It is essential not to confuse the role of state attorney with the role of public manager. The decision is the exclusive competence of the competent authority, elected or appointed, for the exercise of political-administrative decision-making functions, and it is not up to the state attorney, including due to lack of legitimacy and legal attribution, to share or replace the manager's decision.

For no other reason, we criticize the thesis that seeks to impute responsibility to the state attorney who, in the exercise of the advisory function, issues an opinion that is adopted by the authority as the basis for its decision.

According to the Brazilian Federal Supreme Court, in the case of binding opinions, the referee and the public manager could be held jointly responsible, since the favorable opinion, in the view of the Court, would constitute a presupposition of perfection of the act, with the "sharing of the decision power". In relation to the other opinions, with an opinionated character, the referee only responds in case of serious fault (gross error) or intent.

On the contrary, we understand that the responsibility for issuing the opinion, binding or not, is only possible when gross error or intent of the referee is proven, in view of the following arguments (OLIVEIRA, 2019, p. 544-545):

a) the public administration is the responsibility of the administrative authority, and not the legal advisor, under penalty of violation of the principle of segregation of functions;

b) there are several legal interpretations that can be reasonably presented in each specific situation, and it is not possible to hold the state attorney responsible for presenting a reasonable interpretation;

c) inviolability of the attorney who responds only in cases of intent or guilt (arts. 2, § 3; 3, § 1; 32; of the Brazilian Bar Association Statute); and

d) the liability of the state attorney, without due proof of gross error or intent, violates the principle of efficiency and art. 28 of LINDB, as indiscriminate liability, without the investigation of bad faith or malice, makes the state attorney act with fear, without thinking about the best decision to be taken in the light of efficiency, but only in the possibility of suffering sanctions for their opinions (it would be more convenient for the lawyer to deny the practice of acts to avoid their liability).

The uniqueness of state attorney can be demonstrated from three possibilities and perspectives (BINENBOJM, 2010, p. 37-38): a) prior performance: it is the only legal career that operates prior to the configuration of public policies; b) systemic action: it has a systemic view of the limits and possibilities related to public policies, which allows opinions on correcting directions, with the objective of avoiding unwanted side effects; and c) proactive action: public advocacy can act proactively in the prevention of litigation.

In the exercise of its institutional mission, state attorney must ensure administrative coherence, which reveals the need to issue opinions and other forms of legal manifestation, including in the judicial sphere, that guarantee respect for judicial and administrative precedents.

The incorporation of judicial precedents in art. 927 of CPC/2015 and its link to the Public Administration demonstrate the relevance of the role of public advocacy in preserving the stability, integrity and coherence of the legal system.

Considered as state and not government sector, state attorney law has the institutional duty to guarantee, in a preventive and/or repressive way, the legality of state acts.

In exercising the legal defense of the Public Administration, the state attorneys must change the traditional culture of belligerent action, used to handling resources and challenges against judicial decisions that apply consolidated theses.

It is necessary to rethink the management of repetitive judicial actions collections, as well as the strategy in cases relevant to the public interest, with the adoption of measures capable of optimizing the performance of state attorneys, highlighting, for example: a) use of new technologies for efficient administration of lawsuits; b) the provision of waivers of appeal in similar cases and with theses consolidated in the courts; c) the elaboration of normative parameters for attempts to reach agreements in repeated or strategic cases, including the promotion of the establishment of conciliation chambers within the scope of the Administration itself, in order to avoid unnecessary judicializations.

The efficient performance of state attorney in the judicial sphere has positive consequences not only for those involved in the dispute, parties, judges and the public prosecution, but for the community, which starts to see the Public Administration as a serious institution based on the pursuit of efficiency.

Not only in litigation, but especially in the consultative role, which is eminently preventive, state attorney should base its actions on the search for greater legal certainty and state coherence.

The objective is not only to reduce the judicialization of administrative disputes, but to guarantee the presentation of uniform legal solutions for similar cases, a requirement drawn from the principles of legal certainty, good faith, protection of legitimate expectations and equality.

In exercising internal control, state attorneys must guide the respective Public Administration with the presentation of the appropriate legal interpretation of state acts.

At this point, the performance of state attorney should not be restricted to formalistic interpretations, based on strict legality.

From the conception of the principle of legality and, as a consequence, the need to submit state acts not only to the principle of legality, but also to other constitutional principles, expressed or implied, it is imperative that state attorneys, in administrative interpretation, take into account binding administrative and judicial precedents.

In relation to administrative precedents, state attorney must take into account past legal guidelines in similar cases, in order to maintain the interpretative consistency of constitutional, legal and regulatory provisions.

Likewise, state attorney must verify that the acts and decisions submitted to legal consultation are consistent with the previous actions of the Public Administration in similar cases.

In the absence of a relevant and motivated fact to change or overcome the administrative precedent, the members of the state attorney's office must ensure respect for the precedent that decided a similar issue within the scope of that Administration.

State coherence in the exercise of administrative activity also depends on respect for binding judicial precedents. This is because administrative action contrary to binding judicial precedents would violate the principles of equality, legal certainty and protection of legitimate expectations, opening the way for judicialization and the undoing of administrative action, without forgetting the potential liability of the public manager.

Alongside the passive role, consisting in receiving specific administrative consultations or exercising the judicial defense of the administrative entity, state attorney should increasingly base its actions on prevention and proactivity, with the publication of guidelines or administrative summary, the search for consensual solutions to conflicts and, if applicable, the filing of legal actions with the objective of avoiding damages, restoring legality and reimburse any damages to the treasury.

It is true that the concern with the role of state attorney in guaranteeing the effectiveness of the decisions of higher courts in the scope of administrative proceedings is not new. At the federal level, the Attorney General's Office must “unify administrative jurisprudence, ensure the correct application of laws, prevent and settle disputes between the legal bodies of the Federal Administration”, and may even edit administrative summary statements resulting from iterative jurisprudence of the Courts (art. 4, XI and XII, of LC 73/1993). In order to ensure uniformity of administrative interpretation, the effective members of the Attorney General's Office cannot contradict the summary, normative opinion or technical guidance adopted by the Attorney General of the Union (art. 28, II, of LC 73/1993). The opinion of the Attorney General of the Union, approved and published together with the presidential order, binds the Federal Administration, whose bodies and entities are obliged to comply with it (art. 40, § 1, of LC 73/1993).

The concern of the Federal Attorney General's Office with administrative coherence can also be demonstrated by the institution of the Mediation and Conciliation Chamber of the Federal Administration with competence (art. 32 of Law 13.140/2015 and art. 18 of Annex I of Executive Order 10.608/2021), for example, to settle, through mediation, controversies between (a) between federal public agencies, between federal public entities or between an agency and a federal public entity; (b) that involve a federal public body or entity and States, the Federal District or Municipalities or their autarchies or public foundations; (c) that involve a federal public body or entity and a public company or federal government-controlled company; or (d) involving a private person and a federal public body or entity.

It is possible to see, therefore, that the legal system, before CPC/2015, already showed concern with the consistent application of jurisprudence and administrative guidelines in the exercise of state attorney.

However, this role is reinforced with the advent of CPC/2015, since the binding precedents provided for in its art. 927 must be observed by the administrative authorities, regardless of the existence of a summary or guidance from the legal body responsible for consulting the respective federated entity.

In fact, the legal body may issue specific guidance, including through a summary, to the public administrator and other members of the legal body, in order to reiterate and clarify the need to comply with judicial precedent, but this conduct is not a necessary condition so that the judicial precedent is observed by the Public Administration.

V. CONCLUSION

As highlighted above, contemporary or "post-modern" society is strongly marked by complexity, plurality and uncertainty, which increases the challenge of implementing coherent state action and in line with the principles of legal security, good faith, the protection of legitimate expectations and equality.

The equal and coherent treatment of those administered is the duty of the public manager, whose exercise presupposes the existence of a public legal body capable of issuing the legal guidelines necessary for decision-making.

State attorney's Office, a permanent, autonomous and specialized institution, composed of members chosen on the basis of merit and endowed with their own institutional guarantees, proves to be an essential state organ to the Democratic Rule of Law.

In the list of its attributions, the role of guaranteeing the coherence of state acts, with respect for binding administrative and judicial precedents, is highlighted, avoiding schizophrenic administrative actions that are out of step with the public interest.

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Economic and financial determination of mango cultivation under different Irrigation Management, in the Curaçá Project, in Juazeiro - BA

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Abstract— *Mango production is one of the world's main agricultural activities. In Brazil it is among the most produced and exported fruits, generating employment and raising millions every year, being the São Francisco Valley the main center of production of this fruit. Through a case study this work aims to characterize and analyze the cost of production and determine the economic and financial efficiency of mango cultivation worked with the irrigation system by surface furrow and located by micro sprinkling, in the Curaçá Project, municipality of Juazeiro - BA. Regarding the cost of production, it showed that from the sixth year, the most expensive segment is the cultural tracts. It was found that mango cultivation is viable and profitable in both systems, but the irrigation system located by micro aspersion, in addition to providing greater water savings, has better indicators of efficiency and economic viability, compared to the surface groove irrigation system. Thus, the use of the irrigation system located by micro sprinkling will provide water savings in times of water scarcity and future scenarios of climate change, as well as greater profitability to producers, thus creating better acceptance of this technology.*

I. INTRODUCTION

Accelerated population growth is a reality. The world population has already reached about 7.8 billion inhabitants [1]. And that's no different in the area of study. The Curaçá Project is part of the district of Itamotinga, which is located in the municipality of Juazeiro - BA, where it has 15,158 residents, but it is estimated that this population is already approximately 20,000 inhabitants [2].

As the population increases, there is a need to produce more food. Brazil is the second largest supplier of food and agricultural products in the world, and has been consolidating more and more with the possibility of reaching the first place, due to the growing demand, mainly from Asia [3].

It is also noteworthy that food production in Brazil can happen in a sustainable way with the improvement of technologies to obtain gains in productivity, without

necessarily expanding the planting of new areas and without the extraction of more natural resources. Within this perspective is also the production of tropical fruits, which is increasing gradually.

In this context, it deserves attention and emphasis to carry out research studies, the fruit production pole of the Submedio do Vale do São Francisco, since it is the largest center of production and export of fresh fruit in the country. In this pole the fruit crop is exploited in more than a dozen irrigated perimeters, which are settled in the North of the state of Bahia and West of the state of Pernambuco, most of which is located in the municipalities of Juazeiro - BA and Petrolina - PE.

The Curaçá Project, which is one of the largest irrigation perimeters of this region, is located in Juazeiro - BA, and its main plantation is mango cultivation. Mango is the fruit that Brazil exports the most, and it has shown significant growth over the years. Its consumption is mainly in natura, but it is also used for the production of pulps and later the processing of juices [4]. The municipality of Juazeiro - BA, is the third largest mango producer in the country, in which the Curaçá Project is part and contributes directly to this highlight in the national scenario [5].

Given the economic and social importance of mango production for the Brazilian semiarid, and especially for the São Francisco Valley Submedio, where together with the grape are the crops that most generate jobs and income in the region. Thus it is important to carry out studies that seek to analyze the profitability and economic and financial viability, as well as the characterization of the cost of production for producers, contributing to their potentiation of their production and consequently profits, increasing employment and income generation in the region, associated with the correct use and management of natural resources.

Within this context, have already been developed with this theme applied to fruit growing, especially on mango and grape [6], [7], [8], [9]. But it is observed that there is a gap of research that will address the economic and financial issue of fruit production associated with environmental issues, such as water saving, which is one of the essential natural resources for agricultural production. Thus, this work will present the scientific community with a new source of research, which makes the link between economy and sustainability, also opening a range for the realization of new works.

Therefore, the objective of this research is to characterize the production cost and analyze the economic and financial efficiency of mango production under different types of irrigation management, in Project Curaçá, in Juazeiro - BA, emphasising that the choice of appropriate irrigation management will provide not only financial but also environmental gains, aligning the producer's objective of making profits from his investment with the need for environmental measures, given the projections of scenarios of temperature increases and water scarcity.

II. THEORETICAL REFERENCE

2.1 Panorama of mango cultivation

The cultivation of mango (Mangifera indica L.), is one of the world's leading agricultural activities. The mango is classified into three segments: red, yellow and green varieties. The main cultivated varieties are Tommy Atkins, Palmer, Keitt, Haden, Kent, Rose and Sword [10]. Increasingly this fruitful has gained ground on the international stage, helping to meet the food needs of the world's population. The main mango producing countries are India, China, Thailand, Mexico, Indonesia, Pakistan and Brazil [3].

The cultivation of fruit in Brazil has been producing significant growth, both for the domestic market and for the external market, due to favorable climate and soil conditions in relation to other countries, associated to investments in training, technology, infrastructure and logistics, which are determining factors for the sector's growth and competitiveness [11]. The production of mango has been contributing directly to this growth, since it is one of the main fruits cultivated at the national level.

Brazil produced an average of 1,132,802 tons of mango per year in the period from 2008 to 2017 [5]. Several states produce mango in Brazil, but the Northeast region is prominent in this fruit tree, driven mainly by the cultivation of the fruit in the São Francisco Valley, which produced an average of 467,325 tons of mango annually. This average production represents a percentage of 41.2% in relation to the national production in the same mentioned sample period.

Mango production has been growing in recent years, both in terms of production of tons and in terms of revenues [4]. In addition to not needing to import this type of fruit, Brazil is also one of the largest exporters, with about 179,000 tons shipped abroad in 2017. These exports represented revenue of more than US$ 205 million, an increase of about 13.99% over the previous year. The main buyers are the European Union with 132,820 tons and the United States with 33,095 tons.

2.2 Area and localised irrigation

Irrigation is an activity that provides the cultivation of various crops and boosts agriculture around the world.

Irrigation can be defined as the techniques, forms or means adopted to apply water to the soil and favor the plants, satisfying their needs and seeking to achieve the ideal production for each species. This way irrigation has over the years provided food production in various regions of Brazil and the world [12].

Irrigated areas in Brazil have been growing over the years. The number of hectares has increased since 1960 and in 2015 there are already approximately 7 million irrigated hectares, a growth of about 600% to that of fifty-five years [13].

Area irrigation is still used to grow various crops. One of the main types of surface irrigation is furrow irrigation, which consists of the direct application of water to the soil. Is one of the oldest irrigation methods in the world, where the farmer lets the water flow through the soil, causing the water to seep as it moves along. The water is distributed in the furrows mainly by the use of siphon, and requires favorable topographical conditions for efficiency in this type of irrigation [12].

Although furrow irrigation is widely used, it leaves the soil more susceptible to erosion and salinization processes, due to the accumulation of water and the need for soil slope for runoff. This way other irrigation management are more recommended, so that the use of water is more efficient and uniform, and does not cause future problems in the soil and consequently significant losses of productivity [14].

On the other hand, localized irrigation is one of the most efficient and least loss in water use, only 10% of losses [13], essential factor for the production of food potentiating the use of water. In times of water scarcity there is a great need to invest in irrigation systems that provide greater efficiency, so that more can be produced with less water use. One of the main advantages, besides reducing water consumption, is the uniformity that localized irrigation provides, where the soil profile is with well-distributed water quantities thus improving the performance of various crops [14].

2.3 Studies of economic analysis of fruit trees

On the economic issue of the yellow passion fruit culture in the region of Marília - SP, it was identified that the total cost of production per hectare was R$ 37,751.67 or R$ 1.89 per kilogram of fruit. Among the items that most influenced operating costs were those with machines and labor, which represented 31.1% and 23.5%, respectively. The average production shown is 12 to 15 tons per hectare, with the potential to produce up to 35 tons [7].

By analysing the production of the same fruit in six different production poles, they observed that production is viable when it exceeds 19 tons per hectare. In both studies it was proven that one of the biggest difficulties for the viability of the culture is the high price of inputs [15]. The studies showed profitability, especially when grown on a large scale, with a return of R$ 0.21 per kg of the fruit produced [16].

Analyzing the production of table grapes in regions of the state of São Paulo, viability was observed for fruit cultivation, where the region of Campinas had a total cost of US$ 0.81/Kg with a total net revenue of US$ 0.23/kg. In Itapetininga, the total cost was US$ 0.68/Kg with a total net revenue of US$ 0,32/kg. In this way, grape production in these regions of the state of São Paulo is profitable and has a positive return for farmers who cultivate this type of crop [8].

With economic viability analysis also on grapes, but in the municipality of Petrolina - PE, viability for fruit cultivation has been identified, and there is a return on investment from the third year onwards. It was observed that for each R$ 1,00 invested there is a net return of R$ 0,65 [9].

A survey on the cost of organic banana production in the São Francisco Submedio in the State of Bahia, was observed that the cost with inputs corresponds to 58% of the operating costs, being the main expense in this item. The total cost per hectare was R$ 8,364.00, the average annual production is 35 tons per hectare, giving a gross revenue of R$ 15,750.00, resulting in a net margin of R$ 7,386.00 [17].

Analyzing the economic viability of the strawberry crop in Paraná, verified that the size of the cultivated area influences the results, where when the area is very small ends up not recovering the investment in the long term and becoming unviable, highlighting the need for a minimum standard of cultivated hectare for the business to be profitable, with a minimum of one hectare [22]. These same authors also showed the need to market the fruit at a minimum of US$ 1.97 so that negative balances do not occur [18].

Verifying the economic and financial situation of mango cultivation in the municipality of Mauriti - CE, the gross revenue obtained per hectare/year was R$ 25,000.00, with a net income of approximately R$ 18,000.00 [6]. Among the fixed costs that had more relevance was the expenditure on capital goods depreciation, maintenance and water expenditure for irrigation, giving a total of R$ 3.157,67. Among the fixed costs that had more relevance was the expenditure on capital goods depreciation,

maintenance and water expenditure for irrigation, giving a total of R$ 3.157,67.

Studies on the characterization of the Tommy Atkins manga, observed that the cost of production is R$ 0,58 per kg in the first year of harvest (fourth year), from the sixth year the cost is around R$ 0,48 per kg, having a gross revenue per hectare of R$ 20,800.00, obtaining a net revenue of R$ 13,197,91 per hectare, representing a profitability rate of 63.45% [19]. The equilibrium point of kilograms per hectare remained at 5,847.76 from the sixth year which is the year of full production. In this way, the production of mango was economically profitable.

In studies on fruit growing in the Northern Region of the State of Rio de Janeiro, it was found that mango cultivation is recommended, since the result of the Internal Rate of Return was higher than the highest minimum attractiveness rate of 12%, leaving Tommy mango for consumption in natura with a rate of 14.52% [20]. The Net Present Value was calculated with variables from 2% to 12%, and with 2% obtained the return value of R$ 51,675.92 and with 12% the value of 4,886.04, thus obtaining profitability in both NPV rates. Regarding expenses, the items that generated the greatest impact were labor and fertilizer expenditures.

Analyzing the production of organic and conventional mango in the state of Baja California, South - Mexico, satisfactory results were obtained for both productions, and organic production had better rates, with IRR of 91.35% in organic production and 83.02% in conventional production, and the Benefit/Cost ratio was 8.31 and 7.42 respectively [21]. On the production and marketing of the mango in Nariño - Colombia and Guayas - Ecuador, showed 22.75% for IRR and 1.54 for Benefit/Cost. In both works the results found presentation viability and profitability for production of marketing of the mango [22].

III. METHODOLOGY

The units of analysis of this study were four family farms in the Submedio do Vale do São Francisco, located in the municipality of Juazeiro - BA, in the Project of Irrigation Curaçá, which has in the exploitation of the mango its main economic activity. The methodological tool used was the case study, which is a research method that resides in a thorough analysis of one or a few samples, providing a comprehensive and detailed knowledge about the units analyzed [23], [24]. The targets of this study were two production units that irrigate the mango in the form of a surface groove and two other units that perform irrigation in a localized manner (micro sprinkler). These farms work exclusively with the cultivation of mango.

The procedure used to obtain the data was performed in four stages. First, several technical visits were carried out to the production areas in order to follow the various phases of crop management, under the two irrigation systems, as well as the marketing process. This stage was developed during approximately one year, emphasizing that in the properties there are mango areas planted in different years, which facilitates the follow-up of several simultaneous phases, from Year 1 to Year 6 (full production) and subsequent years. In these visits, besides the direct observation of the target phenomenon of the study, information was collected with the technical assistance responsible for conducting the crops, in order to have an identification and quantification of the activities performed by them in the mango production process.

In the second stage, a survey of the water consumption used in the properties targeted by the study was carried out, near the Irrigation district of the Curaçá Project. The third stage consisted of researching the prices of inputs in the areas of crops and in the companies that market inputs of this nature in the district. In the fourth stage, we obtained the sales prices of the product from the properties, district of the Company of Development of the Valleys of São Francisco and Parnaíba (CODEVASF), in the region, and specialized websites in fruit sales.

3.1 Studies of economic analysis of fruit trees

The model developed by the Institute of Agricultural Economics (IEA), an economic arm of the São Paulo Agribusiness Technology Agency (APTA), of the Department of Agriculture and Supply of the State of São Paulo, was used to analyze the production costs of the crop. With this method the costs are inserted in two large groups: the Effective Operating Costs (COE), which are the direct expenses from the preparation of the land to the harvest and the Indirect Costs (IC) that are spent as rent of the land, taxes and others. Total Cost (TC) is the sum of COE + CI expenses.

To determine the economic efficiency of the fruit production system under analysis in this study, the following economic performance indicators were used: Net Income (RL), Total Factor Productivity (PTF), Entrepreneur Return Rate (TRE) and the Levelling Point (PN) [25], [26], [9].

The Net Income corresponds to the total revenue obtained from the sale of the products generated in the enterprise less the sum of all the expenses generated for the production of the same [27].

$$Net\ Income = Total\ Revenue - Total\ Cost$$

Total Factor Productivity must be measured by the ratio between Total Revenue and Total Cost, where the

production system will only be able to sustain itself when the index result is at least 1 [26].

PTF = (Total Revenue) / (Total Cost)

The Entrepreneur's Rate of Return has as main objective to analyze how much the entrepreneur will have of Net Income, per monetary unit spent on the enterprise [27]. The rate is obtained by dividing Net Income by Total Cost or Total Revenue by Total Cost minus one.

Rate of Return = (Total Revenue) / (Total Cost) = PTF - 1

The Leveling Point aims to inform the amount of production needed to equalize and cover the total expenses used to obtain the product. The Leveling Point is acquired by dividing the Total Cost by the Product Price.

Leveling Point = (Total Cost) / (Product Price)

3.2 Economic viability indicators and risk and uncertainty analysis

The following indicators were used to determine economic viability: Net Present Value (NPV), Internal Rate of Return (IRR), Modified Internal Rate of Return (IRR), Profitability Index (IL), Rate of Return (TR) and Discounted Payback [28], [29], [30], [16].

The Net Present Value (NPV) is the sum of the expected income flows in each period (n= 1, 2,..., N), brought to zero period values, at a discount rate equivalent to the Minimum Market Attractiveness Rate, minus the value of the initial investment carried out in period 0 [31].

$$VPL = \sum_{t=0}^{N} \frac{FC_t}{(1+i)^t}$$

Where:
Fct = expected cash flow for each period;
i = minimum attractiveness rate;
t = time period.

The minimum attractiveness rate is understood as the best rate available on the market for application, with the lowest associated risk [32]. Internal Rate of Return (IRR) is the discount rate that equals the sum of cash flows to the value of the investment. I n this way the discount rate equals the inflow flows to the outflow flows of cash, producing a NPV equal to zero.

$$0 = \sum_{t=0}^{N} \frac{FCt}{(1+IRR)^t}$$

Where:
Fct = expected cash flow for each period;
IRR = Internal Rate of Return;
t = Period of time.

The investment that presents an Internal Rate of Return higher than the Minimum Rate of Attractiveness will be considered viable. But when the calculated IRR is very different from the market rate, the interpretation may be compromised [31].

This can be corrected using the Modified Internal Rate of Return (TIRM). The Modified Internal Rate of Return (IRR) differs from the traditional IRR in that it presents a more realistic cash flow, as the financing and reinvestment rates are compatible with market interest.

((1 + TIRM)) / ((1 + TMA)) - 1

The Profitability Index, indicates the calculated return for each invested monetary unit and is given by the relationship between the net present value of positive cash flows (inflows) and the sum of investments, using as a discount rate the minimum rate of attractiveness of the project. Thus the investment will be profitable where the IL is greater than or equal to 1 [33].

IL = (VP (revenue)) / (sum of investments)

Rate of Return that is determined from the ratio of the NPV of positive cash flows to the NPV of negative cash flows minus 1. The investment in the venture will be considered attractive when RT is greater than or equal to zero; Negative TR will indicate unworkability in business.

TR (%) = (NPV (positive cash flows)) / (NPV (negative cash flows)) - 1

The Discounted Payback is the period of time required for the recovery of an investment. Is the time necessary for negative cash flows (investments) to be written off by positive cash flows (profits) [34].

$$I = \sum_{t=0}^{N} \frac{FC_t}{(1+i)^t}$$

Where:
Fc_t = expected cash flow for each period;
I = total investment;
i = minimum attractiveness rate;
t = Period of time.

Due to the characterization of the study object, a risk and uncertainty analysis was performed through the free version MODELRISK Software, worked through Microsoft Office Excel 2016. For this purpose, the Monte Carlo simulation method was used, using probability distributions of input variables (input variables), to generate output variables (output variables). In this way it will be possible to measure the risk associated with the project and determine investment alternatives, and not be restricted to a single value as absolute certainty.

The Monte Carlo simulation method makes it possible to generate random samples in terms of cost or time, which will undergo tests from statistical models, which will allow the distribution of probabilities for a given project risk [35].

Each sample corresponds to a repetition of the method, so the higher the number of repetitions, the lower the error. This method is fundamental for projects that have few samples in the study object, such as the project developed in this research that has only four.

The Monte Carlos simulation can be developed in two basic stages. The first step is the choice of risk variables of the project, based on their relevance in terms of costs and revenues. This stage is important because some of the items that make up the characterization of production cost and revenue, suffer price variations over time. Thus, the items with the greatest influence should be selected to determine the final result [36].

Based on these criteria, the input variables (inputs variables) of this project were considered: manual operations (cultural tracts), water, growth regulator (Paclobutrazol), mechanical operations (cultural tracts), price and productivity. In the second stage, the probability distribution was chosen, and the triangular probability distribution was chosen, where the minimum, maximum and mean values are inserted, which is considered more likely by the variable.

For the variables manual operations (cultural tracts), water, growth regulator (Paclobutrazol), mechanical operations (cultural tracts) were used values with 10% less and more in relation to the average for minimum and maximum values, taking into account that prices may vary over time.

For the variables price and productivity, 60% and 30% were used, respectively, less and more in relation to the average for minimum and maximum. These two items are directly linked and can be affected by pest situations in the crop, higher or lower supply of fruit, as well as consumer demand, climatic situations, among other factors. Table 1 shows the distribution of the risk variables of Manga.

Table 1: Probability distribution of variables to perform the simulations

Variable	Distribution	Parameters
Manual operations (cultural tractors)	Triangular	RiskTriang (45,50,55)
Water	Triangular	RiskTriang (117,130,143)
Growth regulator (Paclobutrazol)	Triangular	RiskTriang (90,100,110)
Mechanical operations (cultural tracts)	Triangular	RiskTriang (117,130,143)
Manga price	Triangular	RiskTriang (0.512,1.280,2.048)
Year productivity 4	Triangular	RiskTriang (16800,24000,31200)
Year productivity 5	Triangular	RiskTriang (22400,32000,41600)
Year productivity 6	Triangular	RiskTriang (28000,40000,52000)
Year productivity 27	Triangular	RiskTriang (25900,37000,48100)
Year productivity 28	Triangular	RiskTriang (23800,34000,44200)
Year productivity 29	Triangular	RiskTriang (21700,31000,40300)
Year productivity 30	Triangular	RiskTriang (19600,28000,36400)

Source: *Own elaboration, based on research data (2021).*

The simulations were performed through stratified sampling, for being more efficient and having greater accuracy. To perform these analyses, the MODELRISK software was used, where 10,000 (ten thousand) interactions (process repetitions) were performed. The number of iterations is the largest available in the program, and was chosen to provide greater certainty in the data found, and to favor convergence to the result.

In these steps, the output variables (output variables) used were NPV, IRR and Cost Benefit analysis, which were widely used in this type of analysis. The minimum attractiveness rate chosen was 6.5%, Selic yield, and 33%, internal rate of grape return, extracted through the average [37], [9], [38].

IV. RESULTS AND DISCUSSIONS

4.1 Analysis of production costs

Analyzing the costs of implantation and maintenance of one hectare with 500 mango plants Tommy Atkins, with cultivation system with irrigation by surface groove (system 1) and with cultivation system with irrigation located by micro sprinkler (system 2), it was observed that in Year 1 the costs with systematization and preparation of the soil represented 13.61% for system 1 (Table 2) and 14.80% in system 2 (Table 3), which presented a lower real cost because there was no need to furrow the soil for the planting of mango seedlings, as it does not need this procedure for irrigation.

Still in Year 1 it is worth noting that the spending on planting was R$ 3.912,00 in the system 1 and R$ 3.820,50 in the system 2, which represents 27,66% and 31,50% respectively, being the most expensive expense for the system 2. in Year 2, the expenses with soil correction were

R$ 460,00 and spending on PPE and soil analysis were R$ 263.00, values found in both systems. In relation to Years 3 and 4, the largest expenses were with cultural tracts, where in Year 3 it was R$ 7,879.00 in system 1 and R$ 5,521.34 in system 2, representing 73.71% and 65.77% respectively of the total expenses. In Year 4, the value was R$ 14,493.00 in system 1 and R$ 11,987.08 in system 2, giving a percentage of 77.60% and 73.88% respectively in relation to total expenses (Tables 2 and 3).

Table 2 - Cost of implantation and maintenance of one hectare of mango (Irrigation system by surface furrow)

Segment	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
	Value	Value	Value	Value	Value	Value
Systematization and soil preparation	1925	-	-	-	-	-
Soil correction	460	460	460	460	460	460
Planting	3912	-	-	-	-	-
Cultural tracts	5298	7482	7879	14493	16154	17815
Harvest	-	-	-	920	920	920
PPE and Soil Analysis	263	263	263	263	263	263
Depreciation	409.90	409.90	409.90	409.90	409.90	409.90
Administration and Technical Assistance	600	600	600	600	600	600
Actual operational cost	**12867.90**	**9214.90**	**9611.90**	**17145.90**	**18806.90**	**20467.90**
Earth's opportunity cost	500	500	500	500	500	500
Opportunity cost of Costing	772.07	552.89	576.71	1028.75	1128.41	1228.07
Indirect cost	**1272.07**	**1052.89**	**1076.71**	**1528.75**	**1628.41**	**1728.07**
Total cost	**14139.97**	**10267.79**	**10688.61**	**18674.65**	**20435.31**	**22195.97**

Source: *Own elaboration, based on research data (2019)*

Table 3 - Cost of implantation and maintenance of one hectare of mango (Irrigation system located by micro sprinklers)

Segment	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
	Value	Value	Value	Value	Value	Value
Systematization and soil preparation	1795	-	-	-	-	-
Soil correction	460	460	460	460	460	460
Planting	3820.50	-	-	-	-	-
Cultural tracts	3424.92	5247.96	5521.34	11987.08	13522.2	15312.94
Harvest	-	-	-	920	920	920
PPE and Soil Analysis	263	263	263	263	263	263
Depreciation	603.51	603.51	603.51	603.51	603.51	603.61
Administration and Technical Assistance	600	600	600	600	600	600
Actual operational cost	**10966.93**	**7174.47**	**7447.85**	**14833.59**	**16368.70**	**18159.55**
Earth's opportunity cost	500	500	500	500	500	500
Opportunity cost of Costing	658.02	430.47	446.87	890.02	982.12	1089.57
Indirect cost	**1158.02**	**930.47**	**946.87**	**1390.02**	**1482.12**	**1589.57**
Total cost	**12124.95**	**8104.94**	**8394.72**	**16223.61**	**17850.81**	**19749.12**

Source: *Own elaboration, based on research data (2019)*

Analyzing the expenses of Year 5, the difference in value with cultural tracts is observed, one of the justifications is the fact that in the system by micro sprinkler the use of chemical fertilizers is less, because it is introduced directly into the water through fertigation, which also greatly reduces labor costs. In Year 6, where full production begins in mango cultivation, there is also a large difference in values in the same segment of cultural

tracts, with the value of R$ 17,815.00 in system 1 (Table 2) and R$ 15,312.94 in system 2 (Table 3), this occurs mainly because in the second system the expenses with water and labor are much lower compared to the first system.

4.2 Analysis of economic viability

In the exploitation of a hectare of mango Tommy Atkins, in full production year, cultivated in the region of the Submedio of the Valley of San Francisco, in the municipality of Juazeiro - BA, in the Curaçá Project, the producers who work with irrigation system by surface furrow (system 1) and those who work with micro sprinkler irrigation (system 2) obtained a gross revenue of R$ 51,200.00 (Table 4). This value was acquired with a productivity of 40 tons per hectare/year carried out in two annual harvests and an average annual price of R$ 1.28 per kilogram during the research data collection period (March 2018 to February 2019).

The cost of production was different in relation to the two types of irrigation system, where in the system 1 was R$ 22,195.97 and in the system 2, R$ 19,749.02, thus decreasing these values of gross revenue obtained a net income of R$ 29,004.03 and R$ 31,450.98, respectively (Table 4). As discussed in the methodology, positive net income indicates the economic viability of both production systems, and system 2 presented better results.

Regarding the benefit/cost, the system 1 presented a result of R$ 2.30, lower than the system 2 that obtained R$ 2.59, but in both of them it can be observed that there is profitability and economic efficiency in these production systems. It can be confirmed by the result of the rate of return of the entrepreneur, which presents a measure of how much each monetary unit generates net income, this index showed that the cultivation of the mango generates in the system 1 R$ 1,30 net income for each R$ 1,00 applied (cost) and in the system 2 generates R$ 1.59 (Table 4).

The level point was 17,340 kg for system 1 and 15,428 kg for system 2 (Table 4), this index establishes the minimum annual production level necessary for the generated gross revenue to be equal to the total costs, thus obtaining net revenue equal to zero. Thus the properties that work with these systems, surface furrow and located by micro sprinkling, and have annual production below this level will make economically unviable the production system.

Table 4 - Economic efficiency indicators

	System 1 (Surface groove)		System 2 (Microspray)	
Indicators	**Year full-production**	**The whole enterprise**	**Year full-production**	**The whole venture**
Productivity (Kg)	40.000	1.026.000	40.000	1.026.000
Gross Revenue (R$)	51.200,00	1.313.280,00	51.200,00	1.313.280,00
Net Income (R$)	29.004,03	684.174,42	31.450,98	756.855,47
B/C (R$)	2,30	2,08	2,59	2,36
TRE (R$)	1,30	1,08	1,59	1,36
PN (Kg)	17.340	491.488	15.428	434.706

Source: *Research data (2019)*

Analyzing all the investment, which has a useful life of thirty years, it was verified that the gross revenue was R$ 1,313,280.00 for both systems, with a total cost of R$ 629,105.58 in the system 1 and R$ 556,424.53 in the system 2, obtaining a net income of R$ 684,174,42 and R$ 756,855.47 respectively (Table 4). With regard to costs, the most expensive segment was that of cultural tracts for both systems.

The productivity during the whole useful life was of 1.026.000 tons in both systems, and the leveling point was of 491.488 tons in system 1 and of 434.706 in system 2. Regarding the benefit/cost the system 1 presented result of R$ 2,08 and system 2 the value of R $ 2,36, with return rate of entrepreneur of R$ 1,08 and R $ 1,36 respectively (Table 4). These indexes show that system 2 also has better results in the long term, but that both systems are economically viable.

Regarding the economic-financial analysis, it is noted that investing in mango cultivation in the study area is feasible in both irrigation systems, because the Net Present Value of R$ 298.746,06 in the system 1 and R$ 336.113,33 in system 2, indicate that the enterprise generates a much higher return to the producer than the capital invested in the implantation and maintenance of the crop. These results are confirmed when the Annualized Present Value is also observed, indicating that in addition to remunerating the invested capital at a rate of 6.5% per year, the investment also provides a surplus to the producer of R$ 22,877.21 in system 1 and R$ 25,738.70 (Table 5).

Table 5 - Economic and financial analysis

Financial Indicator	System 1 30 years old lifespan	Sistema 2 30 years old lifespan
Net Gift Value (R$/ha)	298.746,06	336.113,33
Internal Rate of Return (%)	59,06	76,95
Modified Internal Rate of Return (%)	14,80	15,93
Index of Profitability	9,51	12,74
Rate of Return (%)	8,51	11,74
Annual Net Gift Value (R$/ha)	22.877,21	25.738,70
Discounted Pay Back (Years)	5 years and 3 months	4 years and 8 months

Source: *Research data (2019)*

The results of the Internal Rate of Return and the Modified Internal Rate of Return were also satisfactory in both systems, being 59.06% and 14.80% in system 1 and 76.95% and 15.93% in system 2, respectively, presenting values higher than the minimum attractiveness rate of 6,5%, value for the annual rate of Selic income. The Profitability Index was 9.51 in system 1 and 12.74 in system 2, the Profitability Rate was 8.51% and 11.74%, respectively (Table 5), also certifying the economic and financial viability of the mango exploration.

In relation to the discounted Pay Back it was observed that in system 1 there is the return on investment with 5 years and 3 months and in system 2 with 4 years and 8 months (Table 5), considerably short period leading tothe useful life of the 30-year enterprise according to the cash flow presented (Table 6).

Table 6 - Cash flow

	System 1 (Surface groove)			System 2 (Micro spray)		
Year:	**Cost (R$):**	**Recipe (R$):**	**Result (R$):**	**Cost (R$):**	**Recipe (R$):**	**Result (R$):**
1	14.139,97	0,00	-14.139,97	12.124,95	0,00	-12.124,95
2	10.267,79	0,00	-10.267,79	8.104,94	0,00	-8.104,94
3	10.688,61	0,00	-10.688,61	8.394,72	0,00	-8.394,72
Inv.			-35.096,37			-28.624,61
4	18.674,65	30.720,00	12.045,35	16.223,61	30.720,00	14.496,39
5	20.435,31	40.960,00	20.524,69	17.850,81	40.960,00	23.109,19
6	22.195,97	51.200,00	29.004,03	19.749,02	51.200,00	31.450,98
7	22.195,97	51.200,00	29.004,03	19.749,02	51.200,00	31.450,98
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
25	22.195,97	51.200,00	29.004,03	19.749,02	51.200,00	31.450,98
26	22.195,97	51.200,00	29.004,03	19.749,02	51.200,00	31.450,98
27	22.195,97	47.360,00	25.164,03	19.749,02	47.360,00	27.610,98
28	22.195,97	43.520,00	21.324,03	19.749,02	43.520,00	23.770,98
29	22.195,97	39.680,00	17.484,03	19.749,02	39.680,00	19.930,98
30	22.195,97	35.840,00	13.644,03	19.749,02	35.840,00	16.090,98
Total	629.105,58	1.313.280,00	684.174,42	556.424,53	1.313.280,00	756.855,47

Source: *Research data (2019)*

All the indexes and results found in this research show that mango farming is an economically viable agricultural activity, developed both by the irrigation system by surface furrow and also by irrigation located by micro sprinkler, but that the latter, besides presenting a considerable saving of water annually, keeping the soil less susceptible to erosion and salinization processes, also provides better economic and financial results for producers.

4.3 Risk and uncertainty analysis

With the elaboration of the cash flow it is possible to make simulations for the development of an analysis of risks and uncertainties of the obtained results. For this is used the Minimum Attractiveness Rate (TMA), which was 6.5%, Selic yield, and 33%, internal grape return rate, average of the results found [37], [9], [38]. The indicators analyzed were the Net Present Value, the Benefit/Cost ratio and the Internal Rate of Return.

The data found from NPV and B/C ratio to Minimum Attractiveness Rate of 6.5% show that both projects are profitable. However, the results found in system 2 are more satisfactory. The histograms were generated through the simulations, where it is observed that the NPV has a 90% probability of having values between 9,160.70 and 312,543.03 in the system 1 and between 31,375.18 and 335,479.01 in the system 2. On the other hand, the B/C ratio obtained a 90% probability of having values between 1,46 and 23.11 in system 1 and between 3.61 and 28.87 in system 2 (Figure 1).

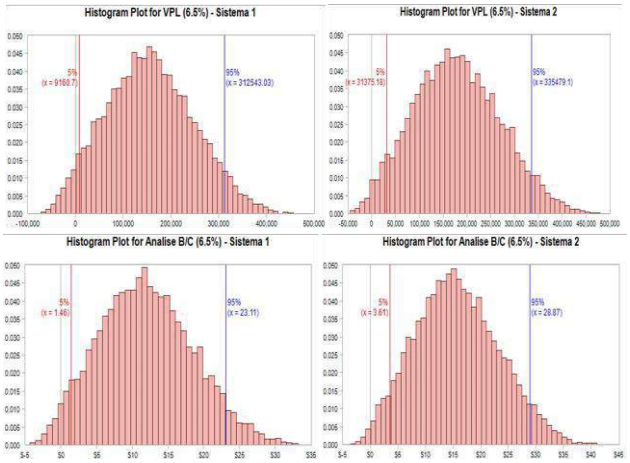

Fig.1 - Histograms of NPV and B/C at a rate of 6.5%

Source: *Research data (2019)*

On the other hand, these same indicators, NPV and B/C, with TMA of 33% had lower values, but still satisfactory, and with system 2 presenting better results in both indicators (Figure 2).

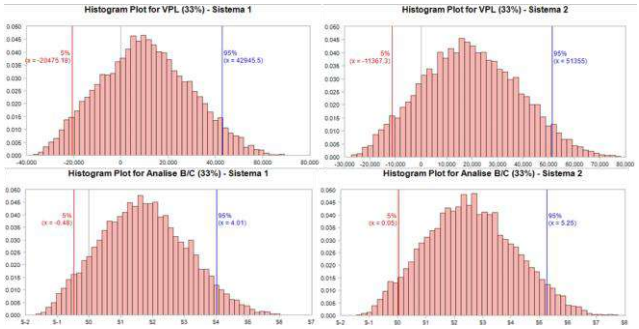

Fig.2 - Histograms of NPV and B/C at 33% rate

Source: *Research data (2019)*

In relation to IRR, less than 5% of the probability of obtaining a value below 10.44 in system 1 and 19.32 in system 2, and 90% of the probability of the values being between 10.44 and 60.41 in system 1 and between 19.32 and 69.82 in system 2 (Figure 3). This indicator shows that the investment provides a return to the producer who works with mango production in both systems, and that system 2 has better results.

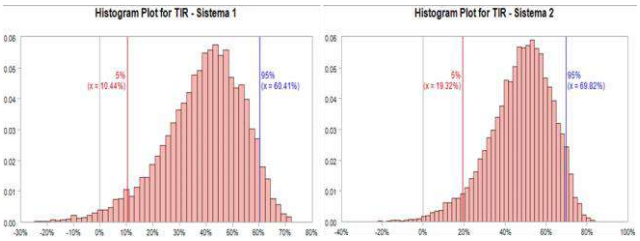

Fig.3 - Histograms of IRR

Source: *Research data (2019)*

V. CONCLUSION

Considering the exploitation of mango culture in the Submedio do Vale do São Francisco, this research sought to characterize and analyze the production cost of this fruit tree, as well as determine the economic and financial viability, under different irrigation management. Regarding the cost of production, it was observed that year 1, year of crop implantation, has higher expenses than years 2 and 3, due to expenditure on the purchase of seedlings and systematization and preparation of the soil for planting. From the year 4, the segment of cultural tracts was the most expensive in both systems, highlighting expenditures on inputs and labor.

With regard to economic and financial viability, this research revealed that the exploitation of the mango is a profitable activity, where through the various indicators analyzed satisfactory results were obtained, presenting positive numbers. Through the analysis of risks and uncertainties, it was found that using percentages of 6.5% and 33% for the Minimum Attractiveness Rate, the results are still satisfactory providing a return to the producer, but that using the 33% rate the return is much lower compared to the 6.5% rate.

It was evidenced that the system 2, of irrigation located by microaspersion, presents better results in all the indicators analyzed in comparison to the system 1, of irrigation by surface furrow. These results were proven through risk and uncertainty analysis. It was found that system 2, in addition to providing environmental gains, such as water savings, also offers the producer greater income and profitability, thus being more attractive the choice for this irrigation system that makes the link between environmental and economic benefits.

Therefore, it is important to point out that new research needs to be developed in this theme, which associates the environmental and economic issue involving fruit farming in the Region of the Sub-Edict of the São Francisco Valley, given the gap that exists of works on this theme,

since the research focuses on work developed on the environmental or economic issue separately, and given the importance and potential that there is in the production of fruit in the region at the national level for domestic consumption and also for export.

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Signal Received Power Mapping in Wireless Communication Networks using Time Series and Geostatistics

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***Abstract*—*Some theoretical and experimental models have been considered for the prediction of the path loss in mobile communications systems. However, one knows that in real environment, the received signal is subject to variations. The model developed for an urban area cannot give resulted acceptable for different urban areas since that, each model has different parameters in accordance with the considered area. This paper presents the results of propagation channel modeling, based on multivariate time series models using data collected in measurement campaigns and the main characteristics of urbanization in the city of Belem-PA. Transfer function models were used to evaluate effects on the time series of received signal strength (dBm) which was used as the response variable and as explanatory variables of the height of buildings and distances between buildings. As time series models disregard to the possible correlations between neighboring samples, we used a geostatistical model to establish the correctness of this model error. The results obtained with the proposed model showed a good performance compared to the measured signal, considering the data of the eleven routes from the center of the city of Belém/Pa. From the map of the spatial distribution of the received signal strength (dBm), one can easily identify areas below or above dimensional in terms of this variable, that is benefited or damaged compared with the signal reception, which may result in a greater investment of the local operator (concessionaire mobile phone) in those regions where the signal is weak.*

I. INTRODUCTION

Nowadays there is a great variety of communications channel models, with fundamental theories and experiments with a prediction on path loss in mobile communication systems. These models differ in their applicability, on different types of terrain and different environmental conditions. Thus, there is not an existing appropriate model for all situations. In real cases, the terrain on which the propagation presents varied topography, vegetation and constructions are randomly distributed. Although the propagation loss calculation can be performed, although with limited accuracy, using techniques such as ray tracing or numerical solutions for approximations of the wave equation.

The propagations models are generally based on the deterministic models (Liaskos et al., 2018; Salous, 2013; Shu Sun et al., 2014)[1-3] and modified based on results obtained from measurement campaigns in one or more

regions [2]. The models obtained are given by expressions that provide the median value of attenuation, like the models of Okumura-Hata(Arthur et al., 2019) [4]consisting analytical expressions of the average attenuation route, for urban areas, suburban and open (rural). These formulations are limited to certain ranges of input parameters, and are applicable only to land almost flat and are valid for frequencies of 150 to 1500 Mhz. and the model of Ibrahim-Parsons(Rozal et al., 2012) [5], which takes into account factors such as the degree of urbanization, land usage, and the variation in height between the mobile station (MS) and the base transceiver station (BTS). These empirical characteristics were extracted from measurements taken in the city of London, on frequencies between 168 and 900 MHz. This model was studied in urban areas without undulations. It is used for distances between antennas smaller than 10 km and receiving antenna height of less than 3 m.

The model of Walfisch–Ikegami(Alqudah, 2013) [6]has its formulation based on characteristics of urban regions, such as density and average height of buildings, and the width of the streets. This model is effective in cases where the height of the antennas BTS is smaller than the average height of buildings a situation where there is considerable guidance signal RF along the routes considered. This model predicts two different situations for calculating the average attenuation path between BTS and the mobile: The line of sight (LOS— line of sight and Non-line-of-sight (NLOS).

This paper presents a model for time series to characterize the received signal strength (dBm) in eleven pathways downtown of Belém/PA. The work consisted in the study of the possible relationship between this received signal strength and the behavior of the height of the buildings and the distance between. Transfer function models were used to assess effects on time series of the received strength and to evaluate the relationship between the height of the buildings and the distance between buildings.

For error correction model in time series, instead of using another ARIMA model, a spatial geostatistical model based on kriging was used. This module includes a set of required procedures for geostatistical techniques (exploratory analysis, generation and modeling of a semivariogram and kriging). With the objective an analysis in two dimensions for spatially distributed data, with respect to interpolation of surfaces generated from the geo-referenced samples obtained from the received strength.

II. RELATED WORKS

The literature analysis of propagation models has investigated different statistical prediction methods to identify appropriate techniques for thispurpose. Currently, many propagation channel models employ the most varied modeling techniques, such as time series modeling and geostatistics. In(Konak, 2010)[7] estimated signal propagation losses in wireless LANs using Ordinary Kriging (OK). In (Phillips et al., 2012) [8] used OK on a 2.5 GHz WiMax network to produce radio environment maps that are more accurate and informative than deterministic propagation models. In(Kolyaie et al., 2011)[9] used drive-tests to collect signal strength measurements and compared the performance of empirical and spatial interpolation techniques.(Y. Zhang et al., 2012)[10] developed a methodology based on time series analysis and geostatistics through experiments using a real dataset from the Swiss Alps. The results showed that the developed methodology accurately detected outliers in wireless sensor network (WSN) data, by taking advantage of their spatial and temporal correlations. Edilberto Rozal et al. [5] presented results of propagation channel modeling, based on multivariate time series models and the main characteristics of urbanization in the city of Belém/PA by using data collected in measurement campaigns. Transfer function models were used to evaluate the relationship between the received signal strength and other variables, such as building's height, distance between buildings, and distance to the radio base station, which were recorded in a street in the city center of Belém/PA, Brazil.(Karunathilake et al., 2014)[11] studied location-based systems to investigate the availability of signal reception levels, specifically 3G and 4G signals. The study was based on geostatistical analysis using the inverse distance weighting (IDW) method.(Molinari et al., 2015)[12] empirically studied the accuracy of a wide range of spatial interpolation techniques, including various forms of Kriging, in different scenarios that captured the unique characteristics of sparse and non-uniform measurements and measurements in imprecise locations. The results obtained indicated that ordinary Kriging was an overall fairly robust technique in all scenarios.(Wen-jing et al., 2017)[13] proposed a traffic prediction method based on the seasonal autoregressive integrated moving average (S-ARIMA) model, according to the characteristics of the network traffic and its respective implementation.(K. Zhang et al., 2019)[14] proposed a system for traffic analysis and prediction suitable for urban wireless communication networks, which combined actual call detail record (CDR) data analysis and multivariate prediction algorithms.(Mezhoud et al., 2020) [15]proposed an approach for coverage prediction based on the hybridization of the interpolation technique by OK and a Neural Network with MLP-NN architecture, this methodology was motivated by the lack of quality of the

MLP-NN test database, which satisfactorily enriched the network's training dataset.(Song et al., 2020)[16] used a novel secure data aggregation solution based on the ARIMA model to prevent tracking of private data by opponents.(Faruk et al., 2019)[17]evaluated and analyzed the efficiencies of empirical, heuristic and geospatial methods for predicting signal fading in the very high frequency (VHF) and ultra-high frequency (UHF) bands in typically urban environments. Path loss models based on artificial neural network (ANN), adaptive neuro-fuzzy inference system (ANFIS) and Kriging techniques were developed. Sato et al.(Sato et al., 2021)[18]proposed a technique that interpolates the representative map of the mobile radio signal in the spatial domain and in the frequency domain.

III. TIME SERIES

A time series is a set of statistics, usually collected at regular intervals.Time series data occur naturally in many application areas, such as economics, finance, environmental and medicine. The methods of time series analysis pre-date those for general stochastic processes and Markov Chains. The aims of time series analysis are to describe and summarize time series data, fit low-dimensional models, and make forecasts [5].

We write our real-valued series of observations as $\ldots X_{-2}, X_{-1}, X_0, X_1, X_2, \ldots$, a doubly infinite sequence of real-valued random variables indexed by integers numbers.

One simple method of describing a series is that of classical decomposition. The notion is that the series can be decomposed into four elements:

Trend (T_t) — long term movements in the mean;

Seasonal effects (I_t) — cyclical fluctuations related to the calendar;

Cycles (C_t) — other cyclical fluctuations (such as a business cycles);

Residuals (E_t) — other random or systematic fluctuations.

The idea is to create separate models for these four elements and then combine them, either additively:

$$X_t = T_t + I_t + C_t - E_t \quad (1)$$

or multiplicatively:

$$X_t = T_t . I_t . C_t . E_t \quad (2)$$

3.1. ARIMA Models

Box and Jenkins [5] first introduced ARIMA models, the term deriving from: AR = Autorregressive, I = Integrated and MA = Moving average.

A key concept underlying time series processes is that of stationarity. A time series is stationarity when it has the following three characteristics:

(a) Exhibits mean reversion in that it fluctuates around a constant long-run mean;

(b) Has a finite variance that is time-invariant;

(c) Has a theoretical correlogram that diminishes as the lag length increases.

The autoregressive process of order p is denoted AR(p), and defined by

$$Y_t = \sum_{i=1}^{p} \varphi_i Y_{t-i} + e_t \quad (3)$$

Where $\varphi_1,\ldots,\varphi_r$ are fixed constants. Y_t is expressed linearly in terms of current and previous values of a white noise series $\{e_t\}$. This noise series is constructed from the forecasting errors; $\{e_t\}$ is a sequence of independent (or uncor-related) random variables with mean 0 and variance σ^2.

Using the lag operator L (the lag operator L has the property: $(L^n Y_t = Y_{t-n})$ we can write the AR(p) model as:

$$Y_t(1 - \varphi_1 L - \varphi_2 L^2 - \ldots - \varphi_p L^p) = e_t \quad (4)$$

$$\Phi(L) Y_t = e_t \quad (5)$$

Where $\Phi(L)Y_t$is a polynomial function ofY_t.

The moving average process of order q is denoted MA(q) and defined by:

$$Y_t = e_t + \sum_{i=1}^{q} \theta_j e_{t-j} \quad (6)$$

Where,$\theta_1,\ldots, \theta_q$ are fixed constants, $\theta_0 = 1$, and $\{e_t\}$ is a sequence of independent (or uncorrelated) random variables with mean 0 and variance σ^2.

Or using the lag operator:

$$Y_t = (1 - \theta_1 L - \theta_2 L^2 - \ldots - \theta_p L^q) u_t \quad (7)$$

$$Y_t = \Theta(L) u_t \quad (8)$$

The combination of the two processes to give a new series of models called ARMA (p, q) models, is defined by

$$Y_t = \sum_{i=1}^{p} \varphi_i Y_{t-i} + e_t + \sum_{i=1}^{q} \theta_j e_{t-j} \quad (9)$$

Where again $\{e_t\}$ is white noise, $\{\varphi_i / i = 1,2,..,p\}$are the coefficients of AR model and $\theta_i / i = 1,2,..,q\}$ are the coefficients of MA model.

Using the lag operator:

$$Y_t(1 - \varphi_1 L - \varphi_2 L^2 - \ldots - \varphi_p L^p) = (1 - \theta_1 L - \theta_2 L^2 - \ldots - \theta_p L^q) \quad (10)$$

$$\Phi(L) Y_t = \Theta(L) e_t \quad (11)$$

According to the target model, the process is non-stationary, so the series should be transformed to a stationary process be the model construction. This can be

often achieved by a differentiation process.The first-order differencing of the original time series is defined as:

$$\Delta Y_t = Y_t - Y_{t-1} = Y_t - BY_t \qquad (12)$$

For the high-order differentiation, we have:

$$\Delta^d Y_t = (1-B)^d Y_t \qquad (13)$$

If we ever find that the differenced process is a stationary process, we can look for a ARMA model of that. The process $\{Y_t\}$ is said to be an autoregressive integrated moving average process, ARIMA(*p*,*d*,*q*). If $X_t = \Delta^d Y_t$ is an ARMA (*p*, *q*) process.

After the *d*-order differentiations of $Y_t$in equation 10, the autoregressive integrated moving average (ARIMA), ARIMA (*p*,*d*,*q*), can be constructed as:

$$\Phi(L) Y_t^d = \Theta(L) e_t \qquad (14)$$

A time series (TS) may be defined as a set of observations Y_t as a function of time [5]. The principal tools utilized for analysis of a time series are the autocorrelation and partial autocorrelation functions.

The autocorrelation function (ACF) represents a simple correlation between $Y_t$and Y_{t-k}as a function of the lag *k*. The autocorrelation function of TS $\{Y_t\}$ may be defined as: [5].

$$\rho = \frac{\sum_{t=0}^{N-k-1}(Y_t-\overline{Y})(Y_{t+k}-\overline{Y})}{\sum_{t=0}^{N-1}(Y_t-\overline{Y})^2} \qquad (15)$$

Where *N* represents the length of the TS and $\bar{Y}$is the expected value from the observations, calculated for the time variation (*delay*) *k*. The autocorrelation coefficient (ρ) of a TS varies between –1 and 1.

The partial autocorrelation function (PACF) represents the correlation between $Y_t$and Y_{t-k}as a function of the lag *k*, filtering the effect of the other lags on $Y_t$and Y_{t-k}. The partial autocorrelation function is defined as the sequence of correlations between (Y_t and Y_{t-1}), (Y_t and Y_{t-2}), (Y_t and Y_{t-3}) and so on, because the effects of prior lag on *t* remain constant. The PACF is calculated as the coefficient value φ_{kk} in the equation:

$$Y_t = \varphi_{k1} Y_{t-1} + \varphi_{k2} Y_{t-2} + \varphi_{k3} Y_{t-3} + \ldots + \varphi_{kk} Y_{t-k} + e_t \qquad (16)$$

3.2. Transfer Function Model

Transfer function model is different from ARIMA model. ARIMA model is univariate time series model, but transfer function is multivariate time series model. This means that ARIMA model relates the series only to its past. Besides the past series, transfer function model also relates the series to other time series. Transfer function models can be used to model single-output and multiple-output systems [5]. In the case of single-output model, only one equation is required to describe the system. It is referred to as a single-equation transfer function model. A multiple-output transfer function model is referred to as a multi-equation transfer function model or a simultaneous transfer function (STF) model [5].

Assume that $X_t$and Y_t are properly transformed series such that both are stationary. In a linear system with simple input and output, the series of X_t input and Y_t output are related through a linear filter as

$$Y_t = \nu(B) X_t + N_t \qquad (17)$$

Where $\nu(B) = \sum_{-\infty}^{\infty} \nu_j B^j$ is referred to as a filter transfer function by Box and Jenkins and N_t is a noise series of the system that is independent of the input series X_t

The coefficients in the transfer function model (17) are often called the impulse response weights.

The objective of modeling the transfer function is to identify and estimate the transfer function $\nu(B)$ and the noise model for $\boldsymbol{N_t}$ based on the information available for the input series X_t and the output series Y_t. The greatest difficulty is that information regarding $X_t$andY_t is finite, and the transfer function in (17) contains an infinite number of coefficients. To alleviate this difficulty, the transfer function $\nu(B)$ is shown in the following rational form: [5]

$$\nu(B) = \frac{w_s(B)B^b}{\delta_r(B)} \qquad (18)$$

Where$w_s(B) = W_0 - W_1 B - \ldots - W B^s$, $\delta_r(B) = 1 - \delta_1 B - \ldots - \delta_r B^r$, and b is a lag parameter that represents the delay that elapses before the impulse of the input variable produces an effect on the output variable. For a stable system, it is assumed that the roots of $\delta_r(B) = 0$ lie outside the unit circle [5]. After obtaining$w_s(B)$, $\delta_r(B)$ and b, the ν_j weights of the impulse response can be obtained by setting the coefficients of B^jon both sides of the equation equal to one another:

$$\delta_r(B)\,\nu(B) = w_s(B)\,B^b \qquad (19)$$

In practice, the values of *r* and *s* on the system (8) rarely exceed 2. Some transfer functions can be seen in [5]. These models may be used to identify the parameters of the transfer function. Analysis of these models show that the occurrence of peaks suggests parameters in the numerator of the transfer function, similar to models of moving averages, and the occurrence of an exponential decay behavior may indicate the existence of parameters in the denominator of the transfer function, similar to the autoregression models.

IV. GEOSTATISTICS

Geostatistics is used in the spatial interpolation and uncertainty quantification for variables that exhibit spatial continuity, i.e, can be measured at any point of the area / region / area under study. Using traditional statistical concepts as random variable (VA) cumulative distribution function (FDA), probability density function (PDF),expected value, variance, etc. These concepts can be found in statistical textbooks. In geostatistics, the VA, represented by $z(u)$, where u is the vector of coordinates of the location, is related to some location in space. In this case, the main statistics are set out below. The cumulative distribution function (FDA) gives the probability that the VA Z is less than or equal to a certain value z, generally called cutoff value(Chilès & Delfiner, 2012; Gooverts, 1984; Isaaks, 1990; Johnston et al., 2001; Pyrcz & Deutsch, 2014; Shiquan Sun et al., 2020; Tobler, 1989)[19-25]

4.1 Description of Spatial Patterns

In earth science is often important to know the pattern of dependence of one variable X over another Y. The joint distribution of results of a pair of random variables $X$and $Y$is characterized by the FDA joint (or bivariate) defined as:

$$F_{XY}(x,y) = prob\{X \leq x;\ Y \leq y\} \qquad (20)$$

estimated in practice the proportion of data pairs below the respective joint values (cutoff values) x and y. This can be shown in the scatter diagram (Fig. 1) in which each pair of data (x_i,y_i)is plotted as a point.

The degree of dependence between the two variables X and Y can be characterized by the dispersion around 45º in the scattergram. The great reliance ($X = Y$) matches all experimental pairs (x_i,y_i), i = 1,..., N plotted on the line 45º.

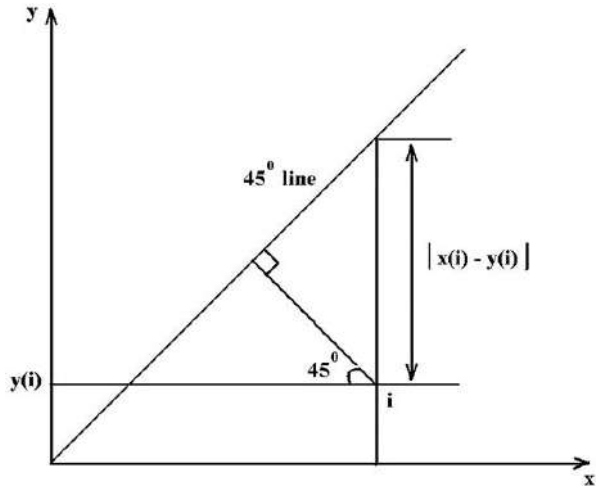

Fig. 1: Pair (x_i ,y_i) on a scattergram

The moment of inertia of the scattergram around the 45º line – called "semivariogram" for all pairs (x_i,y_i) – is defined as half the average of squared differences between the coordinates of each pair, i.e.:

$$\gamma_{XY} = \frac{1}{N}\sum_{i=1}^{N} d_i^2 = \frac{1}{2N}\sum_{i=1}^{N}(x_i - y_i)^2 \qquad (21)$$

The higher the value of the semivariogram, the greater dispersion and less closely related are the two variables X and Y.

In problems of spatial interpolation, where one want to infer (map) a certain area for a given property, $z(u), u \in$ area A, starting from a sample n of $z(u)$. The combination of all $n(h)$ pairs of data of$z(u)$, over the same area/zone/layer/population A with such pairs separated by approximately the same vector h (in length and direction), allows estimating the semivariogram characteristic (or experimental) of the spatial variability in A:

$$\gamma(h) = \frac{1}{2N(h)}\sum_{\alpha=1}^{N(h)}[z(u_\alpha) - z(u_\alpha + h)]^2 \qquad (22)$$

An experimental semivariogram (22) is an estimate of an integral discrete space defining a well determined on average$A$:

$$\gamma_A(h) = \frac{1}{A(h)}\int_A [z(u) - z(u+h)]^2\, du \quad \text{for } u,\ u+h \in A. \qquad (23)$$

Such as a VA $z(u)$ is and its distribution characterizes the uncertainty about the value of certain property located at u, a random function $z(u)$, $u \in A$, defined as a set of VA's dependent feature of joint spatial uncertainty about A. The semivariogram of this random function characterizes the degree of spatial dependence between two random variables $z(u)$ *and* $z(u+h)$ separated from the vector h.

For the modeling of the semivariogram conducted after building the experimental semivariogram, it is necessary that the hypothesis is considered stationary. This hypothesis states, in summary, that the first two moments (mean and variance) of the difference $[z(u) - z(u+h)]$ are independent of location u and function only for the vector h. The second moment of this difference corresponds to the semivariogram, i.e:

$$2\gamma(h) = E\{[z(u) - z(u+h)]^2\} \text{is independent to } u \in A. \qquad (24)$$

Developing the equation above (adding m^2 to all terms for convenience), one obtains:

$$2\gamma(h) = C(0) - C(h), \qquad (25)$$

and that:

$$Var\{Z(u)\} = Var\{Z(u+h) = \sigma^2 = C(0) \quad \text{for all} \quad u \in A. \qquad (26)$$

$Cov\{Z(u), \{Z(u+h) = C(h) \text{forall} u \in A$ (27)

The relation (25) is then utilized to determine the semivariographic model. The variance $C(0)$ is called in geostatistics a baseline (or sill). The semivariogram can be defined as the graph of the semivariance function versus distance$h$,is a technique used to measure the dependence between sample points, distributed according to a spatial reference and for interpolation of values required for the construction of isoline maps [19]. According to Christakos(Christakos, 1984)[26], is the preferred tool for statistical inference because it offers some advantages over the covariance, including:

i) Its empirical calculation is subject to minor errors;

ii) Provides a better characterization of the spatial variability;

iii) Requires the called intrinsic stationarity assumption, i.e. that $z(u)$ is a random function with stationary increments $z(u+h) - z(u)$, but not necessarily itself stationary.

The semivariogram is the preferred tool for statistical inference because it offers some advantages over the covariance [19]. For a continuous function is selected a semivariogram necessary to satisfy the property of positive definite. In practice are used linear combinations in basic models that are valid, i.e., permissible. One of the most used basic models in geostatistics is the spherical model, given
by:

$$\gamma_{(h)} \begin{cases} 0, & |h| = 0 \\ C\left[\frac{3}{2}\left(\frac{|h|}{a}\right) - \frac{1}{2}\left(\frac{|h|}{a}\right)^3\right] & 0 < |h| \le a \\ C & |h| > a \end{cases} \quad (28)$$

The components C $anda$ are denominated the level and range, respectively. The level, also known as "sill" represents the variability of the semivariogram to its stabilization. The range (or variogram range) and the distance are observed up to the level where the variability stabilizes. Indicates the distance in which the samples are spatially correlated (Fig. 2).

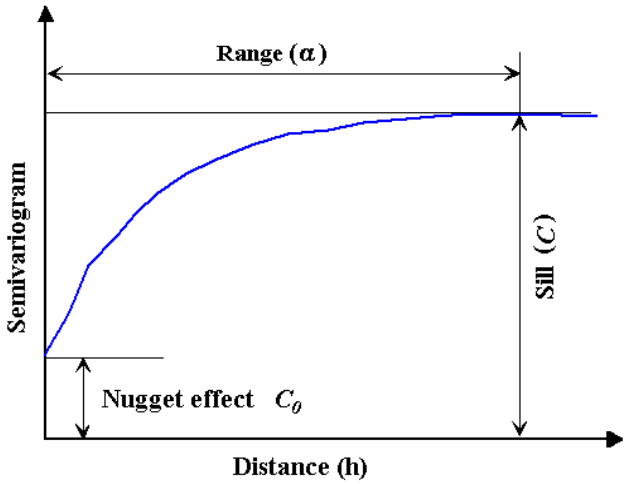

Fig. 2: Parameters of the semivariogram

4.3 Ordinary Kriging

Kriging is a interpolation technique in which the surrounding measured values are weighted to derive a predicted value for an unmeasured location. Weights are based on the distance between the measured points, the prediction locations, and the overall spatial arrangement among the measured points. Kriging is based on regionalized variable theory, which assumes that the spatial variation in the data being modeled is homogeneous across the surface. Ordinary Kriging (OK) considers the local variation of the mean limited to the domain of stationary of the average local neighborhood $W(u)$ centered on the location u to be estimated [24-25]. In this case, one considers the common average (stationary) $m(u)$ in equation 43, e.i.:

$$Z^*(u) = \sum_{\alpha=1}^{n(u)}[\lambda_\alpha(u) z(u_\alpha) + \left[1 - \sum_{\alpha=1}^{n(u)}[\lambda_\alpha(u)\right] m(u) \quad (29)$$

The mean $m(u)$ unknown can be eliminated by considering the sum of the weights$\lambda_\alpha(u)$ of kriging equal to 1. This mode:

$$Z^*_{KO*}(u) = \sum_{\alpha=1}^{n(u)}[\lambda_\alpha^{KO}(u) z(u_\alpha), \text{with} \quad \sum_{\alpha=1}^{n(u)}[\lambda_\alpha^{KO}(u) = 1 \quad (30)$$

The minimization of the error variance ($Var[Z^*(u) - Z(u)]$) under the condition $\sum_{\alpha=1}^{n(u)}[\lambda_\alpha^{KO}(u) = 1$, allows to determine the weights λ_α from the following system of equations called ordinary kriging system (normal equations with constraints):

$$\begin{cases} \sum_{\beta-1}^{n} \lambda_\beta^{KO}(u) C(u_\beta - u_\alpha) + \mu(u) = C(u - u_\alpha) \\ \sum_{\beta-1}^{n} \lambda_\beta^{KO}(u) = 1 \qquad\qquad \alpha = 1, \ldots . n \end{cases} \quad (31)$$

where $C(u_\beta - u_\alpha)$ and $C(u - u_\alpha)$ are, respectively, the covariance between the points $u_\beta$and u_α, u and $u_\alpha . \mu_u$is

the Lagrange parameter associated with the restriction: $\sum_{\beta-1}^{n} \lambda_{\beta}^{KO}(u) = 1$.

The kriging system (31) presents only one solution if:

i) The covariance function $C(h)$ is positive-definite, i.e.:

$$Var\{\sum_{\alpha=1}^{N} \lambda_{\alpha} z(u_{\alpha})\} = \sum_{\alpha=1}^{N} \sum_{\beta=1}^{N} \lambda_{\alpha}\lambda_{\beta} C(u_{\alpha} - u_{\beta}) \geq 0 \quad (32)$$

ii) There are not two completely redundant data, i.e, $u_{\alpha} \neq u_{\beta}$ if $\alpha \neq \beta$.

The corresponding minimum variance of the error, called the kriging variance is given by:

$$\sigma_{KO}^2 = Var[Z(u) - Z^*(u)] = C_0 - \sum_{\varepsilon=1}^{n(u)} \lambda_{\alpha} C(u_{\beta} - u_{\alpha}) - \mu(u) \quad (33)$$

where $C_0 = Var\{Z(u)\} = \sigma^2$.

Substituting the expression for its covariance $C(h) = C_0 - \gamma(h)$, the system (31) and the variance σ_{KO}^2 can be written as a function of the semivariographic model$\gamma(h)$.

Therefore, unlike the more traditional linear estimators, kriging uses a system of weights that considers a specific model of spatial correlation, variable to the area A under study. Kriging provides not only a least squares estimate of the variable being studied, but also the variance error associated(D. Istok & A. Rautman, 1996) [27].

V. MATERIALS AND METHODS

5.1 Database

A local telecommunications company provided technical characteristics of broadcast stations and the received signal of the routes described. This area is the urban center of Belém/PA. The acquisition of vertical and tested measures of the buildings and homes, totaling approximately 4500 points (between residents and buildings) was done by AUTOCADMAP and ORTOFOTO obtained with a plant scanned from**the Company for Metropolitan Development and Administration of Belém - CODEM.** Belém, capital of the state of Pará, belonging to the Metropolitan Mesoregion of Belém with an area of approximately 1 064,918 km², located in northern Brazil, with latitude -01° 27' 21" and longitude of -48° 30' 16", altitude of 10 meters and distance 2 146 Km of Brasília. Is known as "Metropolis of the Amazon", and one of the ten busiest and most attractive of Brazil. The city of Belem is considered the biggest of the equator line, is also classified as a capital with the best quality of life in Northern Brazil.Fig.3 shows the routes used in the measurement campaign.

Fig. 3: Sampling points for power measurement in the study area [5]

5.2 Methodology

5.2.1 Analysis in Time Series

For the statistical analysis of received power along the pathways under study, was used time series model with the use of transfer function for modeling multivariate data sets of received power primarily along the eleven previously mentioned pathways, considering as the response variable and the received power variable distance between the transmitter and receiver, the distance between the height of buildings and buildings as covariates. All analyzes were performed using programs developed with the routines of the statistical soft SAS(*SAS/ETS 9.1 User's Guide*, 2004) [28], which through the subroutine proc arima held the adjustment of ARIMA models. This adjustment, which is performed iteratively, consists of three steps. The first is the identification of the model, where the observed data is transformed into a stationary series. The second step is to estimate the model in which the orders p and q are selected, and the corresponding parameters estimated. The third step is the prediction, in which the estimated model is used to predict future values of the time series considered.

The Figs. 4 to 6 present the graphs of the series which will be analyzed with data collected in eleven ways of the measuring campaign.

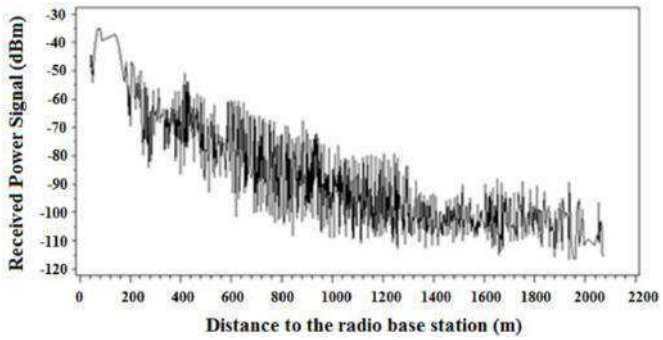

Fig 4: Receivedpowersignal (dBm)

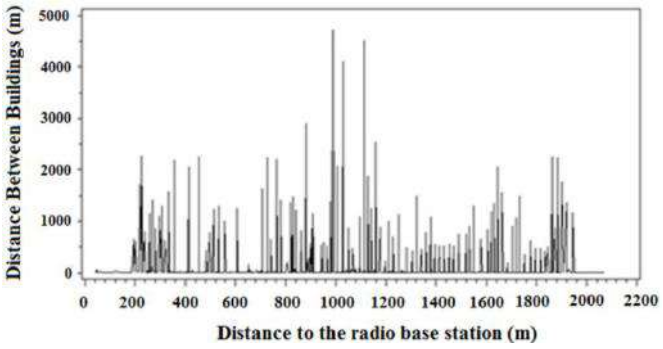

Fig 5: Distance between buildings (m)

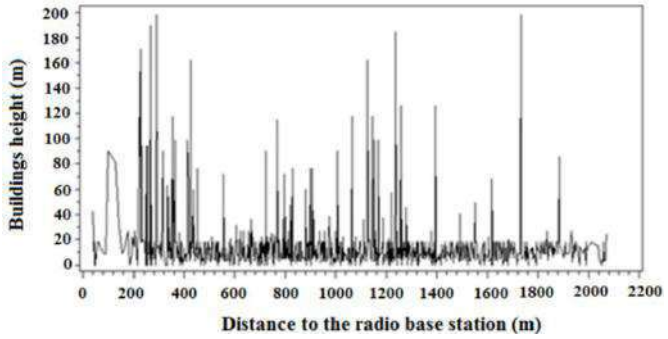

Fig: 6: Height of the buildings (m)

5.2.1.1. Adjustment of Univariate Models for the Explanatory Variables - Identification of Time Series

This phase consists in determining which process generating the series, which filters (ARIMA models) and their orders. The completion of the identification process, in addition to graphical analysis, needs in general the interpretations of the autocorrelation function and partial autocorrelation function. In this study, the identification of each series was conducted using the soft SAS. For the series received power was applied a difference to make it stationary. In all cases, the estimated parameters were significant autocorrelation and residues had no significant, a sign acceptable fit as shown in Table 1. As of now the response variable of received power will be denoted by Y_d and the explanatory variables distance between buildings and height of buildings by X_{1d}andX_{2d}, respectively.

From the analysis of the autocorrelations and partial autocorrelations preliminary models were adjusted for the series (p indicates the significance of the estimate); the results are shown in Table 2. In all cases, the estimated parameters were significant autocorrelations and residuals showed no significant signal adjustment acceptable for the model.

Table 1: ARIMA model adjusted to the series input.

Series (variable)	χ^2	$P_r > \chi^2$	Cross correlations					
Y_d	5.18	0.3946	-	-0.015	-0.038	-0.006	0.018	0.041
	8.37	0.6796		0.013	-0.026	-0.040	-0.023	0.015
X_{1d}	9.47	0.0916	-	-0.029	0.009	-0.045	-0.029	0.054
	13.07	0.2888		-0.017	0.046	0.004	-0.024	0.025
X_{2d}	3.13	0.9995		0.003	0.019	-0.028	-0.017	-0.044
	7.38	0.2868		0.035	-0.006	0.003	0.006	-0.002

Table 2: ARIMA model adjusted to the series input.

Series (variable)	Adjusted Model	Model
Y_d	$Y_d = Y_{d-1} - \underset{p<0,0001}{0,91}\ a_{1d-1} + a_{1d}$	Arima(0,1,1)
X_{1d}	$X_{1d} = \underset{p<0,0001}{128,58} + \underset{p<0,0151}{0,077}\ X_{1d-7} + a_{2d}$	Arima(1,0,0)
X_{2d}	$X_{2d} = \underset{p<0,001}{14,870} + \underset{p<0,0171}{0,076}\ X_{2d-2} - \underset{p<0,034}{0,068}\ X_{2d-9} - \underset{p<0,0109}{0,081}\ X_{2d-11} - \underset{p<0,047}{0,063}\ X_{2d-12} - \underset{p<0,045}{0,064}\ X_{2d-14} - \underset{p<0,038}{0,066}\ X_{2d-15} + a_{3d}$	Arima(6,0,0)

Where *d*: is the distance index, Y_d,X_{1d} and X_{2d} are the variables; a_{1d},a_{2d} and a_{3d} are random errors, p is p-value.

To identify the model transfer function suitable for a data set, one must consider the graph of the cross-correlation function sample. For the cross-correlation function be meaningful, the series of input and response should be pre-filtered.

For pre-filtering the series of input and response appropriate to analyze the correlation, the procedure is as follows:

1. Adjusting an ARIMA model to the series input so that the model residuals are white noise;
2. Filter the host response to the same template used to input the serial:;
3. Making the cross-correlation of the series of filtered response to the filtered input string to determine the relationship between the series;
4. Interpret the cross-correlation graph in the same way a graph of the autocorrelation function. Indicators autoregressive *s* terms indicate the denominator and indicators moving averages indicate terms of the numerator.

The graph of cross correlation pre-filtered with a transfer function numerator terms q and p in accordance with the denominator shows the same pattern after *slags*, such as the graph of the autocorrelation function of an ARMA process (p,q). This is the key to identify the transfer function. Such behavior is not guaranteed without pre-filtering, however. The ARIMA procedure automatically makes the pre-filtering when including the appropriate declarations in code soft SAS [28].

The adjusted model for the received signal power (Y_d) includes explanatory variables X_{1d} (Distance between buildings) and X_{2d}(Height of building) and, according to

the analysis of cross correlations and after a few attempts, the following transfer function model was specified:

$$Y_d = \frac{w_0 + w_2 B^2}{(1-\delta_1 B - \delta_9 B^9)} X_{1d} + \frac{w_0}{(1+\delta_1 B)} X_{2d-1} + N_d \quad (34)$$

The Tables 3 and 4 show estimates of the model parameters of the transfer function obtained through a program of soft SAS and residual analysis for the model obtained, respectively. It is observed that statistics of cross-correlations with the waste input variable were not significant, i.e, the model transfer function provides a proper fit to the data. All parameters showed significant estimates, but the check of residual autocorrelations shows significant value in *lag* 1 (in bold) as shown in Table 4, this indicates that the residuals of this preliminary model are not white noises. That is, it is necessary to estimate parameters for the error process (N_d) for this model.

Table 3: Estimates and statistics of transfer function model obtained by iterative (SAS)

Parameter	Estimate	t value	$P_r > \|t\|$	Lag	Variable
Numerator 1	-	-8.08	<.0001	0	X_{1d}
Numerator (1,1)	-	-2.61	0.0090	2	X_{1d}
Denominator (1,1)	-0.77979	-7.52	<.0001	1	X_{1d}
Denominator (1,2)	0.12130	2.69	0.0071	9	X_{1d}
Numerator 2	0.02997	2.51	0.0121	0	X_{2d}
Denominator (2,1)	-0.78529	-6.20	<.0001	1	X_{2d}

Table 4: Residual analysis for the model

Until the	χ^2	$P_r > \chi^2$	Cross correlations					
6	240.31	<.0001	**-0.498**	0.006	-0.024	0.003	0.014	0.028
12	245.96	<.0001	-0.046	0.029	0.012	-0.048	0.020	0.007
18	248.38	<.0001	0.009	-0.006	-0.025	0.034	-0.016	0.017
24	264.80	<.0001	0.027	-0.044	-0.028	0.067	-0.063	0.068

The equation of the model in notation B of a delay operator can be written as:

$$Y_d = \frac{-0.0055 + 0.00287B^2}{(1 + 0.7799B - 0.1213B^9)} X_{1d} - \frac{0.0299}{(1 + 0.78529B)} X_{2d-1} + N_d \quad (35)$$

The Figs. 7 and 8 show the autocorrelation function (ACF) and a Partial autocorrelation function (PACF) for the residuals. It is clearly observed a high correlation value for *lag* 1 in Fig. 7, evidencing a high correlation between the residuals. This residual analysis can indicate possible missing terms in the model.

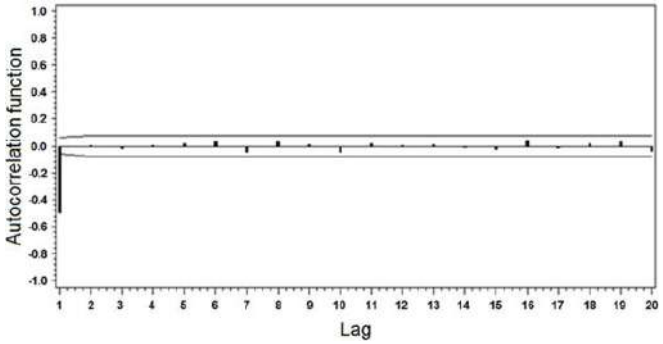

Fig. 7: Analysis for autocorrelation functions (ACF) of residuals (N_d)

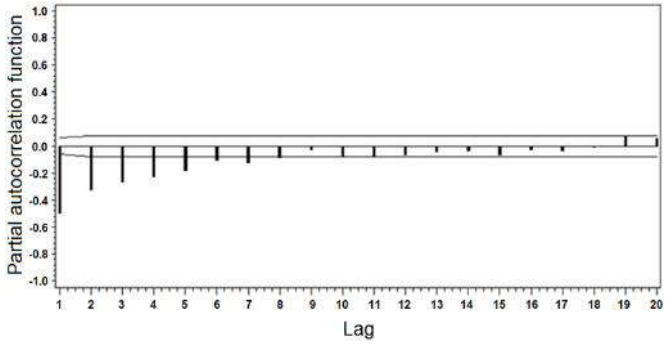

Fig: 8: Analysis for partial autocorrelation functions (PACF) of residuals (N_d)

5.2.2. Geostatistical analysis

In the previous section, we estimated a model in time series with transfer function models in which the residues (N_d) these models are not white noise.

Note that the adjusted model was considered only the macro-localized features existing in the data of the residue of the received signal power, calculated by the time series model, it is not yet taken into account the influence that the data have on its neighbors, the small spatial scale. In other words, the residuals of this model are still present in two components: *ε'(x)+ε"*, is only ε" is distributed independently. In this case, the estimated residuals may still be contaminated by the effect of spatial dependence on small spatial scale.(Fischer & Nijkamp, 1992) [29].

5.2.2.1. Spatial Autocorrelation Diagnosis

One of the ways to diagnose the presence of spatial effects in the data of the residue of the time series model is previously calculated by graphical analysis of the experimental semivariogram. The spatial inference is performed by kriging process which is based on the Regionalized Variable Theory (RVT). This theory identifies the spatial distribution of a variable is expressed by the sum of three components: one structural component having a constant mean or trend; one spatially correlated random component, also called regionalized variation; one spatially uncorrelated random component (residual error).

The analysis of spatial variability of residuals in time series models, calculated by the equation, is carried out with the aid of a semivariogram. This is one of the most important steps of the geostatistical analysis, because the semivariogram model chosen represents the spatial correlation structure to be used in inferential procedures of kriging. The results presented in Fig. 9 shows the omnidirectional semivariogram (isotropic case) and its adjustment model.

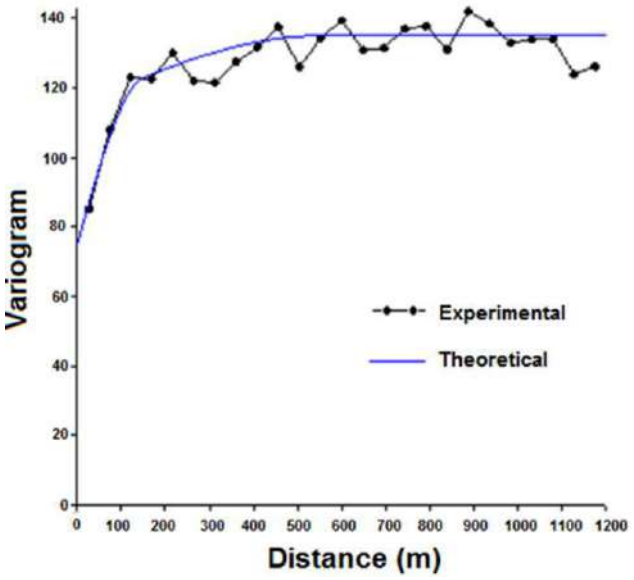

Fig 9: Experimental variogram and theoretical of residues

Whose parameters are the equation 36, is the nested type (double spherical), that is, a combination of two spherical models.

$$\gamma(h) = 75 + 40\left(\frac{150}{2h} - 1{,}5\left(\frac{150}{h}\right)^3\right) + 20\left(\frac{500}{2h} - 1{,}5\left(\frac{500}{h}\right)^3\right) \quad (36)$$

where:

a_1 = 150 *and*C_1 = 40 correspond to the range of parameters and input, respectively, of the first spherical model ($\gamma_{1(h)}$).

a_2 =20 andC_2 = 500 correspond to the range of parameters and input, respectively, of the second spherical model ($\gamma_{2(h)}$).

Based on the structure defined as nested semivariogram (double spherical was performed a spatial inference spatial the kriging process, obtaining the map of the spatial distribution of power received through the program SURFER(Al-sudani, 2019; Bresnahan & Dickenson, n.d.) [30-31].

With equation 50 establishes the geostatistical modeling of residual (N_d) acquired by the time series model (equation 35). The model establishing calculating of the received power in the searched area is given by:

$$Y_d = 75 + \frac{-0{,}0055 + 0{,}00287B^2}{(1 + 0{,}7799B - 0{,}1213B^9)}X_{1d} - \frac{0{,}0299}{(1 + 0{,}78529B)}X_{2d-1} + 40\left(\frac{150}{2h} - 1{,}5\left(\frac{150}{h}\right)^3\right) + 20\left(\frac{500}{2h} - 1{,}5\left(\frac{500}{h}\right)^3\right) + e_d \quad (37)$$

where h is given in meters,

e_d: random error.

Analyzing autocorrelation functions and partial autocorrelation of the residues model found (equation 37) of Figs. 10 and 11. One can notice a substantial decrease in the residual autocorrelation (e_d) when compared to the residues obtained from the time series model (equation 35). Note that there is a significant decrease in the value of the autocorrelation for *lag* 1 (Fig. 10) when compared with Fig. 8. Since non of the *lags* present significant *spike*, soon can be stated that the number of residues of the simulated model is stationary (e_d is a white noise).

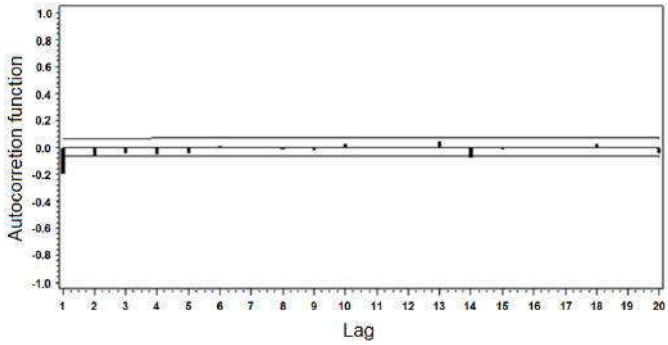

Fig 10:Analysis for autocorrelation functions (ACF) of residuals(N_d)

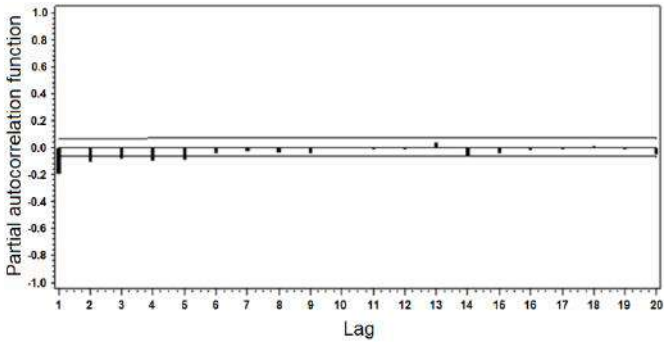

Fig 11:Analysis for partial autocorrelation functions (PACF) of residuals (N_d)

5.2.2.2. Spatial Inference with Kriging

Using the parameters of the semivariogram was held to spatial inference through the process of kriging, obtaining the spatial distribution map of the received signal power (dBm) (simulated model – equation 37) shown in Fig.12. Fig.13 shows the spatial distribution of color levels which provides information on the pattern of distribution of the received power (dBm) obtained in the measurement campaign. One can observe the potential of the methodology adopted, when comparing the maps indicate the spatial distribution of the received power (dBm) by the receiving unit.

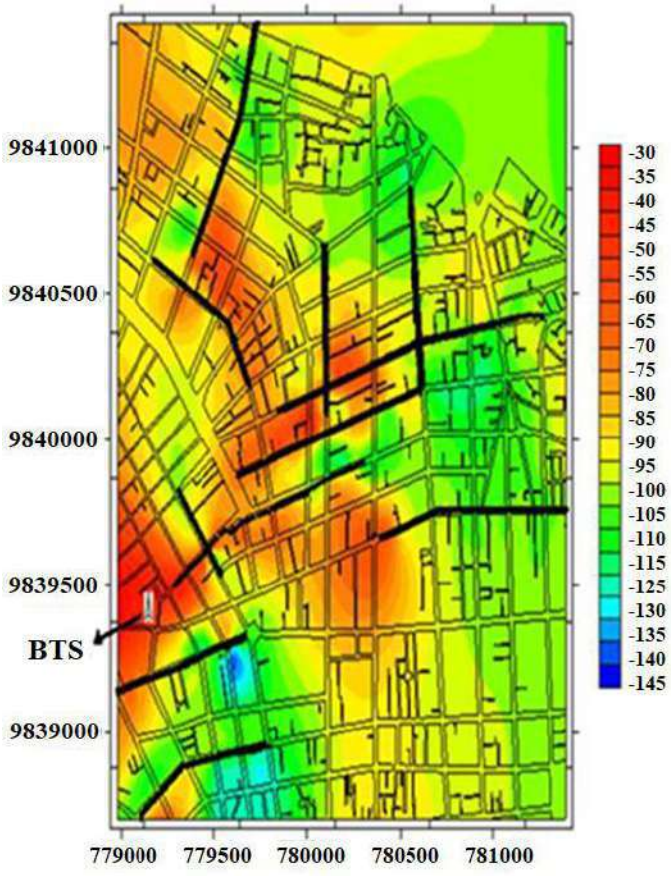

Fig 12: Spatial distribution map of received power (dBm) for Model simulated

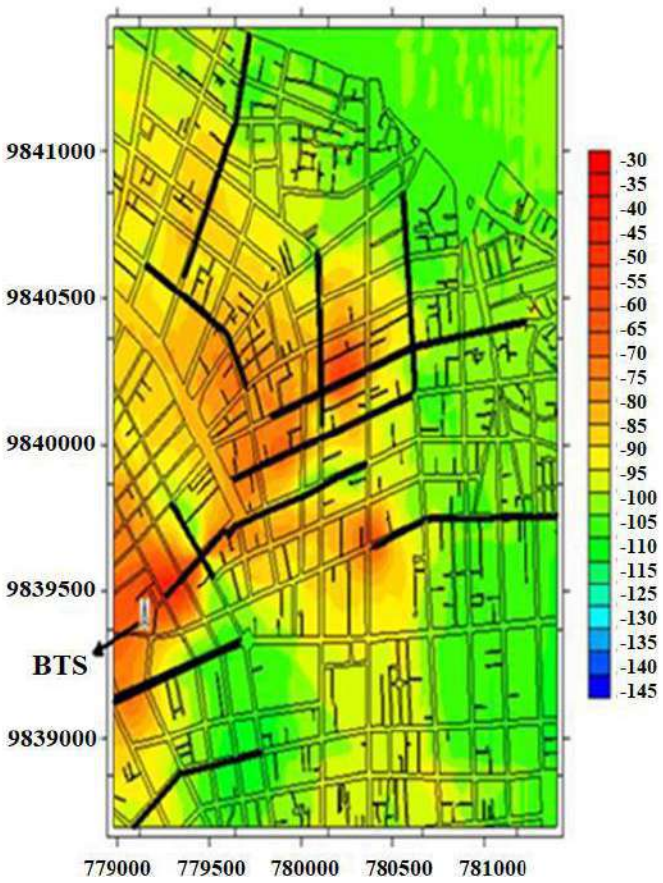

Fig 13:Spatialdistributionmapofreceivedpower (dBm) for measurementcampaign

Note that the kriging shown in Fig. 12 and 13, where one can observe the areas with greater or lesser value of receipt of received power, according to the gradient of colors that allows visual analysis faster and simpler of the study area. Note that there is some agreement between the profile displayed by the maps obtained with the predicted values with the simulated model (Fig. 12) and field data (Fig. 13).

The spatial distribution of values shows the regions marked in red as higher levels of received power (dBm). The regions in green and blue are areas with lower signal intensity. As might be expected, it is observed higher levels of power to the vicinity of the base station and other areasnot far from the BTS.

Note also that much of the region that has a low levelsignal is located at great distances from BTS, however, in the lower left corner of the maps (which are located AvenidasNazaré and Gentil Bittencourt), there is a region of low signal intensity, which can be explained by the higher incidence of heights of buildings and also with tunnels formed by mango trees present on these two pathways.

Fig. 14 the graph shows the response for the model and observed values of the response variable power received through simulated time series models with error correction using a geostatistical model. The confidence intervals of 95% are indicated by the yellow shaded area.

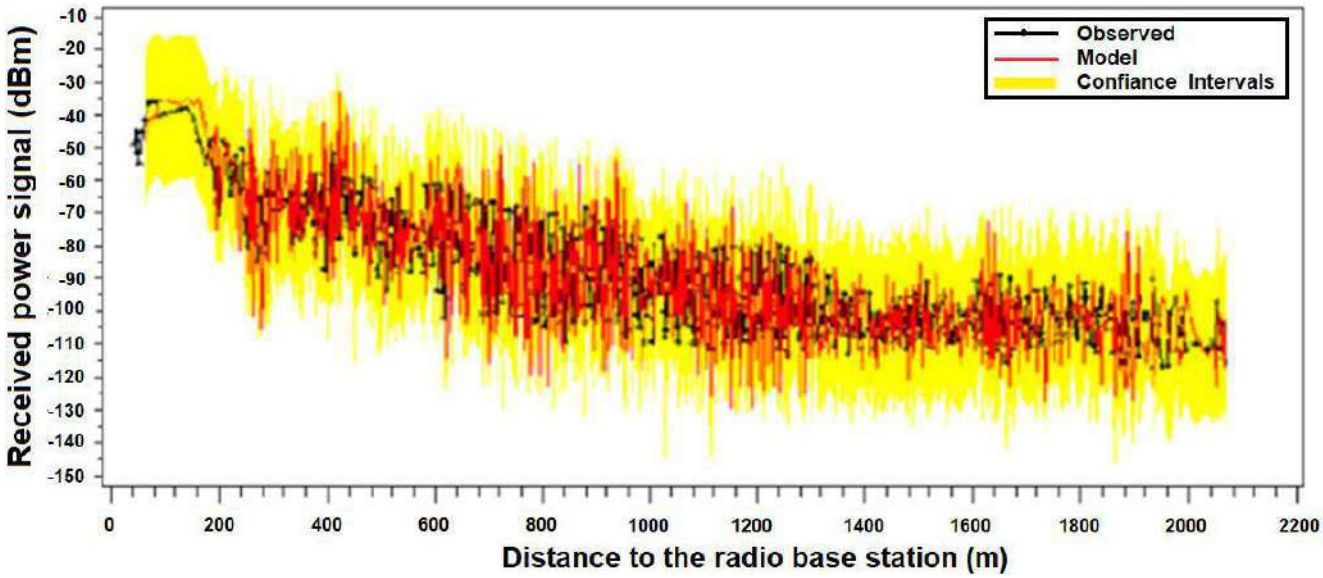

Fig 14:Power of the signal received by the mobile station and estimated by theoretical models and simulated

VI. COMPARATIVE ANALYSIS OF THE RESULTS

After conducting the comparative analysis of the results obtained in measurements with the prediction of theoretical models of Ikegami-Walfisch, Ibrahim-Parsons and Okumura-Hata and the simulated model. The theoretical models consider when calculating the signal attenuation parameters such as height of the transmitting antennas of receptor, types of cities, the average height of the buildings, width of streets, operating frequency and types of urbanization (rural suburban and urban), and the dependence on the distance.

The parameters used in the analysis of models had the following values: The receiving antenna height: $h_r = 15\,m$; the receiving antenna height: $h_t = 35\,m$; the operating frequency: $f = 877.44$ MHz and average width of the street: $W = 22\,m$.

For the qualitative analysis of the measures with forecasts. In Figure 15 we present the experimental results and theoretical simulations performed by the models of Ibrahim-Parsons and Okumura-Hataand the response of the

simulated model time series with error correction developed in this work, to eleven routes from the center of the city of Belém/PA. Table 5 presents the values of the mean square error, the mean and standard deviation.

Table 5: Comparison between the three theoretical models and the measured value for the pathways involved in the measurement campaign

	Mean Squared	**Mean (dBm)**	**Standard Deviation**
Measured	-	-89.7875	15.7682
Proposed	0.33	-89.6232	18.0632
Ikegami-	39.79	-	9.6217
Ibrahim-	13.26	-79.8502	11.0363
Okumura-Hata	16.56	-76.2557	8.8080

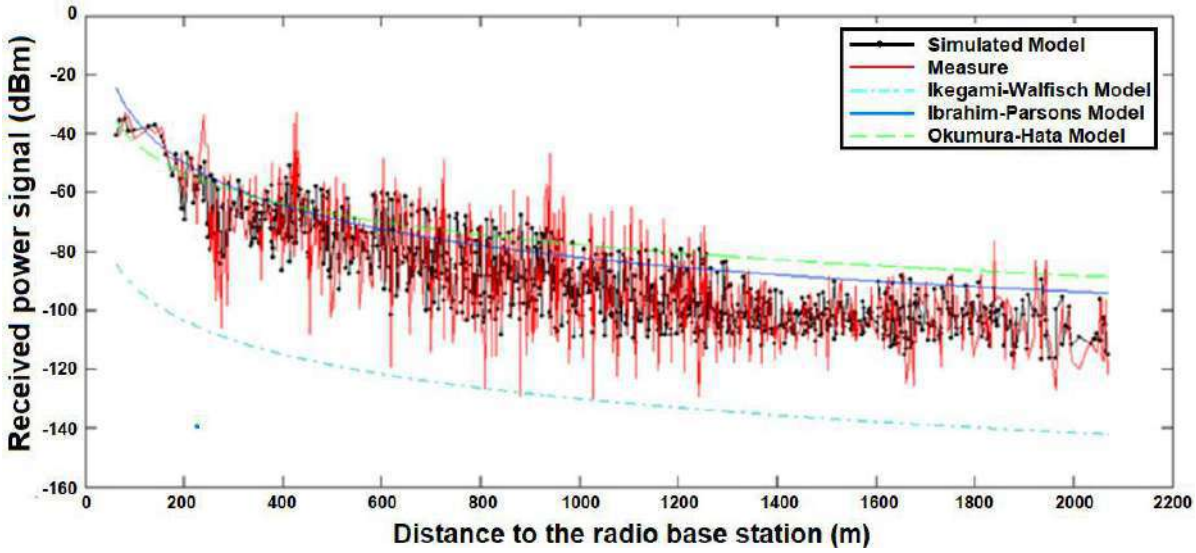

Fig. 15: Power of the signal received by the mobile station and estimated by theoretical models and simulated

Observing Table 5, it is found that, among the models given above, what best describes the signal in the study area is the simulated model developed in series with error correction using geostatistics, which presented an root mean square error 0.33 dB and the standard deviation 18.0632. However, between theoretical models, which is closer to the measurements of the model of Ibrahim-Parsons which showed a root mean square error of 13:26 dB and the standard deviation 11.0363. The model of Okumura-Hata presented the worst results.

In order to make a study of the performance of the proposed model, in order to check its validity, analysis was performed using data collected in another way of measuring campaign (RuaConselheiro Furtado), which was not part of the data processing for obtaining the coefficients entered into the equation (37). Table 6 shows the results of experimental simulations performed by the theoretical model of Ikegami-Walfisch, Ibrahim-Parsons and Okumura-Hataand the response of the simulated model obtained for the RuaConselheiro Furtado.Fig. 16 shows the comparative graph of received signal strength versus distance from the base station to RuaConselheiro Furtado.

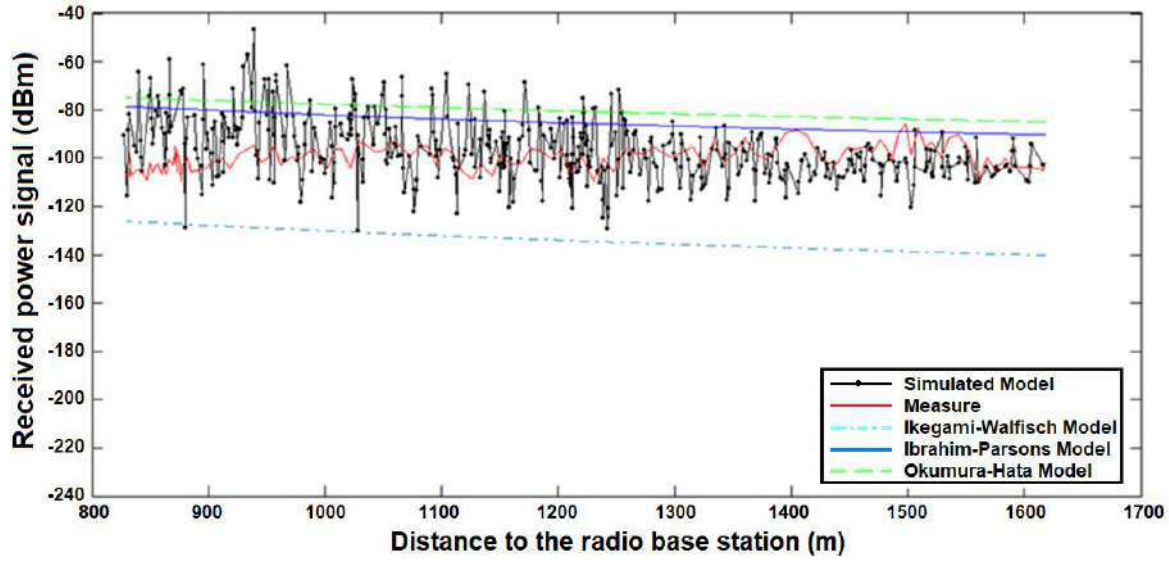

Fig 16: Power ofthesignalreceivedbythe mobile stationandestimatedbytheoretical models andsimulated for Rua Conselheiro Furtado.

Table 6: Comparison between the results obtained for the three theoretical models, simulated model and the measured value for RuaConselheiro Furtado

	Mean Squared	Mean (dBm)	Standard Deviation
Measured	-	-99.4415	9.0356
Proposed	9.04	-	12.8125
Ikegami-	37.73	-	3.8444
Ibrahim-	14.24	-	3.1487
Okumura-Hata	18.40	-	2.7320

VII. CONCLUSIONS

In this work was presented a time series model with error-correlation through geostatic, which consist a forecast of received power along the eleven pathways localized in the urban center of the city of Belém/PA. There has been shown a study of possible relationships existing between the received power signal, the height of buildings, and also the distance between the buildings. Transfer function models have been used for assessment of the received power signal in time series. As the models of classical statistical ignore the possible correlations between neighboring samples, not exploring in a satisfactory manner, the relationships that may exist between the sampling units. The error correction model time series was performed using a geostatistical model that considered the georeferencing data, which allowed the identification of these interaction effects in the same space, using kriging process.

The proposed model showed a good result with mean square error in the order 0.33 dB compared to the measured signal, considering the data of the eleven ways of the measurement campaign; while for models of Ibrahim Parsons and Okumura-Hata this error was around 13:26 and 16:56 dB, respectively.

The results show that the adjusted models retained the same characteristics of the original signal. Moreover, this methodology allows for individualized assessment of all points in the region considered, from the knowledge of their geographical coordinates, and not only the demonstration of generic values as occurs in traditional preparation of propagation models Thus, we obtained estimates of statistics, graphs and maps of dispersion and surface to describe the behavior of spatially variable received signal strength (dBm) in the center of the city of Belém/Pa.

Therefore, the study conducted through statistical analysis in time series with transfer function models and the study of spatial variability of the variables of interest allowed the construction of a model that allowed us to identify by the spatial plant the measurements of received power (dBm) and the gradient of the lines of iso-values, the vectors for better signal reception issued by BTS, identifying homogeneous areas, as well as those where users are harmed or benefited from the service of the local operator.

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Nursing care for patients with laryngeal cancer: An Integrative Review

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Keywords*— *Laryngeal cancer. Nursing care. Oncology.

***Abstract*—** *Objective: The objective of this research is to map scientific evidence on nursing care for patients with laryngeal cancer.Method:This is an Integrative Literature Review, in which seven articles published between 2007 and 2017 were analyzed. For data analysis, the content analysis technique was used.Results: The findings were categorized into 1) Laryngeal cancer prevention - new perspectives and challenges for nursing; 2) Nursing care for patients with laryngeal cancer; 3) Nursing interventions in the communication of laryngectomized patients; 4) Nursing care with pre and postoperative laryngectomy and prevention of pharyngocutaneous fistulas. Preventive, curative and palliative actions are highlighted, through assessments and dressings of the surgical wound, removal of necrotic tissue, care with tubes, late oral feeding to reduce fistula formation and postoperative care, in order to avoid complications and thus reduce the risk of infections, length of stay, hospital expenses and*

improved quality of life, among other precautions. Conclusion:Preventive actions based on the epidemiological profile of illness are essential to reduce the number of cases and deaths, as well as the early diagnosis of laryngeal cancer. Nursing monitors the entire process from diagnosis, hospital stay, submission to treatments and after all that, rehabilitation and readaptation to a new condition.

I. INTRODUCTION

Cancer is a set of diseases with genetic alterations and epigenetic regulatory mechanisms that result in a malignant phenotype with autonomous proliferation and high molecular heterogeneity, which affects its difficult management. [1] Laryngeal cancer is one of the most frequent diagnostic types to affect head and neck structures, representing approximately 25% of malignant neoplasms that affect this region and 2% of all tumors. Head and neck neoplasms include tumors that affect the nasal cavity, sinuses, mouth, larynx and pharynx. [2]

For Brazil, it is estimated 6,470 new cases of laryngeal cancer in men and 1,180 in women for the year 2020. The estimated risk will be 6.20 cases per 100,000 men, occupying the eighth position; and the 16th most frequent with 1.06 cases per 100,000 women. In Brazil, in 2019, there were 3,985 deaths from laryngeal cancer in men and 547 in women. [3]

The larynx is responsible for three important functions of the human body: swallowing, breathing and phonation, it is divided into three anatomical regions: supraglottis, glottis and subglottis. Treatments for patients with laryngeal cancer can have a great impact and change their quality of life. Therefore, it is necessary to have knowledge for an evidence-based practice, with a humanized scientific foundation, which aims not only at the cure, but also to achieve the complete well-being of the assisted individual. [4]

Although surgery has been the historical basis for localized disease and is still an integral part of the treatment, non-surgical options such as radiotherapy and systemic therapy emerged as viable options, therefore, the action of the nurse in a preventive way, which helps in all treatment and rehabilitation to improve the quality of life. [5]

Thus, this study aims to map scientific evidence on nursing care for patients with laryngeal cancer.

II. METHOD

This is an integrative literature review (RIL), in which the studies were analyzed using descriptive statistics. Articles published between 2007 and 2017, in journals indexed in the LILACS, SCIELO, PubMed and Cochrane databases, available in full, were included in this study.

For the selection of articles, the terms applied according to the Health Sciences Descriptors (DECS) were used: “laryngeal neoplasm”, “oncology”, “nursing care” and “palliative care”, combined through the “AND” operator.

In addition, the following inclusion criteria were used: articles fully available in Portuguese, Spanish and English, whose research target was the pathology of laryngeal cancer. The following were considered as exclusion criteria: articles that contained more pathologies than laryngeal cancer in their content, citations, records or allusions to any predisposing or clinical factor of laryngeal cancer, course conclusion papers, master's dissertations or abstracts in proceedings.

For data analysis, only studies that were related to the proposed theme were evaluated and selected. Initially, 37 studies were identified, but after reading the abstracts, applying the inclusion and exclusion criteria, seven studies were effectively analyzed for referring in the results to the theme of nursing care for patients with laryngeal cancer.

The Content Analysis technique was used, which encompasses several research techniques that make it possible to describe the content related to the research context through a systematic process, which enables the inference on the collected data.[6]

Therefore, the six steps indicated for the constitution of the integrative literature review were adopted: 1) selection of the research question; 2) definition of study inclusion criteria and sample selection; 3) representation of selected studies in table format, considering all common characteristics; 4) critical analysis of findings, identifying differences and conflicts; 5) interpretation of results and 6) clearly report the evidence found. [6]

III. RESULTS AND DISCUSSION

In this narrative review, 07 original scientific articles were selected that strictly met the previously established sample selection and showed similarities with the object of this study, as shown in table 1:

Table 1: Distribution of studies.

Study	Authors	Title of the article, journal and year of publication	Drawing of the study	Objective	Results Main
1	Santos MCM, Raimundo DD, Soares E,Guedes MTS	Nursing care for patients with laryngeal cancer from the perspective of comprehensiveness: the approach of nurses at INCA. Rev. Cuidado efundamental.2015.	Analysis of medical record data	Demonstrate the importance of the concept of Extended Clinic in the health-disease process, from the experience of the professional of Nursing with laryngeal cancer patients.	The importance of the Extended Clinic as a philosophy and tool for working processes in health if back to the production of client-centered care.
2	Santana ME, Sawada NO.	Pharyngocutaneous fistula in cancer patient: implications for Nursing. Rev Latino-am Enfermagem. 2008.	Literature review	Identify the main treatments for pharyngocutaneous fistula after total laryngectomy.	The results showed that the treatment for pharyngocutaneous fistula recommends intensive hygienic care and wound treatment.
3	Freitas AAS, Coelho MJ, Menezes MFB.	Men's Health, masculinities and the relationship with laryngeal cancer: implications for men. R.pesq.:cuid.fundam.online. 2013.	Literature review	Analyze the approach to men's health, masculinities and their relationship with laryngeal cancer in the national scientific production, and the implications for nursing.	Studies indicate actions of prevention and health promotion in different care spaces.
4	Oliveir aPP, Amaral JG, Rodriguez AB, Silv aMR, Onofre PSC, Silveira EAA.	Nursing process for men with laryngeal cancer based on the Neuman model.Rev.EnfermaríaGlobal. 2017.	Exploratory-descriptive study	Operationalize the nursing process, proposed by Betty Neuman, for men with laryngeal cancer, aiming to identify stressors and coping patterns triggered in the experience of malignant neoplasia.	It was found that the difficulties in the treatment of laryngeal cancer can be solved with a nursing practice focused on attention and dialogue, supported by an adequate scientific method.

5	SalomãoCHD, MeloAS, Carvalho EC.	Uncertainties of patients undergoing total laryngectomy. Rev.EnfermUEPE.2008	Qualitative study	Identify the uncertainties of patients to respect of this therapeutic process.	It is concluded that such patients need more information for better coping the situation in the postoperative period.
6	LenzaNFB, SilvaSL, Sonobe HM, BuettoLS, MartinsLM.	Pharyngocutaneous fistula in cancer patient: implications for nursing. Rev.bras.cancerol. 2013	Literature review	Describe the main implications of the pharyngocutaneous fistula complication to support nursing care.	The fistula pharyngocutaneous is the biggest and most frequent complication in patients undergoing total laryngectomy.
7	Francisca, BP	La Comunicacion:herramienta fundamentalem la calidad de laatencion integral a lospacienteslaringectomizados.Ver. 2013	Case study	Show the importance of establishing adequate communication as a fundamental tool for comprehensive care of quality with these patients.	Help to nursing team to develop specific care plans and detect day-to-day changed basic needs.

These were organized and categorized into: 1) Laryngeal cancer prevention: new perspectives and challenges for nursing; 2) Nursing care for patients with laryngeal cancer; 3) Nursing interventions in the communication of laryngectomized patients; 4) Nursing care with pre and postoperative laryngectomy and prevention of pharyngocutaneous fistulas; for better presentation and understanding of results.

Laryngeal cancer prevention: new perspectives and challenges for nursing

This category will address the role of nursing in the prevention of laryngeal cancer and strategies to achieve greater reach to the target audience. The public health network benefits from the early detection of cancer, especially when the diagnosis is started in primary care, thus avoiding physical and psychosocial deformities in the individual. [7]

Head and neck cancers are more prevalent in males, due to smoking and drinking habits, as men smoke more and consume alcoholic beverages more frequently and in higher quantities. [8]

State that preventive measures and early diagnosis culminate in the treatment of tumors in early stages and thus can change the current scenario, as there are better chances of cure. As for cases in more advanced stages, a poor prognosis is observed, with shorter survival, despite the treatment. [9]

Given this, for laryngeal cancer to be prevented and diagnosed early, it is necessary for men to be the target of interventions in the field of health policies. The demand for health services by the male public is closely linked to their perception of health care as something not peculiar to masculinity. [10]

Men use health services less often than women and are often slow to seek help, even when they face serious health problems. This can put men at greater risk of developing serious health problems, which in part may explain the higher rates of some serious illnesses in men and shorter lifespans in relation to women. She found that (61%) of men did not participate in regular health check-up appointments, representing a lost opportunity for discussions about preventive health care. [11]

The nurse facing cancer prevention, works from the basic level in health promotion and risk assessment, as well as being aware of the social, emotional and psychological factors that may be linked to the disease. As the majority of the public are men, the disease can generate feelings such as impotence, fear, anxiety, insecurity and the fragility of the disease can undermine their role as provider, generating concern with family income. [12]

Some of the measures that nurses should take for the prevention of laryngeal cancer in primary care are actions aimed at reducing the consumption of alcohol and tobacco, as well as vaccination against the human papilloma virus (HPV), since when staying in the throat increases the risk of infection among people who have oral sex and have multiple partners. Smokers are more susceptible to HPV infections, probably due to the damage caused by smoking to the immune system. [13]

Nursing care to patients with laryngeal cancer

Care is a fundamental nursing activity and patients with laryngeal cancer need humanized care focused on attention and dialogue, based on an adequate scientific method. [14] It is important for nurses to develop a flexible care plan centered on the client, respecting their autonomy with a focus on their recovery and readjustments to their new condition. [15]

Faced with a cancer diagnosis, many changes occur in the individual's life, when it comes to laryngeal neoplasia, there are also changes in their appearance and changes in the way they eat and speak, therefore, many feelings are triggered by the discovery of the disease.[16]

States that the diagnosis and treatment of laryngeal cancer brings with it a great deal of stress. As most of those affected by this pathology are men, they react differently to this emotionally difficult experience. Among the causes of stress are uncertainty about the cure, fear of death, and concerns about supporting your family. [14]

Nursing has experienced difficulties in the daily life of cancer care. In this context, it develops various forms of management so as not to create affective bonds, which is a paradox, as care for people with cancer, at the same time that it mobilizes the most varied emotions, demands a protective behavior and management of feelings and emotions. [17] When nurses demonstrate empathy, they promote a collaborative relationship with patients, which can help to eradicate causes, symptoms or explanations that result in proper diagnosis and appropriate treatments. [18]

Care relationships, despite being everyday, cannot acquire a careless character, but they must always adopt an empathetic and sensitive posture, seeking to perceive themselves in the other's place, depositing sensitivity in care, therefore, care must be understood as an act that goes beyond technical procedures. [19]

Other nursing interventions are equally important to be mentioned in relation to the patient with laryngeal cancer, such as infection prevention and control, patient safety measures and, for tracheostomized patients, it is important that they receive guidance from the nurse regarding care with the tracheostomy, with a nasogastric tube, oral hygiene, dressing, care with nutrition and effective airway aspiration. [20]

Patient care can be improved by preparing him and his family for the medical, psychological and social repercussions of the treatments received, keeping them updated and aware of their medical condition, by applying appropriate procedures in nursing care and training doctors and nurses on how to adequately respond to the post-surgical needs of their patients. [21]

Nursing interventions in the communication of the laryngectomized patient

The treatment for laryngeal cancer takes into account the stage of disease, which can be chemotherapy, radiotherapy and surgery. In more advanced cases, removal of the larynx (total laryngectomy) is recommended, as a consequence, the patient will have a loss of voice and tracheostomy will be performed, which will have a great impact on the quality of life of the individual, as it impairs their speech. [22] The difficulty of communication among people with laryngeal cancer undergoing total or partial laryngectomy is constant, as, in addition to tracheostomy, generalized facial edema is frequent after surgery due to cervical lymph node resection, which makes the movement of the lips impossible. [23]

Communication is a basic human need, and when it is impaired, it affects the individual's ability to interact with the health team and their families. Although one of the basic nursing instruments is communication, within academic training there is little emphasis on speaking and listening skills, however one cannot think about nursing work without mentioning the importance of the communication process. [24]

State that the ability to listen and speak refers to the nurse-patient relationship, however many factors make this relationship difficult, such as the lack of time to talk to each patient, a tendency to deny feelings due to professionalism and dehumanization. [25] Communication for these patients is a daily struggle, all studies reveal that tracheostomy has a huge impact on communication and quality of life. Thus, communication between

laryngectomized patients and health professionals becomes difficult, generating anxiety and anguish in the client, leaving them frustrated and unable to express their care needs. [26]

In a study carried out in Italy, the authors sought to identify the points of comfort and discomfort of trancheostomized patients and, as a result, identified as points of discomfort the patient's feeling of impotence and frustration for not being able to make themselves understood, communication problems and risk of isolation, on the other hand, they realized that one of the comfort points was feeling reassured when knowing that they could call the nurses at any time, as the professionals were constantly around. [27]

In view of this, it is important that the nurse makes an effort to use creativity and other means of communication that help when dealing with the patient, such as using written language, gestures, drawings, illustrations and also making use of non-verbal language. Other important interventions that nursing can provide is therapeutic listening, in addition to involving the family in this process.

Nursing care with pre and post-operative laringectomy and prevention of pharyngocutane fistula

People with laryngeal cancer at an advanced stage undergo a surgical procedure called total laryngectomy, which is a surgical procedure in which the larynx is completely removed and the airway is interrupted, this provides a complete and permanent separation of the part upper airway of the lower, resulting in loss of voice and smell. [28]

Care for laryngectomized patients must be comprehensive, with an evidence-based practice to provide better planning and effective implementation of care, combined with clinical competence and the interpersonal relationship of the nurse with the patient. Some complications were mentioned in the studies, such as impaired swallowing, altered oral mucosa and risk for aspiration, due to complications with laryngectomy. Therefore, nursing care is necessary, such as keeping the head high, performing oral hygiene correctly and taking care of the tube. [29]

It is important to maintain the care with the surgical wound and measures to prevent infections, as well as care for radiodermatitis caused by radiotherapy. As already mentioned, communication is an important tool throughout the treatment process, in which the nurse must pay attention to explaining to the patient what the procedure he will be undergoing, as well as answering his possible doubts about the surgery and educating for self-care. [30]

State that nursing care in the postoperative period of laryngectomy helps in the early detection of complications and favors the implementation of interventions to minimize these effects. The most common complication is the appearance of a pharyngocutaneous fistula, characterized by an opening in the pharyngeal layer, which allows the escape of saliva and its contact with the surgical wound and the skin. [31]

Among the known risk factors for the appearance of pharyngocutaneous fistulas are preoperative radiotherapy, radical neck dissection, systemic diseases, advanced tumor staging, preoperative tracheostomy, hematoma formation, type of suture material used, blood transfusion in the transoperative period, nutritional factors and serum albumin level. [32]

The nursing care for pharyngocutaneous fistulas (FFC) found in the studies was the care with the dressing and the surgical wound, removing all necrotic tissue, taking care of the probe, feeding oral late to reduce fistula formation. [33] Nurses can act in the postoperative period of patients with FFC in order to avoid complications and thus reduce the risk of infections, length of stay, hospital expenses and improvement in quality of life. [34]

IV. FINAL CONSIDERATIONS

Based on this research, it is concluded that preventive actions are essential to reduce the number of cases and deaths, as well as the early diagnosis of laryngeal cancer. Health in Brazil is still focused on the cure, therefore, a large part of those affected by laryngeal cancer reach health services in more advanced stages of the disease, which results in financial and social and family life losses. Nursing monitors the entire process from diagnosis, hospital stay, submission to treatments and after all that, rehabilitation and readaptation to a new condition.

Primary care needs to use strategies in order to strengthen health policies, as well as promote actions to combat the consumption of alcohol and tobacco, disseminating knowledge about ways to prevent and detect the first signs and symptoms of laryngeal cancer, to achieve the target audience of this disease, which are men.

In hospital care, with regard to care for patients with laryngeal cancer, nurses should plan their care based on scientific foundations, and develop a nursing plan centered on the client, building a relationship of trust and seeking methods for the patient to achieve communicate, since nursing care is also concerned with the patient's psychological and emotional aspects.

One of the limitations of this study was the low number of national publications on the role of nursing for patients with laryngeal cancer. Thus, it is important to emphasize

the need for new experimental studies that address all nursing interventions from the primary care service to high complexity, in order to support humanized and scientific nursing care.

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Peaks and Valleys Model for Risks Mitigation in Financial System: A Method Based in Multilevel Thresholding with OBIA for Change Detections in Agricultural Areas, using Remote Sensing

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***Abstract*—** *The Geotechnologies has contributed to continuous and agile monitoring, allowing strategic decision, such as monitoring by Remote Sensing in the use and land cover with the agribusiness, which is one of the main sectors of the world economy. Agriculture is one of the responsible for the positive balance of trade in several countries and which many have government policies that subsidize agricultural credits to encourage the sector. Thus, it's necessary to mitigate risks in the financeable agricultural areas, with quick and transparent inspection. In this scenario, a tool in Python language was develop containing a method, called of Peaks and Valleys (PV) Model, for remote monitoring of agricultural production with multitemporal changes detections. The study was in an area in Brazil, using 9 images from the Nanosatellite Planet, from 2017 to 2019. The method has a decision tree that was able to detect changes in the patterns of agricultural areas, issuing assertive signals in cases of deviation in behavior in the remote monitoring of cultivation, from initial cycle, full and final of maturation agricultural, with messages of warning of vegetation growth or alert of loss of vegetation. In model a multilevel thresholding is performed and descriptors extracted (Entropy, Homogeneity, Correlation and Euclidean Distance). The results indicated that when using multilevel thresholding aggregating contextual information with Object-Oriented refinement by Scale descriptor and application of Low Pass Filter by Mean Convolution, there is significant improvement in results. Was possible to assess the quality of the method and its feasibility for remote monitoring in agricultural production, where the model can be used as a significant indicator of oscillation and multitemporal trends in the use and land cover. Thus, the PV Model can facilitate inspection by of the countries with subsidies for agriculture, whether by inspectors from the Government or by Financial Institutions, in addition to reducing costs in the operational process concentrating face-to-face visits only for areas of large hectares.*

I. INTRODUCTION

Globalization and technological advance have caused changes in the way Organizations. In the competitive and volatile scenario, where information is essential for strategic decision making, it is increasingly necessary to use tools that allow an efficient management of information, helping in the extraction of data and intelligent decisions.

In this scenario, the use of geotechnologies has contributed to a continuous and agile monitoring of the reality in society, acting in monitoring such as in the use and cover the land with the Agribusiness, which is one of the main sectors of the world economy. The agriculture is one of the main responsible for the positive balance of trade in several countries, and the sector is fundamental to the economy of developing countries [5] [43].

In the last years, the world population has been growing exponentially. Thus, it is necessary to optimize and improve the production process, for the better use of inputs, with investments in technology and better cultivation practices, because with the population increase greater demand for food will be necessary. Although, there are few countries that still have uncultivated areas that can be used for agriculture, where 90% of them in Africa and South America [1] [4] [57] [59] [73].

Considering the countries that have uncultivated areas that can be used for agriculture, a lot of do not have technologies for production and the lack of qualified professionals and economic resources. Therefore, within the perspectives and scenarios, the Brazil is an important global producer to supply as business opportunities and the production supply of food in the world. The country concentrates around 14% of the world's fresh water, has a diversified climate with regular rainfall and only 34% of its area is used in agribusiness. It's one of the main producers of agricultural commodities in the world, the 4th largest grain producer and the agribusiness represents an growth in the economy with Gross Domestic Product (GDP) next to 25% [1] [17] [21] [22] [51] [64] [69].

Thus, as different countries, such as Egypt, Morocco, Nigeria, Japan, France, South Africa, among others, have government policies with incentives for agricultural financings, in the Brazil is not different, either by the importance of the sector in the economy whether due to the surplus in the balance of trade or inflation control. The most countries have government incentives in the sector through agricultural credits released by Banks and Financial Institutions. This rural credit is financing for rural producers whose activities involve the production and/or sale of products in the agricultural sector. Soon it is necessary to have risk mitigators in the financeable area in order to monitor agile and efficient manner the reality of agricultural areas, where many of the agricultural practices end up having financing through the National Financial System of countries sponsors. Thus, the use of geotechnologies helps with this monitoring in an agile and transparent way [1] [60] [73] [82].

For example, the Brazil Central Bank (BACEN) recommended that Banks and Financial Institutions, with rural credit operations, use the Remote Sensing to contract and inspect agricultural operations credit operations. According to Resolution, since 2016 the use of GISs (Geographic Information Systems), satellite images, photogrammetry or data obtained through RPAs (Remotely Piloted Aircraft), commonly known as Drones and UAVs (Unmanned Air Vehicles), is authorized to monitor agricultural financings and evaluate of the vegetative development in each phase of crop cultivation, recording the initial, full and final stages of vegetative development. In general, the countries have inspection methods are almost entirely in loco, which makes monitoring costly and often with only reactive actions [7].

One of the main applications of Remote Sensing is in detecting changes in land use and land cover. Through the analysis of a series of satellite images, with acquisition at different times, a comparison is made in the areas of interest in order to identify what, where and how much was modified in the study regions, through the spectral responses of the targets [74] [78].

Considering the context presented, the objective of this study was to propose a method of detection of changes in agricultural areas, by an open source tool with automated emission of messages for the cases in which a change in behavior is detected. Thus, a tool in Python language was developed, called LimiariZC, where was developed modules and built the model that was called Peaks and Valleys, using multi-level thresholding in histograms and analysis based on objects. In this way, with the model are possible risk mitigators of the financeable area and remote inspection instead of in loco, reducing face-to-face work to monitor the development of cultures, analyzing the vegetative cycle of the crops by remote. The model was applied in a study area in Brazil but can be used in any region of other countries for monitoring areas with agricultural financing or that will be financed and thus have greater control and transparency.

II. THEORETICAL REFERENCE

2.1 Multilevel Thresholding

The segmentation is based on two characteristics relative to the shades of grey of an image: discontinuity

and similarity. The discontinuity method considers the abrupt change of gray values and the similarity method is based on the aggregation of pixels according to their similarity to neighboring pixels. Among the types of segmentation based on the similarity feature are the methods of segmentation by region growth, thresholding, basin and pyramid detection. In thresholding segmentation, a discretization of objects by thresholds is made over the image histogram, where segmentation in conjunction with digital processing enables temporal detection of changes. Thus, the segmentation algorithms, at an early stage, contribute to reducing the complexity of classifications in the detection of changes [14] [48].

Multi-level thresholding, or multilevel segmentation, can be defined as an extension of two-level segmentation methods, with the difference that it enables segmentation into multiple classes. Thus, its use is recommended when you have several objects in the scene that differ from the background. The presence of the various objects makes the gray level distribution histogram multimodal, where the segmentation threshold is found by the location of the valleys separating each of the objects into classes [79].

For [58], in a macro way and considering the evolution of the methods over the years, there are two classical methods of thresholding which were derived from the others. The first was the one proposed by Otsu [61], which aims at maximizing the variation between classes to find the optimal separability threshold. The second was the one presented by Kapur [42] that uses entropy maximization to measure homogeneity between classes. Both methods are efficient and precise for unimodal segmentation, that is, with two levels and presenting two classes. However, although the methods can be expanded to a multi-level threshold, the complexity and computational performance of the methods is exponentially intrinsic to the addition of new levels, making the process costly.

In recent years, different models have been proposed in order to foster the academic area with multi-level thresholding, aiming at improving the limitations of the methods presented by Kapur and Otsu [42] [61] for bimodal histograms, such as the work of [81] which uses the weighted variance of objects for detection. In [47] a recursive algorithm for multilevel thresholding is proposed, where the proposed algorithm demonstrates performance improvement over the original method. The study brings an approach that aims to maximize the variance between classes, the calculation of accumulated probability and moments of zero order and first order.

For [32] brings a hybrid approach to multilevel thresholding using the Otsu method and adjustments to the Gaussian function. The algorithm called Nelder-Mead (NM-PSO-Otsu) demonstrated that it improved the results presented through the original method. However, most models bring mathematical and computational complexity.

According by [71], thresholding methods can be grouped into six categories, according to the use of detection techniques, and they are based on histograms (focusing on the analysis of peaks, valleys and smoothing of curvatures), clusters (where gray level samples are grouped in parts separating the object from the background), entropy (where the algorithms use entropy to separate the regions between the objects and the background), in object attributes (where the similarity between the gray level and the binary images is measured, as in fuzzy similarity), in spatial methods (where they use the highest probability of distribution, as well as the correlation between pixels) and in local adaptive methods (where they consider the local value of each pixel).

Although there are different thresholding methods, those based on histograms are simple and quick to perform, as in general the logic of the technique is that pixels assume a categorization according to a defined pattern, and those that do not fit this label remain in another category. In general, in histogram-based methods, thresholds are selected based on the analysis of thresholds that promote the best separability of classes, adapting the Otsu method and using Gaussian models [11] [36] [55].

In a macro way, histogram-based thresholding techniques can be classified on two fronts. The first with thresholding techniques that determine the ideal thresholds, optimizing a certain objective function [33] [50] [80], where approaches based on entropy such as Shannon, Renyi [3] [67] [72] entropy correlation and cross entropy [68] can be found. However, the main associated obstacle is the high processing time. On the second front, there are techniques that seek the optimal thresholds through the form of histograms, where it is assumed that the intensity of pixels is similar on the same objects and distinct on different objects [50].

The proposed work reflects a multilevel threshold that can be applied to any type of histogram and aims to verify in an automated way whether or not a crop has been harvested. Thus, the model assumes that when there is a vegetation cut, becoming exposed soil in the satellite image, the response in the histogram would present a different gray level value for the region, compared to the same location in the histogram of the image at the previous time, displaying a valley instead of a peak and vice versa. The same occurs for vegetation, where it would present a higher frequency compared to the exposed soil.

2.2 OBIA - Object Based Image Analysis

The process of image classification allows, besides the identification of targets in satellite images, quantitative analysis of objects of interest in the scene, such as studies of the evolution of the environment, calculation of areas, among other factors in the detection of patterns and monitoring of behaviors. The process of extracting the information in the images is performed through classifiers, which have mathematical methods that directly assist in the stage of the classification process. Most methods are based on the attributes of tone, color and texture of the targets. One of the classifiers divisions is the main unit of analysis, being defined in classifiers per pixel and per region [18] [52].

The classifiers per pixel operate with the attributes of tone and color, as is the case of the classifiers of Parallelepiped, Euclidean Distance, Maximum Likelihood among others. The classifiers by region, on the other hand, in most cases work with the aspect of color, tonality and texture, like the Isoseg and Bhattacharya classifiers. While pixel by pixel classifiers use only the isolated spectral information of each pixel, those by region, besides the spectral information of each pixel, make use of the spatial information that involves the relationship between the pixels and their neighborhood. Thus, in region classifiers, it is necessary to use the segmentation technique to fractionate the image into regions with similar responses [14] [48].

In high spatial resolution images and in classifications where the spectral response of the targets is similar, the classifiers per pixel and per region may not perform efficiently. In such cases, the use of object-based classification becomes more satisfactory as a result of these types of classifiers using, in addition to hue, color and texture, other characteristics pertinent to the image, such as shape, location, size or scale among other attributes of the target of interest in the scene. In object-based classification, the region of pixels is called the object, and the characteristics of the objects are used in the classification decision. For the generation of objects, segmentation is required, where the user uses the object attributes in a decision tree for the classification [10].

Object based classifiers are based on the GEOBIA (Geographic Object Based Image Analysis) system, also known as OBIA (Object Based Image Analysis). Such classifications refer to a knowledge-based analysis, with automatic image interpretation, through Object-Oriented data analysis. Instead of the classification being performed only in isolated pixels - being pixel by pixel, without considering the neighborhood - it uses as parameter the segments or set of pixels. Therefore, it considers geometric particularities of the targets, such as area or scale, color, dimension, texture, format, proximity of segments, among other particularities and refinements. Thus, it not only uses spectral, but also structural and spatial characteristics in the process of class distinction [12] [56].

According by [31], the OBIA approach brings an advance in automatic classifications of orbital images, where it allows a better discrimination of features in high resolution images. Because it has less influence on the spectral mixing of targets, it automatically distinguishes the gray levels of the image, when compared with conventional classifiers. Because it is knowledge-based analysis and has less human intervention, automatic classification is close to reality in the field.

The GEOBIA paradigm consists, in a macro way, of the segmentation and classification steps. Segmentation defines the division of the image into groups with homogeneous characteristics taking into account factors defined by the operator, such as compactness, scale and smoothness. The classification is based on the definition of decision rules that reveal the properties of objects expressed by their attributes. Thus, the classification based on objects allows a better discrimination of features in high resolution images. Because it has less influence on the spectral mixing of the targets, it better distinguishes the grey levels of the image [14] [52] [54].

In the proposed method, the Peaks and Valleys Model (PV) was implemented, where it brings a multi-level thresholding approach by aggregating object-oriented (O.O.) contextual information. Through the extracted thresholding, the classification of the detected segments will be performed, which will be refined based on objects by the Scale descriptor, besides the context analysis of the segments through the extraction of the Entropy parameters and the Homogeneity and Correlation texture descriptors. In addition, the attributes of Euclidean Distance between the segments will be used, as well as the extraction of statistical parameters of Mean, Standard Deviation and Coefficient of Variation (CV). The descriptors extracted were intended to verify the behavior of the attributes before and after the O.O. refinement and before and after the application of the filter in the histograms, in order to verify if the OBIA information and the use of filter aggregated to the multilevel threshold promotes improvement of the results.

The Scale attribute used in OBIA refinement will be used to delimit the dimension of each object found. Through the parameter, the heterogeneity regarding the size of the objects will be checked. The larger the delimitation of the scale value, the larger the size of the regions generated. From the input parameters, defined by

the user in the tool developed, it will be possible to define the minimum percentage of area that each segment has, based on the total pixels of the image. If the object has a number of pixels lower than the determined percentage, the class will be grouped next, forming clusters according to the established definition, so that all classes have the minimum percentage of pixels stipulated, refining the segmentation for the effective recognition of patterns. The scale factor value may vary from zero to a user-defined finite value [6].

Entropy reflects the randomness of the image data, since the more dispersed the data, the higher the entropy values will be. Thus, the value reflects the impurity of the data, that is, the lack of homogeneity between the information [70]. The proposed method applied Shannon's entropy [72], which quantifies the information and measures the degree of uncertainty and can be used in the characterization of textures [9]. For the attributes of Homogeneity and Correlation, Haralick's descriptors [30] were used, which determine texture characteristics of the selected images. Homogeneity is a spatial autocorrelation measure representing the distribution of pixels along the cluster and/or image. The descriptor assumes high values when the texture presents small variations of gray levels, with a range from 0 to 1 [30]. In the Correlation, it is possible to analyze the similarity between the segments by means of the mean and standard deviation values, where the measurement allows verifying how much a pixel is correlated with its neighbor. Thus, the texture correlation measures the linear dependence of pixels in relation to their neighborhood. The comparison is performed on all pixels of the class and returns the average value to the cluster. The descriptor has values ranging from -1 to 1, where when an image or class has the pixels fully correlated, the value obtained is 1. When they are fully correlated, the value is -1 [30]. While the descriptors mentioned reflect the intra-cluster quality, the Euclidean Distance represents the inter-cluster separability, that is, it represents the geometric distance in multidimensional space, and the higher the value of the distance calculation, the less similar - or more dissimilar - the objects will be. Therefore, the smaller the value of the distance, the more similar the analyzed regions are. Thus, the distance between class ranges is expected to be the greatest possible, indicating the good separability of clusters [19].

The statistical parameters of Mean, Standard Deviation and CV are measures of dispersion that indicate the regularity of a data set, being possible to analyze the oscillation around the mean. The smaller the deviation, the closer the values are to the mean and the bigger, the more distant the values are from the mean. Thus, through the variables it is possible, for example, to check the mean of the objects that belong to a certain cluster and analyze if the pixels are close to each other or vary significantly. Also, the smaller the CV value found for the clusters, the more homogeneity there will be in the data [15].

Through the analysis of the extraction results of the attributes in the images, the knowledge model will be defined so that rules can be established for the detection of seasonal changes in the bi temporal analysis of the scenes, so that the multitemporal monitoring of changes can be performed.

2.3 Change Detections

There are different techniques for detecting changes through multitemporal image analysis developed in recent years, and there is no universally accepted method [20] [74]. The parameters of choice of these techniques depend on the objective of the research, as well as the preferences of the operator in the use of certain tools. In a macro way, the techniques of change detection can be grouped in five modalities: ratio between bands, difference between bands, analysis of main components, temporal spectral classification and comparison of individual classifications [39].

According by [28], the techniques of band ratio, subtraction or difference of image bands and main components are the most used for the detection of changes, being able to monitor changes in the spectral response pattern of vegetation as a function of time, either due to phenological changes of plant species or by anthropic interventions.

Among the approaches to detect change is pixel analysis, with studies from urban development [76] to changes in land use coverage [63]. However, the use of pixels as comparators of change is not an adequate approach when using high-resolution images, mainly because of the lack of contextual information for decision making and only pixel tonality or radiation [16] [34]. Furthermore, such detections are susceptible to noisy classifications with the so-called "salt and pepper" effect when considering only the pixel [8] [12] [16].

The task of distinguishing objects in an image, in a digital way, can be extremely exhaustive, requiring very elaborate filters and reaching very efficient results. However, requiring a high quality in the detection of changes, usually also requires a high price, that is, the algorithms have now high cost, high mathematical and computational complexity, high specificity and low robustness. In order to meet the requirements in a timely manner, digital image processing systems use, at a primary

stage, segmentation to highlight the background object [41] [53] [75].

A statistical trend analysis was proposed in order to complement the automated histogram sweep in search of thresholds in order to minimize possible false positive and/or negative alert emissions. The trend analysis aims to verify if the change occurred between the pair of scenes is due to loss of vegetation or vegetative growth.

The rules for emitting the flags were implemented by means of a decision tree proposed and developed in the tool created, considering a set of variables and descriptors of first and second order extracted from the base of analyzed images, where a spatial analysis of the objects will be carried out in order to evaluate if there were changes or not. Traditionally, decision tree algorithms, such as J48 [29], Random Tree [83], Random Forest [83], REPTree [83] and Logistical Model Trees or LMT [45], start from a set of chained rules forming a hierarchical structure similar to a tree. In J48, each node of the decision tree is assigned an attribute that best subdivides the classes into homogeneous sets, where the tree pruning criterion is used so that the search is not extensive. In Random Tree, a random quantity of attributes is considered at each node, without pruning the decision tree [27]. Unlike the others, in Random Forest the objective is the generation of several decision trees by means of randomly selected attributes, the chosen attributes being called bootstrap where there is replacement in the samples in order to improve the interpretation of data, forming new subsets that will constitute the decision tree [49]. In REPTree the decision tree uses information of gain and variance, where the values are changed according to the pruning aiming at error reduction [27]. Finally, the LMT algorithm aims the generation of trees through logistic regression, where the objective is to select relevant attributes in the data set through repetition [25].

In the study presented by [40], different classification algorithms based on trees were evaluated to select attributes in order to avoid cyber attacks, where Random Tree demonstrated the best predictive accuracy, with fewer false positives/negatives among the evaluated algorithms. In the analysis made by [37], Random Forest obtained 82% accuracy in the classification of ten tree species through WorldView-2 images in a study region located in eastern Austria. Although the algorithms have expressive results in several areas for data mining and pattern recognition, it was chosen to create the native tree of the proposed method through the attributes of statistical trend analysis for the emission of signals in the monitoring of alerts/warnings, because the analyzed data indicate a common behavior to express the trend. Thus, in the empirical model generated, the set of descriptors should be considered as attributes to direct the hierarchical tree, without the substitution of the parameters by the repetitivity employed in the traditional decision tree algorithms, aiming at finding the best separability attribute.

III. MATERIALS AND METHOD

3.1 Study Area and Materials

The study area is concentrated in the eastern portion of the Federal District (DF) around the region called PAD-DF, Federal District Directed Settlement Program, near the border of the state of Goiás in the municipality of Cristalina between latitude -16.09815 and longitude -47.47153 encompassing an area close to 70 hectares (ha), as shown in Fig. 1.

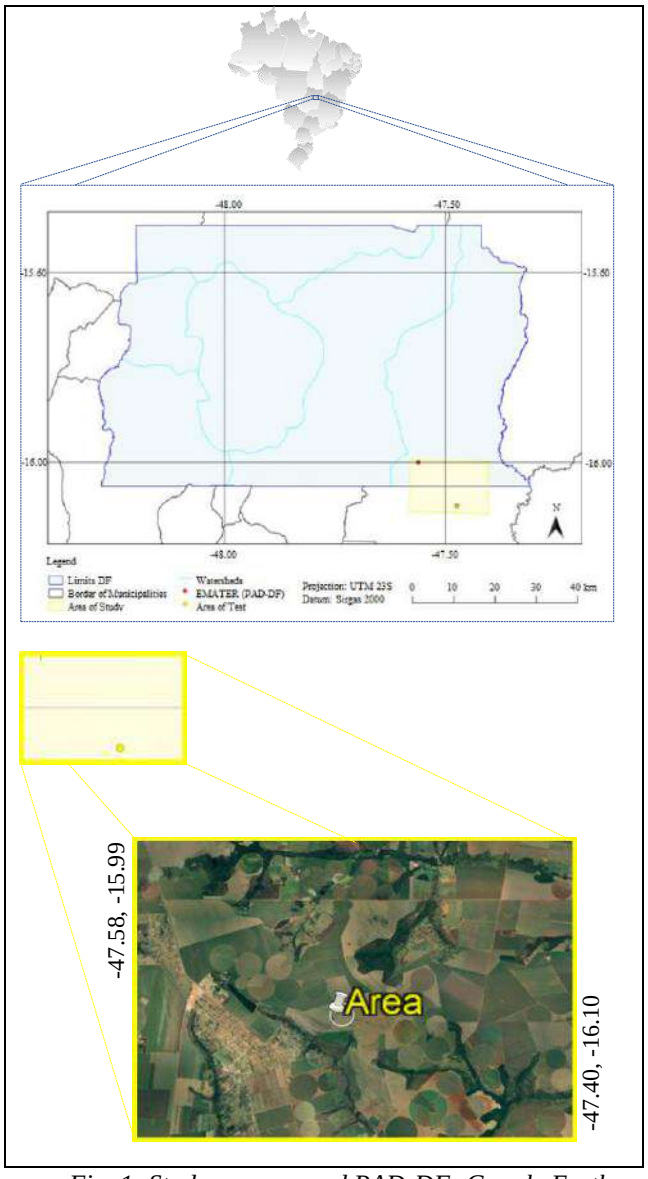


Fig. 1: Study area around PAD-DF: Google Earth image from April 10, 2020.

The polygon was chosen because it visually presented different nuances in the plot, which could represent different classes in the images and consequently multimodal histograms for the scenes. According to the field visit made in the property in 10/23/2019, in the plot there is the diversification of Horticultural crops. Thus, detailed tests were applied to the polygon in order to analyze the effective applicability of the tool developed in the distinction and separability of thresholds or classes of images. According to data from the Brazilian Agricultural Census and land structure [35] [38], of the total 6.5 MM of rural properties in the country, about 86.5% have less than 100 ha. Considering the DF dimension, the value rises to 94.3%. Thus, the size of the study polygon covers the largest quantity of rural properties.

The PAD-DF is a program implemented in 1977, with the intention of occupying large areas of the Brazilian Cerrado with agribusiness. The program arose from the need to offer an economic and agricultural destination to the areas of the Brazilian Cerrado in the Federal District, at a time when research initiatives and incentives for agricultural activities were emerging. Thus, it covers an area of over 60 thousand hectares, containing several types of economic initiatives, from areas with cereal plantations, horticultural crops, cattle farming, poultry farming among others, through producer settlements in isolated areas, rural nuclei and agricultural colonies, and in the region some of the main agricultural crops produced in the Brazilian Cerrado are found, such as soybeans, corn, wheat, cotton, beans, onions, potatoes and carrots [13] [26]. According to Table 1, nine Nanosatellite Planet images were used for monitoring the agricultural development cycle.

Table. 1: Images used for monitoring of the culture development cycle.

Imagery Date		
Nov 14, 2017 (Time: 12h45'10''; % cloud: 0%)	**Nov 28, 2017** (Time: 12h43'58''; % cloud: 0%)	**Dec 28, 2017** (Time: 12h45'48''; % cloud: 0%)
Feb 14, 2018 (Time: 12h48'00''; % cloud: 0,16%)	**Apr 27, 2018** (Time: 12h50'43''; % cloud: 0%)	**Oct 04, 2018** (Time: 13h39'52''; % cloud: 0%)
Jan 03, 2019 (Time: 12h52'13''; % cloud: 0%)	**Jan 15, 2019** (Time: 12h58'38''; % cloud: 0%)	**Feb 02, 2019** (Time: 12h58'55''; % cloud: 0%)

The Planet images were defined as the scope of this work by the imaging characteristics of the nanosatellites, with a significant daily and spatial resolution of 3 meters, allowing the traceability of the plots with agricultural financing in an agile way, being fundamental for monitoring the vegetational cycle of crops. Thus, as the images are made available almost instantly when captured by the sensor system, if any abnormality outside the standard is detected in the automated monitoring proposed by the tool, it is possible to adopt timely actions in an agile and effective manner, such as, for example, on-site inspection for cases where some inconsistency was actually detected. Thus, it was adopted as a premise that the better the spatial temporal resolution the better the monitoring.

The analysis and selection of images were based on the criteria of scene availability, dates based on the phenological periods of the crops present in the plot, non-existence of clouds and visual inspection that indicated significant seasonal changes in the scenes, aiming to find periods with greater contrasts to evaluate the differences and consequently apply and validate the proposed method with assertive signs for the crops. The images used are the Ortho Scenes level 3B, which are made available by the supplier with geometric, radiometric and orthorectification corrections, in addition to being made available georeferenced, normalized and scaled with Radiance in the Top of the Atmosphere (TOA), being delivered in the analytical products for the 4 bands (R, G, B, NIR) [65].

Envi 4.8 and QGIS 2.18 applications were used to cut out the plot on the images and validate the accuracy of the classifications. However, the execution of the method proposed and implemented in the tool is independent of the use of other software. All processing was performed on a microcomputer with Intel I-7 processor, with processing speed of 2.8 GHz, RAM of 16GBytes, HD capacity of 1 TByte, SSD 224 GBytes and Windows 10 operating system.

3.2 Methodological Approach

The methodological procedure was divided into three stages, as shown in the Fig. 2.

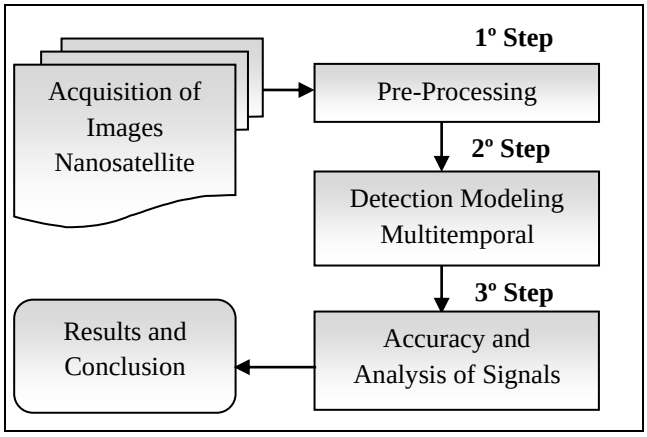


Fig. 2: Macro flowchart of Methodology.

3.2.1 Methodology – 1º Step

In the first stage the pre-processing of nanosatellite images was carried out, with the selection and clippings of the study areas, as well as the necessary treatments in the scenes for the complete effectiveness of the proposed method. In this way, in the clippings of the areas, masks were created to delimit only the plot of interest, besides the conversion of the scenes to 8 bits. After several tests, the conversion of the images was chosen to improve the performance and optimize the processing time in the execution of the models, besides minimizing the existence of short peaks and shallow valleys in the images.

3.2.2 Methodology – 2º Step

In the stage, a Multitemporal Detection Modeling was developed. The proposed method was implemented, in Python language, through the development of a tool, called LimiariZC, where a multilevel thresholding model called Peaks and Valleys (PV) was developed, with the objective of to propose a method for detecting changes in agricultural areas, with automated emission of messages for cases in which behavior change is detected. In the model, an automated histogram scan is performed in order to find the location of peaks and valleys in any type of histogram. The model aims at verifying if in a certain location the crop continues with the evolutionary growth according to the standard behavior or if there are signs of crop cutting or vegetation loss. In this way, it is possible that images are compared to pairs performing a bi temporal seasonal detection, from pre-planting to harvesting, passing through the different phases of cultivation.

In the Fig. 3 shows the macro task flowchart of the PV model developed in the change detection tool.

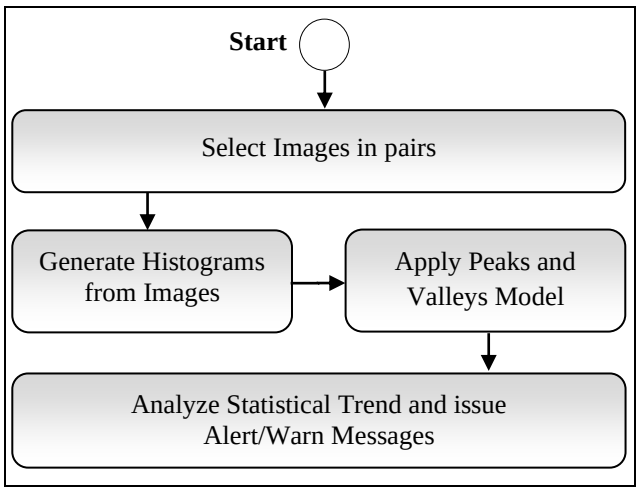


Fig. 3: Macro flowchart of the Peaks and Valleys Detection Model.

For each of the input images, the corresponding histograms are generated. In order to attenuate the short peaks and shallow valleys in the scenes, generating classes with a small number of pixels, it is possible to apply in the PV model low-pass convolution filter of the medium type in the histograms, besides an object based refinement by the Scale descriptor which agglutinates the classes according to the minimum percentage customizable considering the image dimension, forming clusters according to the established definition. With the application of the model, the statistical trend of the scenes is evaluated, emitting - according to the rules defined in the proposed decision tree - messages of vegetation loss alerts or vegetative growth warnings.

3.2.2.1 Peaks and Valleys Model

The purpose of the model is to search for the valleys in the image, that is, the places where the thresholds of separation of the scene classes from the grey level of the pixel are concentrated. In this way, if there is a valley, a threshold will be detected, and the image will be segmented through the threshold. The automatic thresholding algorithm developed allows the detection of the valleys through the signal transition of the histogram values, where every time there is a signal transition from negative to positive it indicates the position in which a valley is located, therefore, a new threshold and a possible new class. Each of the segments, delimited by the thresholds, comprises a new region fragment with homogeneous units. In this way, a monitoring is performed throughout the histogram in order to find the separation thresholds.

The Peaks and Valleys detection algorithm is executed according to the listed tasks:

1. For each histogram, the algorithm acts as if it divided the histogram into sub-regions or rectangles;
2. For each of the sub-regions the corresponding areas will be calculated;
3. For each one of the histograms, a resulting vector shall be created;
4. For each corresponding resulting vector, the result of each area calculation of the sub-regions will be stored;
5. In the resulting vector, automated searches will be performed verifying the signal transition between the elements (thresholds);
    - ✓ If there is a transition from negative (-) to positive (+) sign, it indicates the position where a "valley" is located;

- ✓ If there is transition from positive (+) to negative (-), it indicates the position where a "peak" is located;

6. After all thresholds in the image are detected in the resulting vector, each threshold interval will be associated with a class. Thus, the cluster of pixels located in a given threshold range will be part of the same class;

7. Through object-based analysis, the thresholds (or segments) can be refined by extracting attributes, using the Scale descriptor. The values of the parameters will be defined by the user, where the tool developed allows the customization of the parameters by the operator, according to the analysis of the input scenes;

8. In the resulting vectors, comparisons will be made between the stored thresholds for each one of the histograms, as well as analysis of statistical tendency in the images, aiming at finding changes in behavior from one analyzed image to another;

9. In case of detection of behavior changes in the different phases of the evolutionary cycle, according to the maximum percentage range of oscillation defined by the user and the statistical trend analysis, alerts/warnings will be issued by the developed tool.

The area calculation of each sub-region, containing the signal transitions, will be implemented through the mathematical model in Equation 1:

$$A_n = [(X_{n+1} - X_n)(Y_{n+1} - Y_n)] \qquad (1)$$

Where An is the nth area calculation of the sub-region, n is the pixel position of the analyzed image, X_n the abscissa of the nth gray level and Y_n the ordinate of the nth gray level.

In the sequence, the values are stored in a resulting vector. Subsequently, the resulting vectors of each of the histograms are compared to each other for further classification. The vectors are analyzed to monitor possible class changes in the study areas, and detection is performed on each of the input images. The resulting vector, containing all calculations and signal transitions for the input images, is given by Equation 2:

$$V_{Result} = [A_0, A_1, A_2, A_3, \ldots, A_n] \qquad (2)$$

Where V_{Result} is the vector containing all the results of the subregion calculations, concentrating all the signal transitions and the result of the area calculation, from the first to the n-th pixel of the image.

In Fig. 4, the proposed modeling for searching peaks and valleys is exemplified in the histogram of each input image. For each subregion of the histogram, each position of the pixels corresponding to the pair of coordinates (x, y) is monitored. Area calculation is performed for each of the segments, and the result is stored in the resulting vector of each histogram. Thus, there will be a resulting vector for each image analyzed, concentrating in each vector all the signal transitions of the calculations. The resulting vectors are compared among themselves, aiming at identifying, from a pre-established range, if the behavior of the resulting vectors is similar to each other, issuing warnings in cases of deviations from expected behavior. Thus, it is as if the input images obtained in different periods were being compared among themselves, aiming to identify behavioral changes.

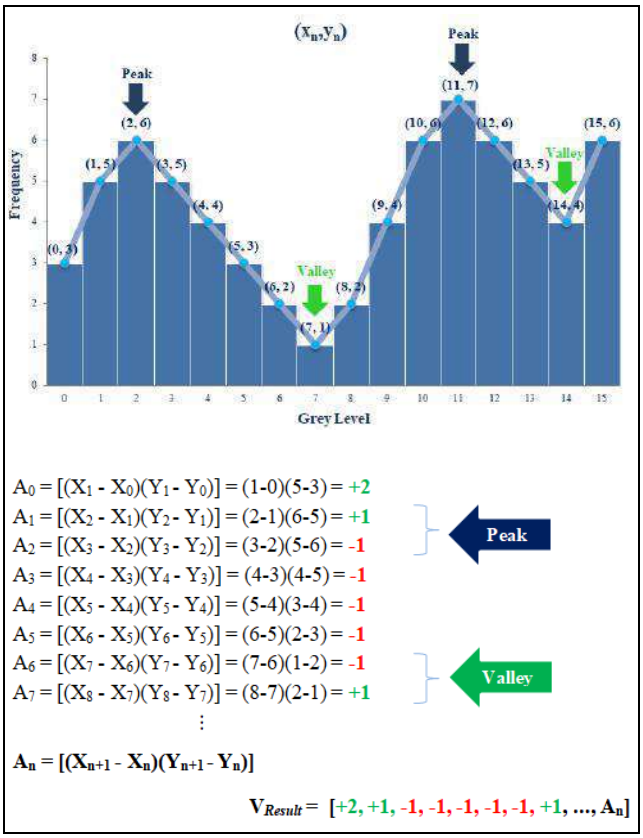


Fig. 4: Modeling proposed in the Model of Peaks and Valleys.

Mathematically, the automated scan in the histograms, is performed as if the intention was to obtain the maximum and minimum points of a polynomial function. Thus, for a histogram with known polynomial degree, if the mathematical calculation of the first and second derivation was performed, it would be possible to discover the inclination of the tangent line to an f(x) function and thus find the points of minimum and maximum of the curvature [23]. However, the automation process is not trivial, since it should be customized according to each histogram because the function f(x) is not always the same. This is

due to the fact that there is no standard polynomial behavior due to the shallow peaks and valleys in the image histograms. Thus, as for each image the degree of polynomial is different, the solution proposed in this article is the implementation of the algorithm that performs automated scanning, in search of the points of abscissas and ordinates in which there is the signal transition between peaks and valleys. If the comparison of detected thresholds or valleys is different in the pair of images analyzed, it is a strong indication that there were changes between the scenes, otherwise the quantitative would be equivalent.

3.2.2.2 Statistical Trend Analysis and Alert/Warning Emission

Based on the different images and tests applied, an exploratory analysis of the data was performed in order to characterize the behavior of the possible classes involved in the study for multitemporal detection modeling. Statistical trend analyses were performed in order to identify the spectral behavior of each of the growth and vegetation loss patterns, in order to obtain the spectral response of each of the targets and thus be able to complement the warning emission of the peak and valley model, in order to avoid false positives and/or negatives of vegetation loss. After the extraction of different first and second order statistical parameters, it was found that the attributes listed in Table 2 could be assertively used for detection of the vegetation (VEG) or the loss of vegetation with the presence of the exposed soil (E.S.).

Table. 2: Statistical Trend Analysis for the Emission of Signalizations.

	ALERT	**WARNING**
VARIABLES	**I1 = VEG and I2 = E.S.**	**I1 = E.S. and I2 = VEG**
Mean	I2 > I1	I2 < I1
Entropy	I2 > I1	I2 < I1
Standard Deviation	I2 < I1	I2 > I1
Maximum Peak Frequency	I2 < I1	I2 > I1
Coefficient of Variation with Homogeneity Analysis	ΔCV < 0 H < 0	ΔCV >= 0 H >= 0

Thus, according to the statistical criteria analyzed, in the seasonal bi-time analysis between the scenes, an alert or warning signal should be issued for the monitored area. The warning message will be used to signal possible loss of vegetation while the warning message will be used to indicate vegetative growth trend. Through statistical trend analysis with the proposed attributes, a native decision tree was created in the tool for issuing the flags.

3.2.3 Methodology – 3º Step

In the 3rd stage the analysis of the Alerts/Warnings emissions was performed by visual interpretation of the input images, aiming to evaluate the implemented model of automated change detection. The results were compared in order to verify if visually the signals, in fact, should be issued and/or if in the assessment areas there were signs of some undetected, in order to avoid false positives and/or negatives. Thus, the agricultural areas of the multitemporal application were individually analyzed, being evaluated by means of the keys of interpretation regarding color, shape and texture [24].

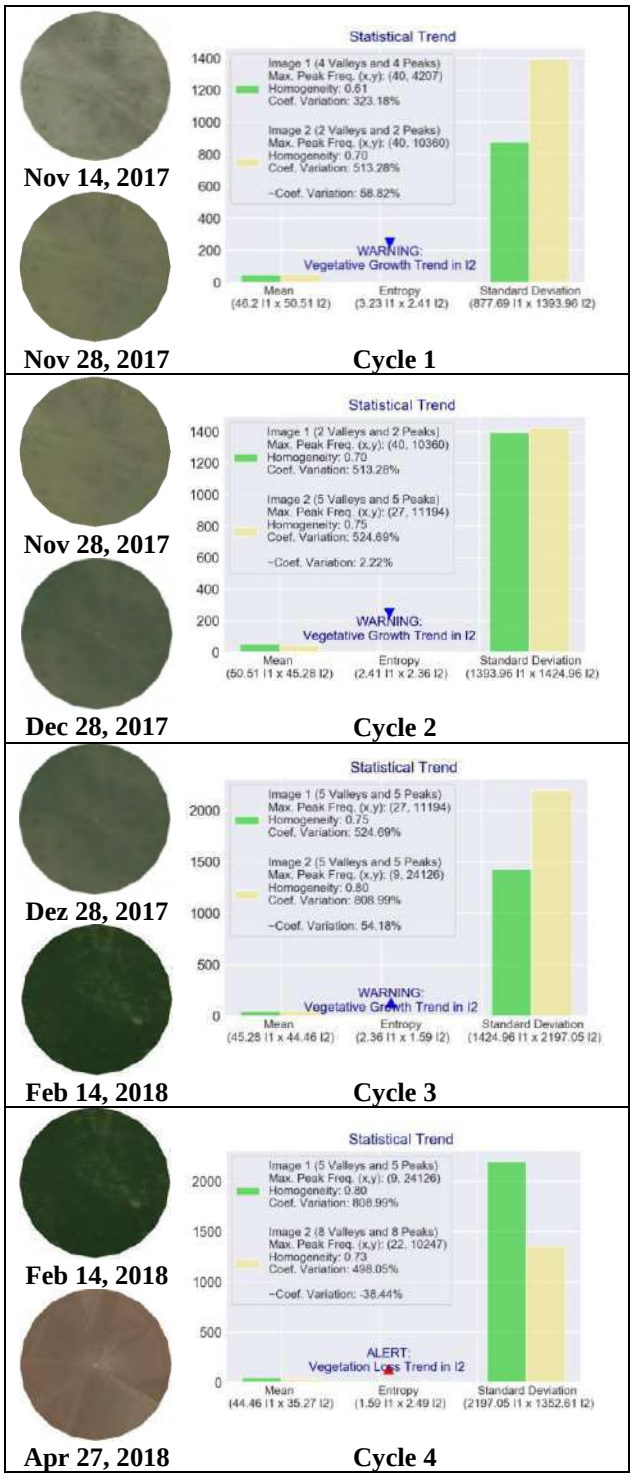
IV. RESULTS AND DISCUSSIONS

The Fig. 5 shows the monitoring for the vegetative cycle of the stall from initial, full, maturation to cutting. For each image comparison, the statistical trend analysis is extracted, informing by means of signs the trend of the stall: if of warning of vegetative growth or alert of vegetation loss.

The proposed and developed method takes on average 25 seconds to process areas up to 100 ha. As can be seen in Fig. 5, the alerts and warnings issued were assertive in all tests, where it can be ratified by the visual comparison of the images with the different nuances of exposed soil and vegetation. Thus, it was verified that in the bi temporal analysis between the pair of images, when there are changes in vegetation nuances, indicating greater vegetative vigor in the most recent scene, a warning message of vegetation growth was issued, according to the transitions on 11/14/2017 and 11/28/2017 (Cycle 1), 11/28/2017 and 12/28/2017 (Cycle 2), 12/28/2017 and 02/14/2018 (Cycle 3), 10/04/2018 and 01/03/2019 (Cycle 6), 01/03/2019 and 01/15/2019 (Cycle 7) and 01/15/2019 and 02/02/2019 (Cycle 8).

On the other hand, in the biennial analyses of 02/14/2018 and 04/27/2018 (Cycle 4) and 04/27/2018 and 10/04/2018 (Cycle 5) the loss of vegetation is clear, indicated by the presence of exposed soil on the scene. Thus, an automated warning message of vegetation loss tendency was issued based on the decision tree developed.

Still analyzing the results presented in Fig. 5, in the Cycle 5 images although both scenes indicate the presence of exposed soil, the most recent image (04/27/2018) appears lighter and closer to white nuances indicating less vegetation remains compared to the older image (10/04/2018). Thus, the message of the warning of vegetation loss was flagged, indicating that the proposed method in the PV Model was assertive even for exposed soil transitions.



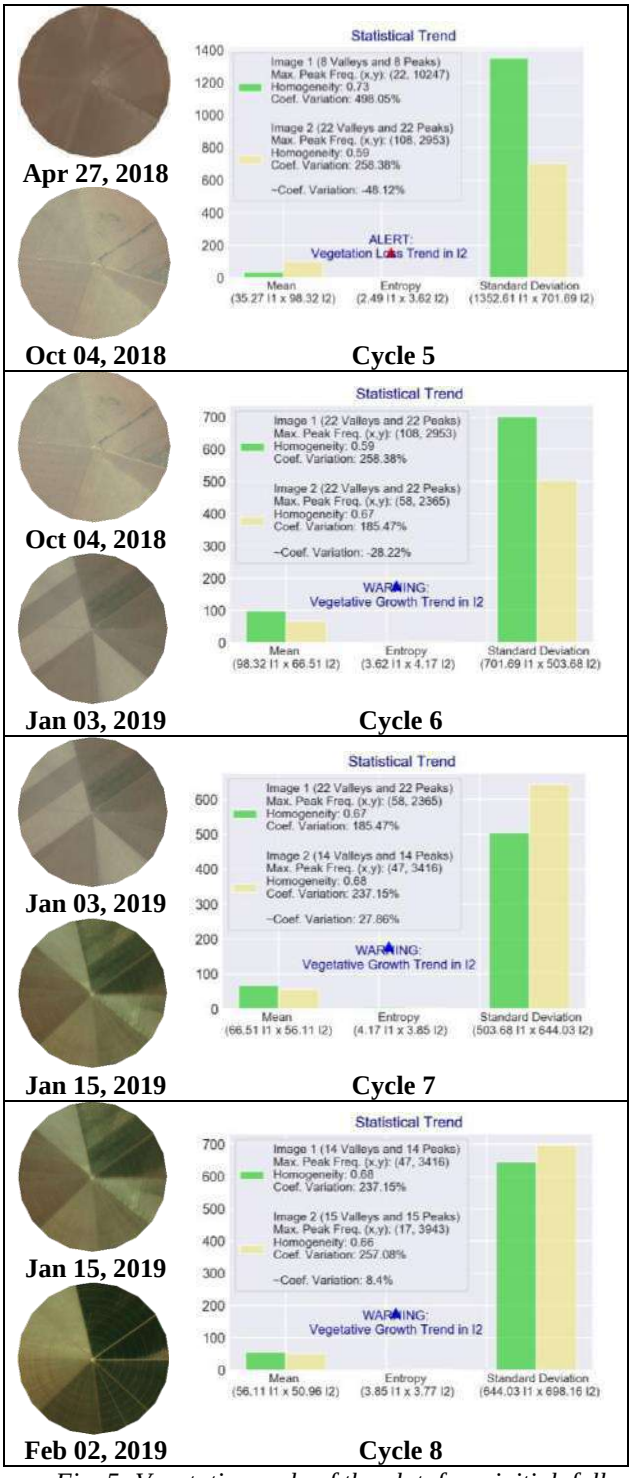


Fig. 5: Vegetative cycle of the plot, from initial, full, maturation and cutting.

For the images of the area that succeeded the pre-planting, in the scenes of 01/03/2019, 01/15/2019 and 02/02/2019, representing Cycles 7 and 8, vegetation growth alerts were issued for the evolution of the initial vegetative cycle, full and maturation, according to the analysis of statistical trend performed. With the effectiveness of the alerts and warnings issued in an automated way, the accuracy of the threshold

classifications obtained in the tool was verified, according to Fig. 6.

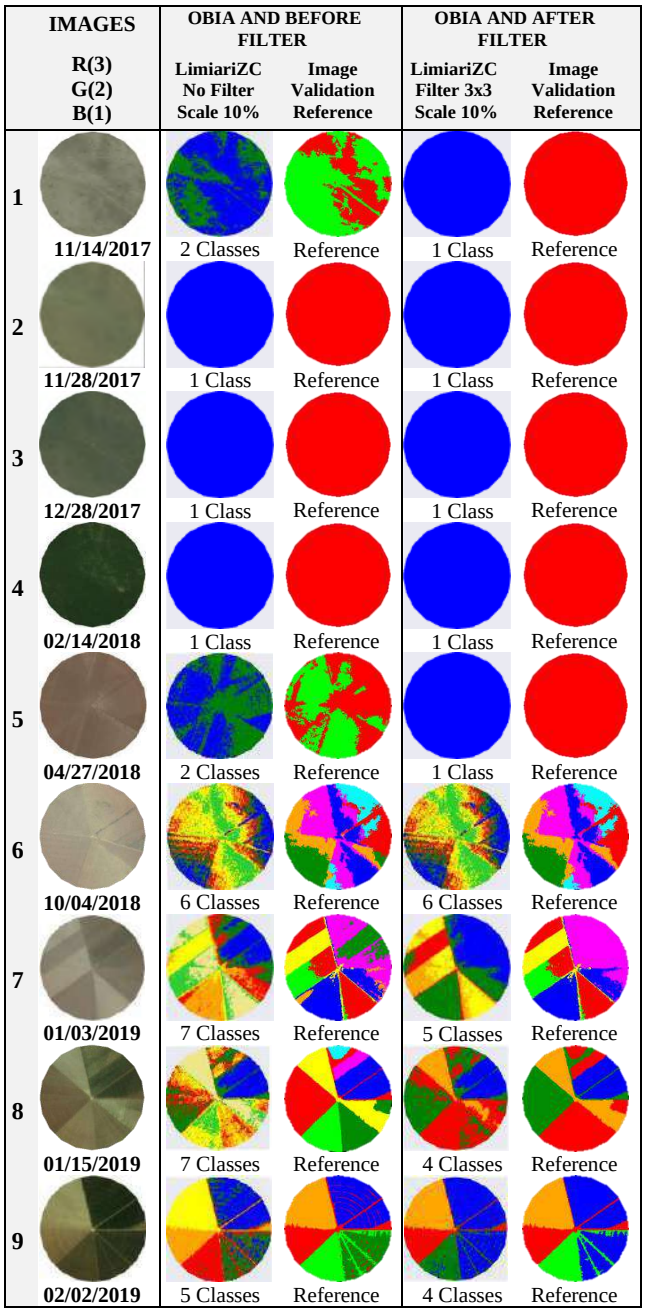


Fig. 6: Classifications extracted with the respective validation reference.

The validation of the classifications was performed by adopting as reference image the classification by visual interpretation, such classification being adopted because it acts in a proportional manner to the thresholding logic, where the visual interpretation, by means of screen digitalization with vectorization of the image, allows aggregating in a polygon the pixels with visually similar characteristics. Thus, in the PV model the groupings are formed based on the valley, which represents the gray tone with the lowest value in the histogram and separate similar regions based on the proximity of gray level. Thus, studies show that when the visual classification is used as a reference map of the actual scenario, it allows the decrease of the classification error with consequent increase in overall accuracy [66] [77].

Fig. 6 shows the analyzed input images with the respective threshold classification generated with OBIA refinement by 10% Scale, before and after the application of the filter passes low average convolution with 3x3 dimensions, besides the reference image used in the validation. The accuracy was extracted for the images with OBIA refinement and the use of the filter due to the application of the descriptors demonstrating that this is where the results had better quality in the groups.

For all the bimonthly analyses performed, the descriptors of Entropy, Homogeneity, Correlation and Euclidean Distance of the scenes were extracted in order to verify the behavior of the attributes before and after the O.O. refinement and before and after the filter application. The tests indicated that when the filter is applied to the scenes and the multilevel threshold with O.O. refinement there is a significant improvement of the extracted descriptors. In Fig. 7 to Fig. 10 we find as an example the attributes generated in the comparison of the scenes of Cycle 8, expressed in Fig. 5, with bi temporal analysis between the images of 01/15/2019 and 02/02/2019 which represent areas with expressive heterogeneity.

As can be seen in Fig. 7, the application of O.O. refinement and the use of the filter decrease the entropy in clusters extracted by the multilevel threshold. Considering the entropy values for the complete scene, for image 1 (01/15/2019) before O.O. refinement and without applying the filter, the highest entropy value was obtained for class 11, out of the 15 classes initially detected for the scene, with a maximum entropy of 2.48. For image 2 (02/02/2019), the highest value was for class 8, with 16 classes initially detected, with maximum entropy of 3.09.

After refining O.O. by Scale, for image 1 the maximum Entropy value decreased to 2.2 and now for class 2 the maximum of 7 classes detected after refining. For image 2, the maximum entropy value is now 3.0 and for class 4 it is 5 classes detected. With the application of the filter, the values before and after the refinement increase from 3.09 to 2.89 in image 1 and from 3.14 to 3.04 in image 2. Thus, the Entropy descriptor shows that when the multilevel thresholding with OBIA and filter is performed, there is a significant improvement in the impurity within the clusters, thus making the segments more homogeneous and the thresholding classification with better assertiveness tendency.

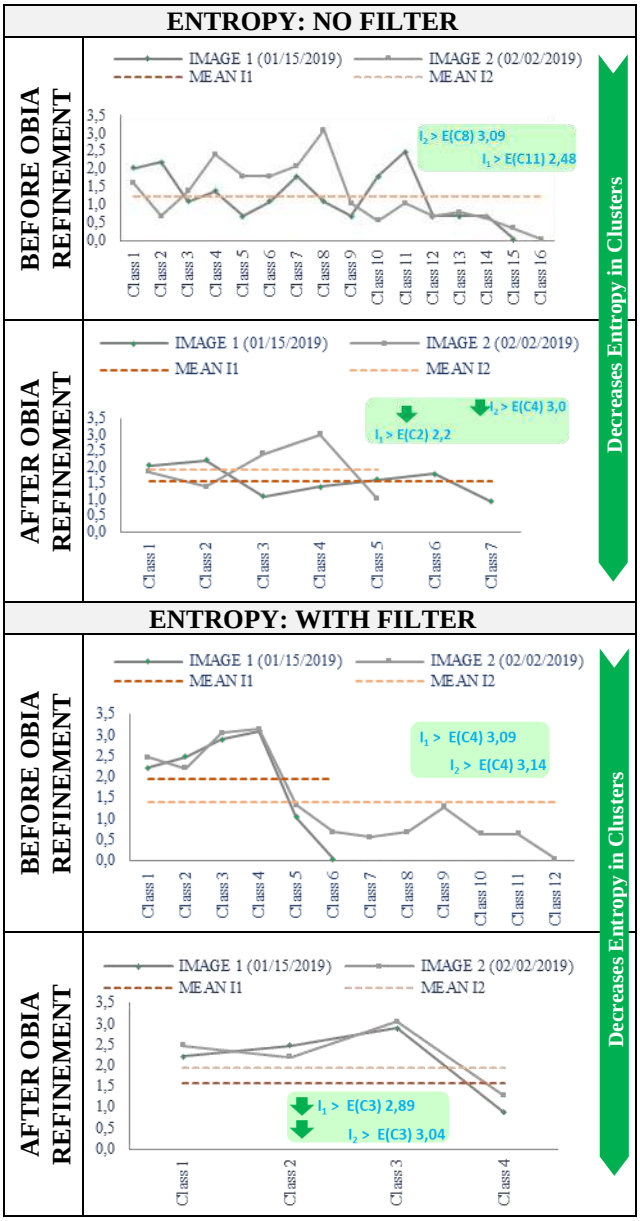


Fig. 7: Entropy: Comparative Before and After OBIA Refining by Scale and Before and After Filter Application.

As can be seen in Fig. 8, the application of O.O. refinement and the use of the filter increase the homogeneity in the clusters extracted by the multilevel thresholding. Considering the homogeneity values for Fig. 1 (01/15/2019) before O.O. refinement and without application of the filter, the extracted homogeneity values of the threshold classes ranged from 0.57 to 0.82. For image 2, the values were in the range 0.62 to 0.89. After the O.O. refinement by scale, for image 1 the homogeneity values were in the range from 0.59 to 0.82 and for image 2 they remained from 0.62 to 0.89. With the application of the filter, the values before and after the refinement went from 0.70 to 0.83 to 0.72 to 0.83 in image 1 and from 0.66 to 0.87 to 0.68 to 0.87 in image 2, increasing in both scenarios the minimum values of homogeneity in the classes. Thus, the descriptor of Homogeneity, which varies from 0 to 1, shows that when the multilevel thresholding with OBIA and filter is performed, there is a significant improvement in homogeneity within the clusters, making the segments more homogeneous and the thresholding classification with better assertiveness tendency.

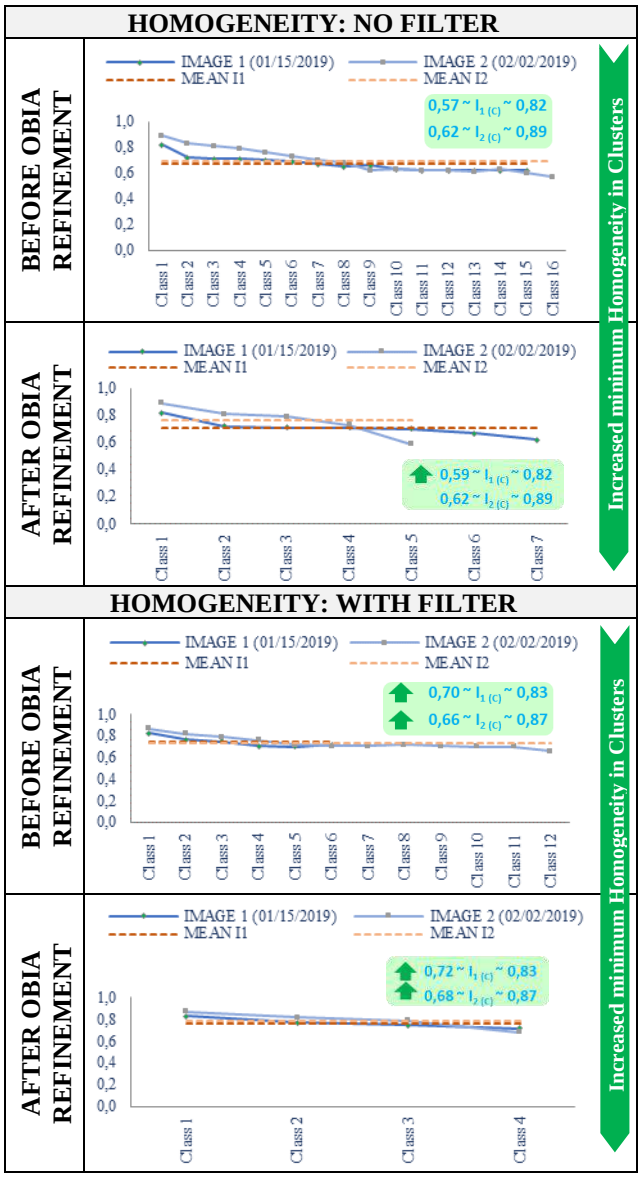


Fig. 8: Homogeneity: Comparative Before and After OBIA Refinement by Scale and Before and After Filter Application.

As can be seen in Fig. 9, the application of O.O. refinement and the use of the filter increase the Correlation in the classes extracted by the multilevel threshold. Considering the correlation values for image 1 (01/15/2019) before O.O. refinement and without the application of the filter, the values extracted from the threshold classes ranged from 0.97 to 0.99, as well as for

image 2. After O.O. refinement by scale, for image 1 the correlation values ranged from 0.98 to 0.99 and for image 2 they remained from 0.97 to 0.99. With the application of the filter, the values before and after refining remained at the nearly maximum descriptor values ranging from 0.99 to 1.0 for both images. Thus, the correlation descriptor, which varies from -1 to 1, demonstrates the similarity between the pixels of the threshold classes, that is, when the multilevel threshold with OBIA and filter is performed, there is significant improvement in the correlation of pixels within the clusters, making the segments more similar and the threshold classification with better assertiveness tendency.

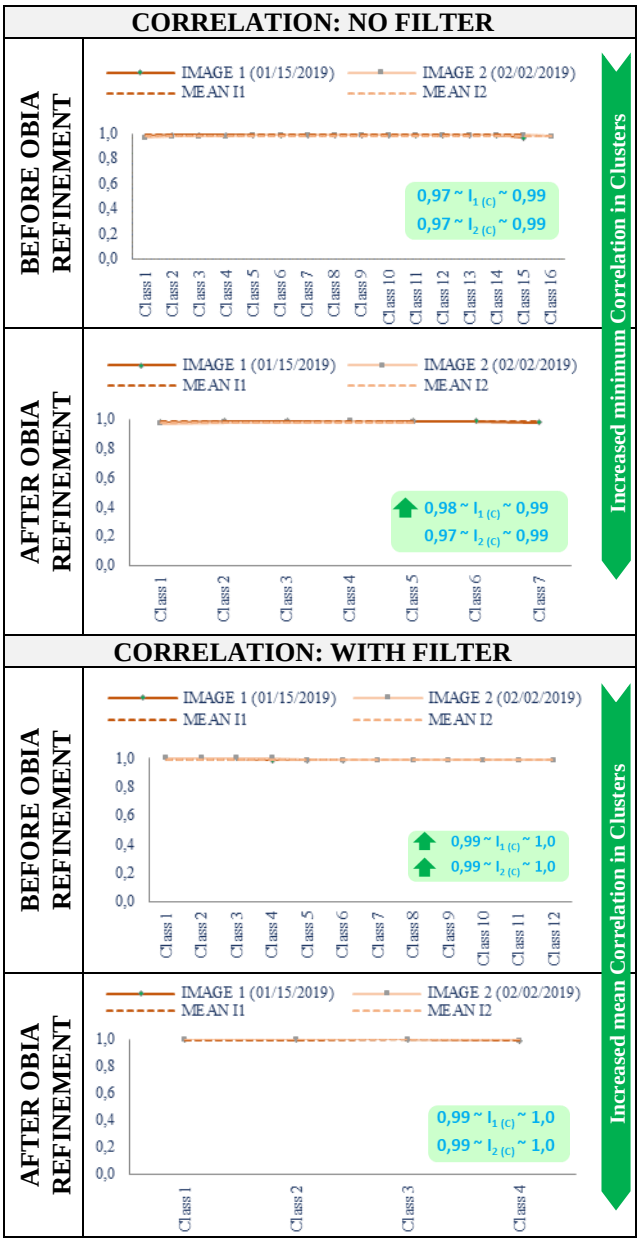


Fig. 9: Correlation: Comparative Before and After OBIA Refining by Scale and Before and After Filter Application.

As can be seen in Fig. 10, the application of O.O. refinement and the use of the filter increase the Euclidean distance between clusters, that is. the separability between the clusters or classes extracted by the multilevel threshold.

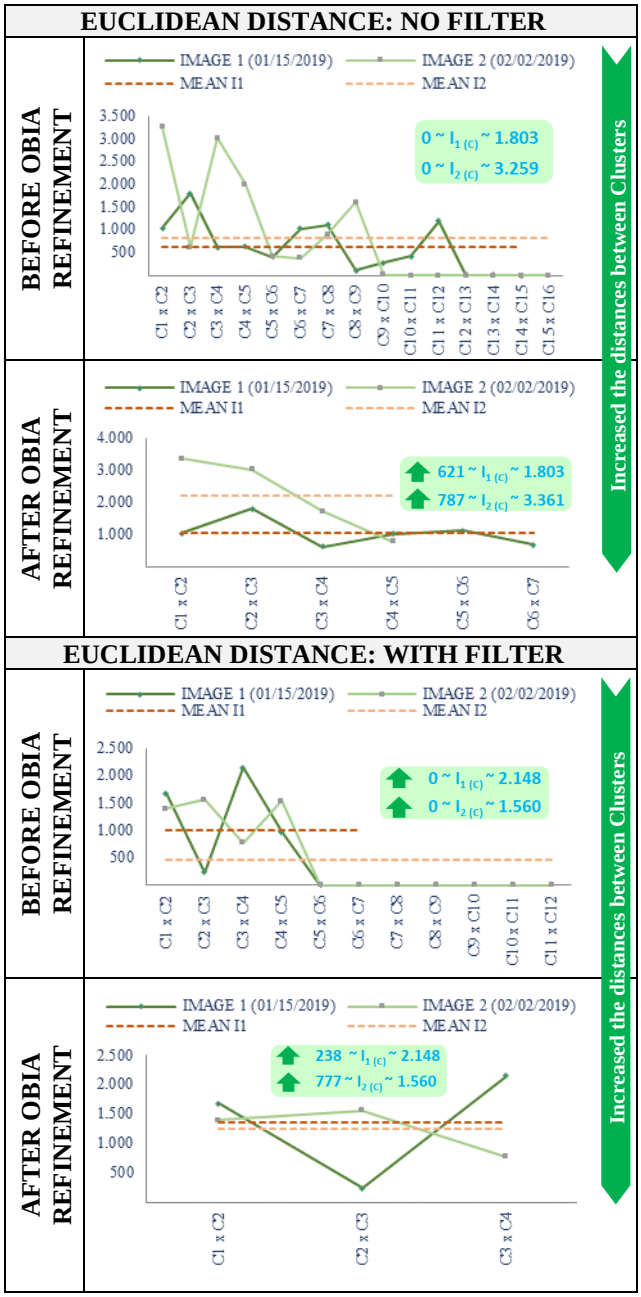


Fig. 10: Euclidean Distance: Comparative Before and After OBIA Refinement by Scale and Before and After Filter Application.

Considering the distance values for image 1 (01/15/2019) before O.O. refinement and without applying the filter, the values extracted from the threshold classes ranged from 0 to 1.803 for image 1 and from 0 to 3.259 for image 2. After O.O. refinement. With the application of

the filter, the values before and after the refinement went from 0 to 2.148 to 238 to 2.148 in image 1. Thus, the Euclidean Distance descriptor shows that when the multilevel thresholding with OBIA and filter is performed, there is a significant improvement in the separability between the clusters, making the segments more homogeneous in the intra-cluster comparison and more dissimilar in the intercluster comparison, that is, increasing the distance between the segments and making the threshold classification with better assertiveness tendency.

Based on the results presented, it is possible to affirm that in addition to the extracted threshold classifications having had assertive signals of the culture development cycle, representing what actually occurred in the plot by the statistical trend analysis, according to Fig. 5, the visual validation of the signals ratifies the quality of the extracted threshold classification, in addition to the extraction of the descriptors finding that the use of OBIA and filter in the multilevel threshold improves the quality of the segments and consequently the threshold classifications.

Table 3 shows the accuracy metrics extracted for each of the classifications in Fig. 6. Thus, the Global Accuracy (G.A.), the Kappa (K), Tau (T) and the Global Disagreement of each of the classifications were generated, being obtained by the sum of the Quantity Discordance (Q.D.) and the Allocation Discordance (A.D.). To test the statistical significance between the Kappa indexes, for each classification intervals with 95% confidence were constructed for the coefficient, where bilateral Z hypothesis tests were performed in order to verify eventual equalities between the classifications at the level of significance of 5%, and comparisons were made between the classifications of the same model and classifications of different models. Thus, the null hypothesis was accepted or rejected from the comparison of the p-value with the significance level adopted, where considering the tabulated Z-value of 1.96 for the significance level of 5%, the results of the Z-Test classifications above 1.96 or below -1.96 were considered statistically different. Therefore, for classifications with Z calculated between -1.96 and 1.96, the hypotheses of equality between the classifications were accepted.

For the 18 classifications performed, about 33.34% of the classification confusion matrices are statistically equal to the 5% significance level, considering the same parameters for the classifications and study regions, before and after the application of the filter with Object-Oriented refinement by the Scale descriptor. Thus, considering the 95% confidence level, the equivalent classifications are those that had global accuracy at 100% with Kappa and Tau indexes of 1.0. Also, such classifications had the p-value of 1.0, being superior to the significance level of 5% with statistically significant acceptance of the null hypothesis of equality for those classifications. For the other classifications, the p-value was lower than 0.002, a value lower than the 5% significance level with rejection of the null hypothesis of equality among the classifications.

Table. 3: Metrics for the PV Model with OBIA refinement, before and after of the filter.

IMAGES	PEAK AND VALLEY MODEL WITH OBIA						Z-Test $H_0: K_1 = K_2$ $H_1: K_1 \neq K_2$	
	NF YF	G.A. (%)	K	T	Q.D. (%)	A.D. (%)	Z Score	95% Conf
1	NF	72.55	0.49	0.45	26.9	0.5	-187.4	≠
	YF	100	1.0	1.0	0	0		
2	NF	100	1.0	1.0	0	0	0	=
	YF	100	1.0	1.0	0	0		
3	NF	100	1.0	1.0	0	0	0	=
	YF	100	1.0	1.0	0	0		
4	NF	100	1.0	1.0	0	0	0	=
	YF	100	1.0	1.0	0	0		
5	NF	75.25	0.50	0.51	1.3	23.4	-151.3	≠
	YF	100	1.0	1.0	0	0		
6	NF	54.40	0.44	0.45	4.3	41.3	10.36	≠
	YF	51.21	0.41	0.42	11.8	37.0		
7	NF	77.51	0.73	0.74	16.1	6.4	-27.7	≠
	YF	84.90	0.80	0.81	11.8	3.3		
8	NF	58.81	0.51	0.52	22.1	19.1	-53.9	≠
	YF	77.13	0.68	0.70	7.7	15.1		
9	NF	84.04	0.80	0.80	4.6	11.4	-50.6	≠
	YF	93.75	0.91	0.92	1.8	4.5		
Mean	**NF**	**80.28**	**0.72**	**0.72**	**8.38**	**11.34**		
	YF	**89.67**	**0.87**	**0.87**	**3.68**	**6.67**		
Median	**NF**	**77.51**	**0.73**	**0.74**	**4.35**	**6.40**		
	YF	**100**	**1.0**	**1.0**	**0**	**0**		

* NF: No Filter; YF: Yes Filter; G.A.: Global Accuracy; K: Kappa Coefficient; T: Tau Index; Q.D.: Quantity Disagreement; A.D.: Allocation Disagreement; 95% Conf: 95% Confidence; ≠: Classifications are Differents; =: Classifications are Equals.

With the results of the classifications, we noticed variations between the different agricultural practices

present in the short and annual cycle plot in terms of accuracy, where more homogeneous areas with less variation in the time of the crop development cycle had greater assertiveness and less errors in the models. Thus, the more heterogeneous the crops within the stand, that is, crop diversity - according to the images in Cycles 6, 7 and 8, there is a tendency to be less global accuracy and agreement rates compared to crops in the stand with homogeneous areas.

Considering the mean and median values presented in Table 3, it is evident that the use of the filter aggregated to the OBIA refinement in the multilevel threshold, presenting higher classification results in relation to the model before the application of the filter. As compared in Table 4 with the mean and median values of the classifications performed for the complete development cycle of the plot, in the analyses performed, when the PV model was applied by multilevel thresholding with OBIA and filter, the results of global accuracy in median was 100%, being 29% higher in comparison with OBIA without application of the filter, with 77.51%.

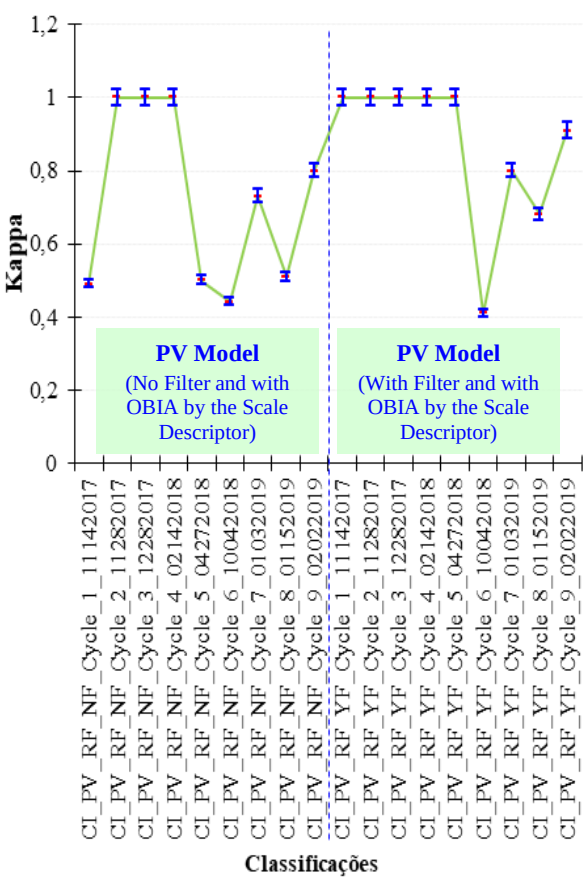
Table. 4: Comparisons of mean and median values for the PV Model Classifications.

		Model PV^1	Model PV^2	ΔPV^1 x ΔPV^2
Mean	**G.A. (%)**	80.28	**89.67**	11.7%
	Kappa	0.72	**0.87**	20.8%
	Tau	0.72	**0.87**	20.8%
	Q.D. (%)	8.38	**3.68**	-56.0%
	A.D. (%)	11.34	**6.67**	-41.2%
Median	**G.A. (%)**	77.51	**100**	29.0%
	Kappa	0.73	**1.0**	36.9%
	Tau	0.74	**1.0**	35.1%
	Q.D. (%)	4.35	**0**	-
	A.D. (%)	6.40	**0**	-

PV^1: Peaks and Valleys Model Without application of the Filter and with Object-Oriented Refinement by the Scale Descriptor.
PV^2: Peaks and Valleys Model With Filter Application and Object Oriented Refinement by the Scale Descriptor.

The Kappa and Tau agreement rates had a median value of 1.0, being respectively 36.9% and 35,1% higher in comparison with OBIA without application of the filter. While the global median disagreement of quantity and allocation was 0% for the PV model by multilevel thresholding with OBIA and filter, the values were 4.35% and 6.40% respectively in comparison with the multilevel thresholding complemented with OBIA, but without the application of the filter. Considering the values in average, the variation in the measures of accuracy, agreement and disagreement are slightly smaller, however, the results with the application of filter and OBIA are still more expressive.

Fig. 11 shows the 95% confidence intervals (C.I.) for each of the Kappa coefficients obtained for the classifications performed. The C.I. takes into account the standard error, which is obtained by dividing the standard deviation by the square root of the sample size.



*CI_PV_RF_NF (Classification Confidence Interval for Peaks and Valleys Model with Object-Oriented Refinement by the Scale Descriptor and without Filter);
*CI_PV_RF_YF (Classification Confidence Interval for Peaks and Valleys Model with Object-Oriented Refinement by the Scale Descriptor and with Filter).

Fig. 11: Confidence Interval: Comparative Before and After OBIA Refinement by Scale and Before and After Filter Application.

According to Fig. 5 and Fig. 11, from the classifications extracted in the model developed, for the classifications with maximum Kappa value of 1.0 (Cycles 1 to 5), the confidence interval had in the lower limit the value of 0.98, demonstrating the excellence of the classification at the level of significance adopted. For the model after the application of the filter, the lowest Kappa index was for Cycle 6 in the image of 10/04/2018, with value of 0.41. With the 95% confidence interval, the value range for this classification varied from 0.40 to 0.42. From the visual inspection of the scene, although initially it seems to present low diversity in the plot and there are characteristics of exposed soil, different nuances can be observed in the plot, being ratified by the information of 6 classes detected by the threshold originally extracted, according to Fig. 6. Thus, it is likely that the accuracy extracted was impacted by mixtures within the plot, such as soil being prepared for planting, which made it not so homogeneous in the transition period between scenes.

V. CONCLUSION

The application of tool developed in Python, called LimiariZC, with the development of module for Peaks and Valleys model, with Object-Oriented refinement and the use of the filter, presented significant results of classifications, where it was found that in the multilevel threshold present in the PV model, when OBIA information is incorporated in addition to the use of filters, of medium convolution passes low, the results are more assertive. The different methods present in the literature regarding thresholding, aiming to find optimal thresholds of separability by different techniques [2] [32] [62] [81], in a macro way present high computational cost, complexity, high specificity and low robustness, and in general do not aggregate the contextual information allowing the O.O. refinement of the classes, which according to the results presented in the proposed approach showed to have the best accuracy.

Moreover, the low response time in processing - around 25 seconds for execution of the model for areas of up to 100 ha, which represent almost 90% of the rural properties in the country, contemplating in processing the emission of signals - with reduced investment cost, add innovation and differential technology, making the proposed method effective and attractive.

The decision tree built for the emission of automated signals for the detection of changes in the multilevel thresholding model, by means of an analysis of statistical trend from the extraction of a set of variables and descriptors that demonstrated a standard behavior of knowledge for remote monitoring of crops, proved to be significant in the emission of warning signals of loss of vegetation or warning of vegetative growth. The tree originated from the proposed method aimed that the attributes would direct the hierarchical tree, without the substitution of the parameters by the repetitivity employed in traditional decision tree algorithms such as J48, Random Tree, Random Forest, REPTree, Logistical Model Trees among others [27] [29] [37] [45] [49] [83], in order to find the best separability attribute.

The results indicated that the attributes extracted from Entropy, Homogeneity, Correlation, Euclidean Distance and Coefficient of Variation, whether extracted intra-clusters or inter-clusters, were positively affected with the use of the multi-level threshold with OBIA aggregated to the use of the filter. Although the work demonstrates the effectiveness of the descriptors to ratify the improvement of the clusters extracted by the automated multi-level thresholding with O.O. refinement and application of the filter, the use of descriptors in the monitoring corroborates with studies presented in which they proved feasible for the detection of changes [44] [46]. In the comparison of images with filter before and after O.O. refinement, it was observed that when the image goes through a filtering process, with smoothing of the short peaks and shallow valleys in the histograms, the filter decreases the Total Coefficient of Variation of the scene indicating less dispersion around the mean and improvement of the accuracy in the threshold classification. Also, the descriptors extracted indicated an improvement in the degree of impurity within the classes, making the groupings more similar, with greater homogeneity of pixels and classes more uniform, and correlation between pixels with improved threshold classification. Thus, it was detected that the separability between classes increased, demonstrating greater group isolation and a more precise classification with more dissimilar clusters when compared to each other.

Thus, with the set of results, it was possible to assess the quality of the proposed method and its feasibility for remote monitoring in agricultural productions, where the alert/warning emissions showed assertive results in all tests demonstrating the feasibility of attending in the mitigation of risks in the fundable area, without necessarily having on-site visits.

The results obtained showed that the model can be used as a significant indicator of oscillation and multitemporal trends in land use and cover for detecting changes without necessarily carrying out on-site visits and in line with the Government Consultancy for agricultural financings with the recommendation of the Central Bank of Brazil and which can be extended to other countries due to population growth and the need for new areas for planting with the

consequent release of agricultural credits. Thus, the methodology aims to monitor the development of cultures, reducing face-to-face work. Finally, although the models were applied in a study area in Brazil, can be used in any region of the planet for monitoring areas with agricultural financings or that will be financed, allowing greater control and inspection by those responsible for releasing agricultural credit, that usually has government subsidies.

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Perception of Death in the view of Christians

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Abstract*—*The social conception of death is distinct in several social groups, as a result of a long historical process, marked by different customs that involve existential, subjective and spiritual dimensions. This article aims toseek to obtain the perception of the Christian community about death, and choices in the face of a terminal illness. Raising issues related to euthanasia, and the moment of death, both of the person himself and that of loved ones. The results obtained show the opinion against euthanasia on the part of Christians, it is clear that they do not consider the possibility of taking the life of a human being in cases of terminal illness. It was found that Christians choose life, be it with almost unbearable suffering, or not.

I. INTRODUCTION

Death is a natural phenomenon, just as all living beings were born one day, they will also know death, in one way or another. Normally, the time to leave is not chosen, except in cases of suicide or euthanasia. Among the various groups with different opinions on the topic in question, Christians are one of those who have a more fixed and immutable opinion.

For this quantitative and investigative research, a questionnaire was used as an instrument to collect data regarding the perception of Christians about death. This questionnaire was prepared by the researcher and her advisor. This questionnaire was applied to 20 Christians, 10 of them Protestants, and 10 Roman Apostolic Catholics. It was applied to both sexes, aged 18 to 40 years old.

THE ELABORATION OF MURRING THROUGH THE WAY OF RELIGION

Psychoanalysis, a theoretical current in psychology, studies the unconscious of the human being, and explains the mourning process, which is carried out through the reality test, which when repeatedly evidencing that the object no longer exists, demands that the libido detach itself from the lost object, thus having an elaboration of the mourning.

Grief is a slow and painful process, which has as characteristics a deep sadness, removal from any activity that is not linked to thoughts about the lost object, the loss of interest in the external world and the inability to substitute with the adoption of a new object of love (FREUD, 1915).

The grieving process is one of the biggest challenges to the balance of the psyche and that, depending on the type of loss, such as violent, early deaths, loss of a child, among others, the elaboration can become very complex, with great possibilities partial failure of this work, and even serious psychological problems may arise.

Psychoanalysis also brings us to the definition of symbolism as being a parallel between two ideas, one will replace and represent another primary and unknown idea of the conscious mind.

When suffering a loss, the subject must have an elaboration, some people take a short period for this, while others take a longer time, this will depend on the subjectivity of each human being. At first, all this suffering caused by mourning comes to the subject through the real, in a second moment it becomes through the symbolic.

One of the most common and satisfactory forms of mourning is for religion, in this article we deal with Christianity.

A Christian on hearing of the death of a loved one will seek comfort in his faith and beliefs, we easily perceive this when hearing statements such as "He is in a better place" "He is with Christ", thus minimizing the dimension of suffering.

Christians regard death as "profit", as an encounter with Christ, they consider it not as the end of a life but as the beginning of a "new cycle" (the "new heaven and new earth"). Even though death is considered a gain, it is not easy to face. The “eternal return” is the crucial mark, that is, life flows continuously, being punctuated by death, which marks the transformation of life.

We can notice how significant the belief is made in a person's life, when seeing even non-Bible practitioners seeking comfort in Christianity at that time, reflecting on their life and even repenting for their acts considered sins.

EUTHANASIA ON THE VIEW OF CHRISTIANS

Currently, there are several possibilities in the face of the suffering that occurs during the last moments of a person's life, such as euthanasia, which is the act of providing death without suffering to a terminally ill patient, affected by an incurable disease that produces intolerable pain. for example, however, the idea that we find in Christianity is that the only one worthy of taking a subject to death on this occasion is God.

A human being causing the death of another, as a result of a clinical condition, is considered a homicide by Christians, and not a way to help others. The Christian would find himself disobeying one of the "Ten Commandments", the "Thou shalt not kill".

CHRISTIANS IN RELATION TO PROFESSIONAL AID

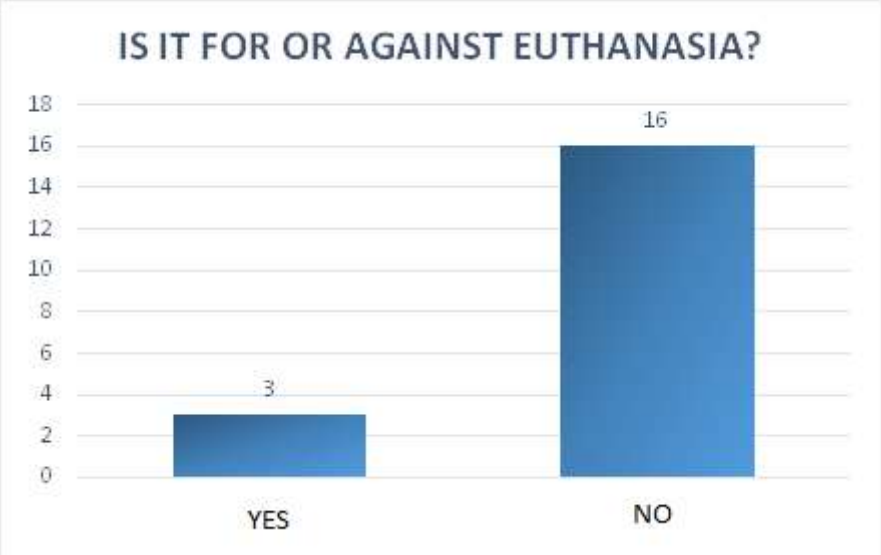
Mourning is characterized as a loss of a significant link between a person and his object, therefore a natural and constant mental phenomenon during human development. In this context, as it is a constant event, it ends up directly implying the work of health professionals, becoming a necessary knowledge for adequate protection for those who suffer the loss. One of the professionals with an extremely important role in this context is the psychologist, who will accompany the terminally ill patient, helping to understand their clinical condition. The psychologist will also be working with the subject's relatives in a terminal state, both in the acceptance process and in the case of the patient's death, helping in the elaboration of the mourning of these relatives.

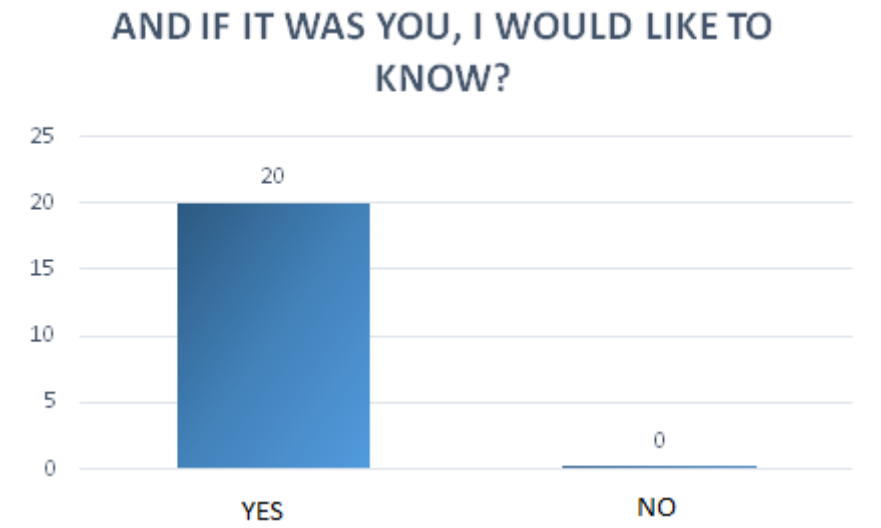
When the psychologist or health professional is adequately trained, there is a greater preparation to deal with death situations, as, for example, in the great catastrophes in which deaths occur, being able to follow up on family members in the recognition of corpses. One of the objectives is to assist as emotional support for family members and in the grieving process. The professional with the best conditions to understand and support families in pain allows them the feeling of protection, as well as providing validation of the mourner's feelings and emotions (Ramírez, 2011; Reverte, García, Penas, & Barahona, 2014).

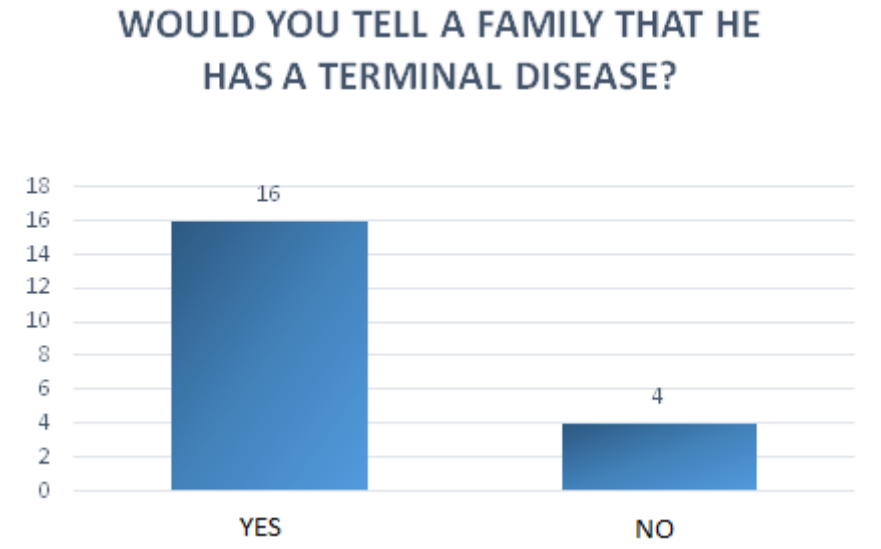
However, there is still some prejudice in relation to these professionals, including some Christians, who are totally supported by religion and do not think they need professional help, there are those who think that it was God who made him go through mourning, it will give you the strength to face that moment. Currently, fewer people think that way, but they still exist.

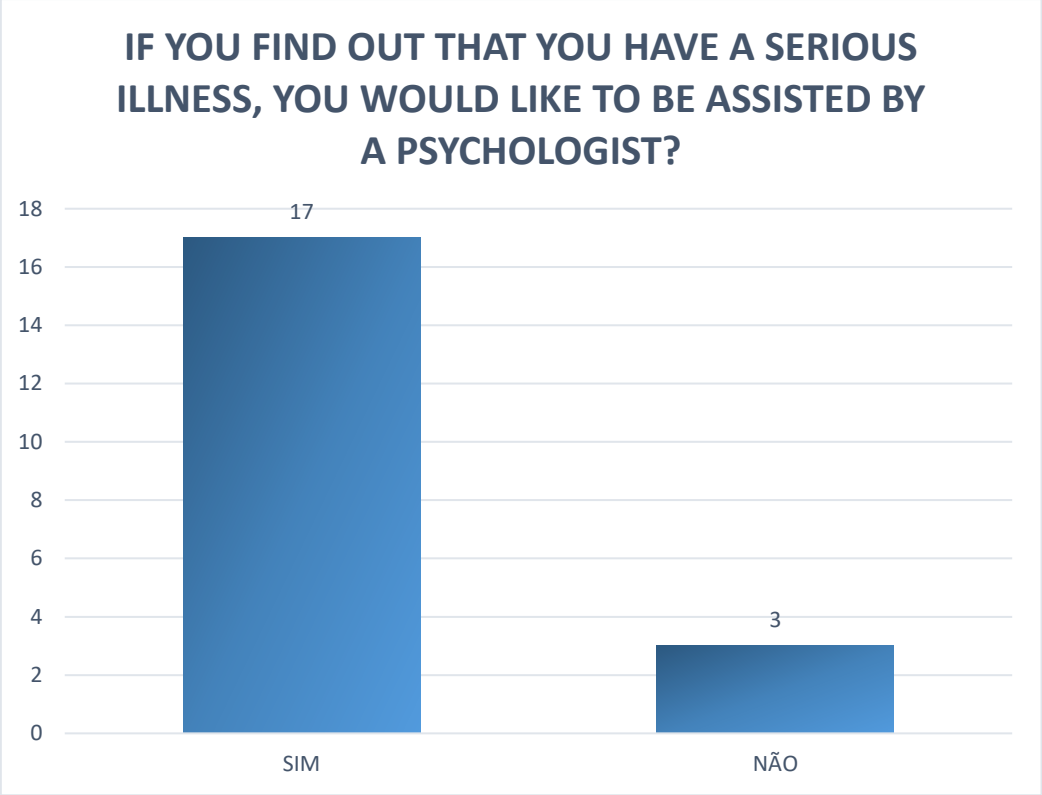
II. RESEARCH AND RESULTS

For a better perception of the view of Christians in relation to death, the present field research was carried out. The collected data follows:


IS IT FOR OR AGAINST EUTHANASIA?
18
16
14
12
10
8
6
4
2
0
3
16
YES
NO


AND IF IT WAS YOU, I WOULD LIKE TO KNOW?
25
20
15
10
5
0
20
0
YES
NO


WOULD YOU TELL A FAMILY THAT HE HAS A TERMINAL DISEASE?
18
16
14
12
10
8
6
4
2
0
16
4
YES
NO



The sample showed 85% of respondents are against euthanasia, with only 3 (15%) in favor. Only 4 (20%) of people would not reveal to a family member that they have a terminal illness, however all 20 (100%) would like to be informed if they were in such a situation. All participants, even those who said they were in favor of euthanasia, would not interrupt their own life or that of a loved one in the event of a terminal illness. Of the subjects submitted to the research, 17 (85%) would like to be assisted by a psychologist in case of a serious illness.

III. FINAL CONSIDERATIONS

Talking about death is always taboo. Death is seen as something unpronounceable, an irreparable loss.

In this research, the data collected indicate that 100% of the interviewees would like to know if they were dying, as this would give them a chance to better enjoy their time with their family members.

It is possible to realize that even in the face of the suffering of a loved one, the interviewees mostly agree that they should not postpone their death. Regardless of the doctrines, they agree that man should not take the life of another, because he does not have that right.

The best thing to do is to keep the patient in a condition that is at least comfortable, so that he can spend his last days well.

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Physical and Psychological Trauma Caused by Traffic Accidents

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***Keywords*—Death, Christians, mourning, euthanasia.**

***Abstract*—*This article aims to bring understanding about the Physical and Psychological Traumas Caused by Traffic Accidents, which every day has occurred with greater frequency. The traumas left by the victims end up harming their life in society, their work, among others. It is a fact that the larger the population, the greater the number of people who use transport, however, it should also be taken into account that traffic accidents also occur with pedestrians. Another factor that needs to be understood is that accidents generate many costs and consequences for victims and their families. Not only in relation to material costs, but also emotional ones, which make it difficult to return to society and socialize with other people.GOALS: The aim is to make the theme more explicit, showing that the physical and psychological traumas that traffic accidents cause to victims cause many consequences in society's life, bringing harm to the victim and several consequences. METHODOLOGICAL APPROACH: it is a quantitative bibliographic research, being carried out online and also in different sources, with different authors and websites, which could bring information about the proposed question. A reading and selection of texts that brought answers that are concrete to explain the subject clearly and objectively was carried out. RESULTS: In view of the authors and websites surveyed, it can be understood that physical trauma can affect the daily life of injured people, and simple everyday actions such as dressing and eating can become major challenges. Furthermore, it was possible to understand that accidents bring many costs to both the health system and the victim. Regarding psychological trauma, it is understood that they are emotionally imprinted on the victim, leaving her with fears of going back to her routine, in addition, they cause various stress, which may develop into depression.*

I. INTRODUCTION

Currently, we cannot think about what people's lives would be like without the means of transport that help them move around and quickly come and go. But, with the great growth of the population and the means of transport that are needed, a high rate has emerged in society, that is, the high rates of traffic accidents that happen daily all over the world. These, for the most part, leave trauma to the victims, beingthese, both physical and psychological.

Physical traumas cause a lot of damage both for the victims and for the health system in general, because for each accident that occurs, there is an engagement to help the victims at the right time. That goes without saying, from the expenses of the hospitals' health system to attend

the patient with all the emergency support. That's why it becomes so relevant to discuss the topic, because every day, more deaths occur all the time. In addition, many of the surviving victims are for a long period recovering and in some cases, with consequences that are irreversible, harming their family life and in society with the others involved.

Traffic accidents can occur with cars, pedestrians, cyclists and also with motorcycles, the latter are very dangerous and in many cases are fatal, being responsible for a large number of deaths. According to Silva et. al. (2015, p. 1689), "among the damage caused to patients who survive motorcycle accidents, motor and psychological sequelae and mutilations stand out. According to data from the World Health Organization (WHO), between 20 and 50 million victims of traffic accidents survive with trauma and wounds". Thus, the relevance of the subject within our society can be seen.

So, one of the problems we have is the large number of motorcycles that travel on public roads, many of them irregularly. Not everyone is able to buy cars and therefore opts for the motorcycle as it is more accessible and even easier to get around in congested traffic. However, it can still be observed that there are many vehicles that travel in bad conditions on the roads. Another factor that needs to be mentioned is that serious accidents do not only occur on major highways, but also in small places on dirt roads, where drivers are even more irregular, underage driving, loose animals, do not respect their space on the road, among others.

Therefore, this study aims to understand how traffic accidents involving different vehicles can leave trauma to victims. Try to speak a little more objectively and concretely about this subject. Seeking to anchor in several selected authors who could serve as support to find answers and clarify the topic in question.

Because people victims of accidents carry the marks of the lived experience, these can make it difficult to return to social life, because in addition to the physical traumas, there are also psychological traumas that can isolate the person, leaving them with fear and unwilling to return to the daily routine.

Taking into account that, nowadays, more and more lives are lost in accidents, many do not even reach adulthood. And the traumas left can lead to lifelong problems. So, talking about this topic becomes of paramount importance, and it is essential that when discussing the subject, we can contribute to greater understanding, and who knows, to an awareness of greater responsibility when driving, seeking extra attention and simple care that can save many lives.

The numbers found in surveys demonstrate that Brazil is among the countries with the highest rates of traffic accidents and the factors are numerous. However, it becomes necessary for each one to do their part, seeking greater care when driving and thus, perhaps the numbers could decrease in a more significant way these days.

II. GOALS

The objective of this work is to show a little about the physical and psychological traumas that traffic accidents cause to victims. It also aims to demonstrate how these end up changing people's lives within the society in which we live. In addition, it also demonstrates how the consequences left by traumas can lead to different problems both individually and collectively. Problems such as medical expenses, mobility difficulties, emotional difficulties, stress, disabilities, depression, among others.

III. METHODOLOGICAL APPROACH

The methodological approach used for the construction of this work was a bibliographical research, searching online and other sources, such as books, magazines, etc., for materials that could theoretically help its elaboration. The research has a qualitative character, that is, it is a literature review in order to answer the proposed question. At first, a selection of texts that were in line with the theme was carried out. Among the analyzed authors, some who were in agreement with the proposed theme were selected. Then, a detailed and careful reading was carried out, to select the conceptions that could answer and clarify better, about the physical and psychological traumas that remain in the victims of traffic accidents survivors. These articles were the theoretical basis for the construction of this work,

IV. RESULTS

Every day the number of vehicles on the streets grows, this great demand also generates countless accidents all the time. According to a survey carried out byWorld Health Organization (WHO) in 2009 with 178 countries, showed that about 1.3 million people die every year, because of traffic accidents. Of those who manage to survive, at least 50 million people live with various sequelae. Brazil appears in fifth place in the ranking of countries that have more deaths from traffic accidents. (Metro Newspaper, 05/01/2017).

Traffic accidents can be classified as a casual event that has no intention of happening on a public road, causing victims with injuries, whether physical or even emotional, by shock or some collision. It is understood as a problem

of urban life and civilization caused by the circulation of motor vehicles in everyday life within the society in which we live (OLIVEIRA, 2015, p.12). However, it must be said that vehicle accidents are not only a problem in large urban centers, but are also frequently seen in small towns and rural areas. One of the factors of these accidents is certainly the lack of adequate inspection, where recklessness is clear. Usually minors drive vehicles and mainly motorcycles at high speed, in addition,

By analyzing the data found, we noticed that in the ranking of the roads with the most accidents, the "BR-381 ranks first in deaths: 192 deaths in 4.6 thousand accidents were found in the stretches between Belo Horizonte and the border with São Paulo and between the capital of Minas Gerais and Governador Valadares, in Vale do Rio Doce." (UAI PORTAL, 2017)

Even so, from aaccording to the website Happened in the Valley "from January to April 2016, Minas recorded 82,802 accidents. In the same period of 2017, there were 80,795 occurrences, a drop of 2.5 percentage points". So, you can see that,there was a considerable drop when comparing the first four months of 2017 with the previous year, however, this drop is still not enough given the large proportion that still persists.

Although statistics show a reduction in the number of traffic accidents in the state of Minas Gerais, the numbers still show a large portion of accidents that occur in the state. According to a publication by the UAI Portal (made by Marcia Maria Cruz02/26/2015), "soly at Hospital de Pronto-Socorro João XXIII, a reference in Minas Gerais in caring for traffic traumas, 13,627 victims were treated last year as a result of being run over, crashes and other accidents involving cars, buses and bicycles".

These traffic accidents occur due to different factors, among humans, Cruz (2013) apud Martins (2016, s/p.) states that they are related to "the unsatisfactory training of those involved, linked to incompetence, disqualification, inexperience, among others, or to their adverse physical and psychological conditions, such as fatigue, drowsiness, stress, aggressiveness, euphoria, haste and inattention. Causes that generate traffic errors by its users". However, it should also be taken into account that many roads are in very bad condition; the rainiest periods and vehicle failures, among other external factors that can lead to daily traffic accidents.

Physical Traumas

Accidents leave marks on victims, whether physical or psychological, traumas that in many cases are irreparable to return to a normal life within society. Filho (2012, p. 151) states that traffic accidents are the main causes of death and are also responsible for different types of injuries "in varying degrees of extent and magnitude, permanent and temporary disabilities, sequelae, pain and suffering for victims and their families around the world."

This extension of injuries changes the life of the accident victim, making them more prone to various problems, especially physical ones, as the damage from an accident can change an individual's life routine, leaving marks that will make it difficult for them to move. , work, do simple things. About the physical traumas Mattoso and Cravo (s/d, s/p.) highlight that:

Physical disabilities resulting from traffic accidents cause serious damage to the individual, such as financial, family, travel, professional and also for society such as hospital and social security expenses, etc.

Physical impacts are the immediate consequences of an accident, which can be temporary and easily treated, such as fractures, bruises, trauma, but can also be permanent and disabling such as paralysis, amputations, neurological injuries.

While Prado (2001) apud (BARROS, 2008, p.28) states that: "Violence in traffic generates and redimensions individual and collective issues. At the individual level, traffic accidents primarily affect the individual and, at the collective level, they generate impacts on the family, the work group, the health care service and social security, that is, society as a whole. " The authorToletino (2013, p. 20) adds that, "fatal accidents are just the tip of the iceberg because accidents with sequelae and accidents that evolve to full recovery should be considered, but have a long hospitalization time, sometimes needing , of surgeries. And he adds that they are also responsible for overloading health services with a high demand from health professionals, hospital beds, and intensive care units." However, there are still other expenses, which can bewith social security, or material damage to vehicles; the loss of loads; removal to patio; lawsuits and also damage to public and private property (ZIMMERMAN, 2008).

Therefore, it can be said that the damages will depend on the type of injury that the person will suffer after a traffic accident. In addition, the impacts of accidents will not only be on the victim, but will also reflect, in a certain way, on the collective that surrounds them, that is, the family. Thinking like this, it can be said that the greater the physical injury, the greater the difficulties to be faced after the accident.

According to Cruz (2015, s/p) "the sequelae left by a crash can range from a broken leg or arm to more serious consequences, such as head trauma and spinal cord injuries, among others." already stopSilveira and Souza (2016, p. 378) accidents can compromise the individual's perception of theirliving conditions, their psychological

well-being, with a reduction in the ability to work, and limitations in physical aspects, thus resulting in a decrease in the individual's quality of life. They also emphasize that, the sequelae of accidents bring many limitations to the performance of "the most basic and important daily activitiessuch as mobility, work, health and autonomy for daily activities (dressing, bathing, eating, among others), there are also abrupt changes in lifestyle and health due to injuries."

Given the conceptions of Cruz (2015) and Silveira and Souza (2016), it can be said that the physical traumas left by traffic accidents affect the quality of life of the victim in general and also that of their families, leaving them largely dependent on other people, temporarily or for life, varying by the complexity that the injury caused.

According to Ramos (2008), bringing the conceptions of Siate (2004), the trauma mechanism can happen through the compression of the body, creating injuries, that is, due to the slow deformation of the body (crushing) or through the impacts that are caused as a result of excessive speeds. Thus, it is noted that speed contributes to the impact of the accident, among other factors. In addition, the way in which the crash occurs in vehicles also influences, that is, whether it is frontal, lateral or rear. When the accident happens to the pedestrian or the cyclist, they do not have any support or protection that can support them at the time, so depending on the impact it can cause death. Motorcycle accidents are much more complicated too, as the passenger only has the helmet as protection, your body is free for any impact it may suffer. In addition, at the time of the accident, it may be at high speed, which generates greater consequences and seriousness in the face of the accident. For the most part, physical injuries can be permanent.

Psychological Trauma

Psychological trauma, another factor that needs attention, because, after a traffic accident, the victim's life is no longer the same, most of the times it affects the emotional, psychological and social aspects, leaving the victim afraid that it will occur. something again. In addition, the sequelae left can cause other challenges, according to Martins (2016), when the person becomes disabled due to the accident, they experience psychological suffering, because they feel responsible for the family's survival in many cases. , comes to believe that he has become a burden for his family, becoming a sad and depressed person.

Based on Martins' conceptions, it can be noted that when the accident leaves a disability, the person feels unmotivated for being dependent on others, which leads to psychological problems, depression and even greater social isolation. These invisible sequelae can be an even greater damage than the visible ones, as the victim hides his feelings, may feel guilty about the accident, thinking about what he could have done to avoid it, among other issues that cross the mind of the injured victim.

According to Cavalcante et. al. (2009, p. 1765) "when a person perceives the moment of the accident as very dangerous, he may experience a peri-traumatic dissociation, feeling robotic or out of the traumatic scene, as if he were in a movie, which may bring disturbance mental since dissociation is a defense that has the cost of "disintegrating mental processes". And he emphasizes that, "a study that investigated three million people involved in road accidents, estimated that between 8 and 40% of them will have post-traumatic stress disorder in the first year after the accident. Thus, it is fair to say that the victim of an accident will have a stress disorder that will certainly harm their daily life. In addition, the person is not always able to forget the facts that occurred,

According to Magalhães (2006) Apud Martins (2016) understand that the post-traumatic stress disorder that is in the victim who suffered a traffic accident, in general, can manifest a loss in the post-accident psychosocial adaptation, with depressive and anxiety traits that can reinforce the feeling of being sick and debilitated. And that these manifestations in accident victims make it difficult for them to resume social and professional activities.

Therefore, accident victims do not feel good emotionally to return to society in a natural way. With that, they start to look for help in therapies and medications, to try to have a normal life, like the one they had before the accident. This psychological and emotional difficulty also affects family members who are trying to find answers and solutions. According to Cavalcante et. al (2008), relatives of injured victims are unevenly affected, given the impacts and consequences it causes. It can affect the health of the entire family group, bringing a commitment or perhaps strengthening the social network to be able to overcome the problems.

Thus, it can be understood that the psychological traumas that are left after accidents are diverse and their consequences will vary in each person's life. However, it is important for the victim to seek some psychological help to overcome obstacles and be able to settle down and return to his normal life within society.

V. FINAL CONSIDERATIONS

From the data collected, it is observed that Brazil is among the countries with the highest rate of traffic accidents. And this high number of accidents is due to the excess of vehicles that circulate each day on public roads, where

several factors are responsible for the cause of accidents, including: human failures, vehicle failures and also factors such as bad roads, rain, and others more. These impacts are different depending on the type of accident or even the type of vehicle that the person is impacted on.

It could also be seen that traffic accidents kill daily and that survivors face both physical and psychological trauma. Regarding physicists, we can observe that they generate costs for both the health system and the victim. In addition, many of the survivors of accidents are left with sequelae, from the simple to the more complex, being still dependent on someone to take care of. Thus, the injuries caused to the victims cause several problems, these can also affect the psychological, making the person more prone to a state of depression and sadness.

In addition, it is important to understand that the victim's recovery is usually slow and this generates several problems such as: difficulties to support their family, loss of monthly income, medical expenses, need for daily help, therapies, physiotherapy, among others.

About psychological trauma, it can be understood that the victim's emotional state is very debilitated, where the images can come back daily in the memory, bringing a disorder to the person, needing to seek help from a professional to return to society. In addition, the entire group suffers from traffic accidents and patient rehabilitation.

It should also be said that, through this study, it was possible to understand that large parts of the deaths that occur in Brazil are related to traffic accidents. Not only in large BR, but also in small towns, many of these fatal. Therefore, it is understood that public policies need to pay more attention and seek strategies aimed at greater awareness to reduce traffic accidents. And also seek to resume security measures and punishment for the infractions that occurred. Only then will it be possible to avoid so many lost lives and countless traumas, both physical and psychological.

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Integrative Review - Mental health and COVID-19 - depression in times of Quarantine

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***Keywords*— Mental Health, COVID-19, Depression.**

***Abstract*—** *Objective: To evaluate how to maintain mental health to minimize depression or prevent its emergence in quarantine times. Literature Review: COVID-19 caused a major worldwide movement in 2020, this disease emerged in China in 2019, but spread rapidly in the world. Thus, people were forced to adhere to social isolation to avoid the spread of the virus, but with this, other problems arose, which were linked to the mental health of the subjects. Thus, cases of anxiety and stress were increased, as well as intensified the depression of the subjects, which is a major problem. Therefore, it is necessary to look for ways to mitigate these conditions that were caused by the modification of the subjects' routine, however, this is a challenge, because to overcome these problems it is necessary to have well-established routines with scheduled activities. Conclusion: It is concluded that social isolation has contributed to the increase in depression, however, it is important to seek healthy habits and routines to minimize its impacts.*

I. INTRODUCTION

In times of quarantine due to COVID-19, social isolation has caused subjects to develop anxiety and stress, which has been a major problem, especially for people who have depression. Therefore, it is important to look for ways to understand how to overcome these problems to prevent these problems from getting worse, and it is important to look for ways to practice healthy habits to occupy the mind (BROOKE J and JACKSON D, 2020).

These problems occur because there has been a moment of uncertainty, which changes the entire routine of the subjects, which is a major problem for those who already suffer from some mental disorder. Moreover, in these subjects, these issues can further accentuate this generalized anxiety picture, so it is important to seek assistance from specialized professionals, who have often attended online at this time of crisis (ARMITAGE R and NELLUMS LB, 2020).

Online care has contributed significantly to the improvement of anxiety and excessive stress. However, it is important to create a routine, incorporating the performance of pleasurable activities, healthy eating, exercise, among other things. Thus, the subjects can avoid the worsening and emergence of these critical problems in moments of social isolation (WANG C, et al., 2020).

Therefore, taking into account the situation of social isolation provided by COVID-19, as well as its impacts on the mental health and depression of the subjects, this study aimed to evaluate how to maintain mental health to minimize depression or prevent its emergence in times of quarantine. This objective was achieved with the exhaustive analysis of the specific literature on the subject, indicating what measures can be taken to ensure the mental health of individuals.

II. BIBLIOGRAPHIC RESEARCH METHODOLOGY

The methodology used was based on (OLIVEIRA et al., 2018).

To identify articles that report behavioral changes in the population due to social isolation, caused by the pandemic of the new Coronavirus SARS-COV-2 and depression in quarantine times, searches were performed for scientific articles in the PubMed, ScienceDirect, Sciello, Google Scholar, Dialnet, and DataSus databases.

In the present study, the research strategy on the subject COVID-19, depression, and mental health consisted of the use of the keywords in English: 1. COVID-19 AND Depression; 2. COVID-19 AND Quarantine; 3. COVID-19 AND Mental Health. The following filters have been added to the search in ScienceDirect: only journals; title, abstract; keywords.

After consulting all the databases and using the search strategy adopted, repeated articles were identified between the different data sources. The criteria and filters for the inclusion of the articles in this work were: Original research articles that conceptualize the relationship between the depressive effects of social distancing, due to the COVID-19 pandemic, in different types of research fields, covering research completed in the present languages: Portuguese and English.

The studies taken from the study were grouped in the following order: repeated, irrelevant, other publication formats (edict, short communications, perspectives, letters), and other languages that were not well understood. In addition, manual searches were performed in bibliographic references of the review articles found with the previously predetermined keywords.

III. RESULTS

Further studies are needed to identify the endemic direction of the population's depressive problems during a process of social isolation because of other social and family psychological problems. Therefore, because of the different searches in the databases, 37 articles have been used that cover the theme addressed in this study. After the removal of the duplicate articles, the exclusion criteria were applied. Through manual search, 2 more articles were retrieved (Fig. 1).

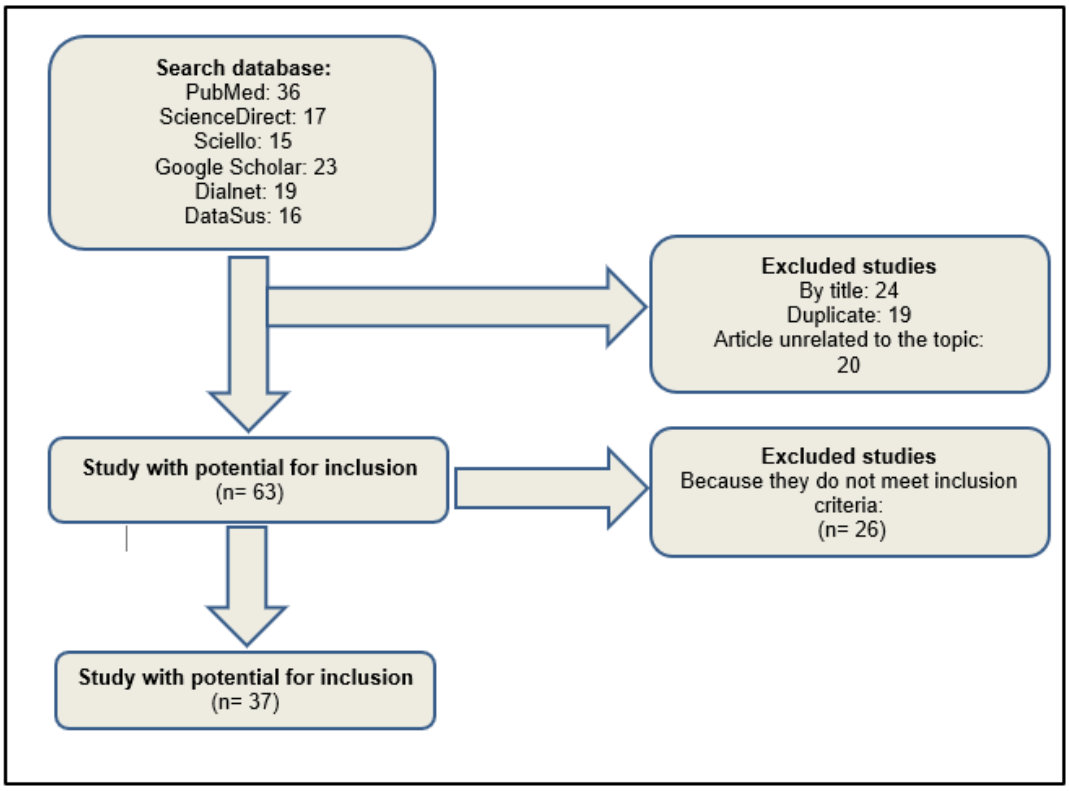

Fig.1: Flowchart of identification and selection of articles prepared by the authors, 2021.

Finally, through a word cloud, the keywords used to collect information in databases were visually identified. Larger words indicate factors that lead to the incidence of increased depression and mental health problems, given the SARS-COV-2 pandemic according to the region where it is located. The lowest, the lower the incidence (Fig. 2).

Fig.2: Source: Prepared by the author (2021).

FACTORS OF SOCIAL ISOLATION

Social isolation consists of separating the subjects or else the groups of conviviality with the other beings of society, and this event can occur on a voluntary or not basis. It is worth mentioning when the group or the subject himself is spontaneously isolated due to religious, personal, or mental health issues, it can be affirmed that voluntary social isolation occurs. However, when there is a reason for force greater force in which the government is forced to impose, either by a pandemic, by war, or by urban violence, it can be affirmed that isolation is forced. Thus, it can be affirmed that social isolation is related to external and interior factors. The main causes of these types of social isolation, as well as their variants, are explained below (KLINENBERG, 2016).

Voluntary isolation, as mentioned above, is related to religious reasons, personal will and depression and other psychiatric diseases. Concerning religious motives, it is important to point out the Amish who choose to isolate themselves socially from the groups so that they can maintain, according to them, the religious purity of the community. These peoples are extremely conservative Christians, and they do not tolerate any interactions with modernity, especially with technologies. Another reason for social isolation is a personal will, and some individuals choose not to live with other individuals for their reasons, and for this there is no force greater to force them to isolate themselves (ISLAM A and KUMAR B, 2020).

And finally, the last link with voluntary isolation is depression and other psychiatric diseases. Therefore, when subjects are affected by diseases such as borderline syndrome, bipolar disorder, depression and other psychiatric comorbidities, they may opt for social isolation. However, this option is not something that the person chooses since illness is not a choice. However, it is stated that isolation is voluntary because it does not emerge due to external factors (KONNING EA, 2019).

Involuntary isolation, violence, wars and pandemics can be mentioned. Violence occurs when its indexes rise suddenly in a place, with this it is necessary to establish social isolation through a touch of recourse. This is necessary to prevent the population from getting in direct contact with homicides, for example. Thus, the curfew needs to be imposed by the subjects themselves or by the government, and this measure is essential due to social conflicts. About wars, similar to what took place in Syria in 2015, there is a curfew, and this factor is important to prevent citizens from suffering the direct impacts of war. It is worth mentioning that this mode of confinement has good results, however, it is not effective, because there are possibilities of bombing, which can destroy the population's home (GADE, EK, 2020).

When the main reason is the epidemics and the main reason, such as the one that started in the world in 2020 (started in 2019 in China), citizens are also obliged to adhere to social isolation. It is important to mention that epidemics occur only within countries, usually in several regions. On the other hand, the pandemics begin when the epidemic goes beyond the borders of one country, reaching other continents, and in the face of these situations, the leaders and governments of nations are obliged to adopt such measures. When addressing the pandemic due to the Coronavirus established in 2020, it can be affirmed that several governments have determined the social distancing and quarantine, which has occurred through the closure of schools, trade, among other activities (GADE, EK, 2020).

It is worth pointing out that such measures seek to avoid the rapid spread of diseases until a solution to the problem is found. In more extreme cases, there is also the imposition of the horizontal lockdown, which is a tactical measure aimed at the complete isolation of citizens, who remain in their homes. In addition, the lockdown prevents most services and trades from being opened, that is, in this case there is no flexibilization of these activities as occurs in quarantine (CUDJOE TKM, et al., 2020).

In a way, social isolation is beneficial, as it can serve as an excellent situation to put plans into practice, allows people to organize their pending issues, bring families closer together, help subjects get to know each other better, and preserve health. However, it is believed that social isolation has more negative than positive consequences, regardless of whether it is forced or voluntary.

Even though it is not the focus of this work, it is important to highlight that social isolation also has impacts on the economy, because the population stops consuming and circulating on the streets and consequently, failing to move trade and the service delivery sector. With this, there is a lack of revenue and a sharp drop in sales and such a situation in Brazil has a great impact, since the country is highly dependent on the sector of service and trade (WEILER LM, et al., 2019).

In addition, social isolation has a high chance of considerably affecting the mental state of subjects who adhere to it. For individuals suffering from depression and other types of disease, this situation can mitigate the situation, and in cases too severe, such diseases can culminate in suicide. When social isolation is forced, psychological diseases can also appear in individuals, even if healthy. This occurs because when someone is forced to stay at home, they tend to develop generalized anxiety, which is a condition that can easily evolve into depression. Thus, if the consequences of isolation have not been adequately addressed, they can have a catastrophic impact on people's lives (READ S, 2019).

DEPRESSION - STRESSFUL EXTERNAL FACTORS

When talking about depression, it can be affirmed that this disease has several origins, and may manifest itself in several ways, besides having several clinical conditions. Therefore, it presents a picture in which complexity varies considerably, and it tends to present several somatic and psychic symptoms considering the various clinical and psychophysiological issues. It is believed that women are more prone to depression and that more than half of the world's population has this pathology (FEITOSA MP, et al., 2011).

In this context, it is highlighted that depressive syndrome manifests itself in three ways, these being self-devaluation, psychomotor glorification and alteration of affections. In addition, it is related to a number of complex elements related to affect, that is, this disease encompasses several specific symptoms associated with behavior, motivation and cognitive field. Thus, depression can be considered as a state that is determined by the reduction of happiness, as well as the probability of decreasing pleasurable experiences (SOARES GB and CAPONI S, 2011).

Therefore, this disease has many symptoms, among the main ones can be highlighted suicidal idealization, social isolation, inactivity, irritability, difficulty concentrating, among other things. Even with sadness presenting a nuclear affection, along with it may arise other side effects such as hostility, irritability and anxiety. Usually, the physiological expression of depression is characterized by a deadly and sad look, in addition to a slaughtered expression that represents a lack of hope and suffering (CUNHA RV, et al., 2012).

It is worth mentioning that depression acts as an affective disorder, and in it, there are also variations in mood that can impact the subjects in their relationships with others, since they begin to devalue, which contributes to the reduction of their self-esteem, as well as the way of relationship with the most varied situations. Therefore, the way of thinking of depressives is characterized by negative images, lack of hope, discouragement, self-deprecation, negative and distorted expectations of oneself, the future and the world in general (TAVARES LAT, 2010).

The incapacity and discouragement that plague the depressed are part of their routine, which, in more severe cases, can lead to the emergence of delusional thoughts, and all things that occur revolve around the ruin, guilt and hypochondria. These subjects tend to anticipate negative situations, often having pessimism as the guiding principle of their lives, both in the way of thinking, acting and speaking (RAZZOUK D, 2016).

Cognitively, depression acts by reducing concentration and attention due to a drop in energy levels needed to perform tasks, thus, activities are performed without efficacy and clarity. For these subjects, any activity is too tiring, and this occurs before even starting it. In addition to this intense fatigue, there is nervousness and a feeling of weakness, and in these situations physiological issues can be observed, such as decreased desire, lack of appetite, changes in sleep pattern, amenorrhea, headaches and changes in body mass (COUTINHO MPL, et al., 2016).

Depressed people usually underestimate their successes and abilities, letting the negative side of their activities appear in a variety of situations. In addition, other syndromes can be triggered with depression such as deficits of self-esteem, self-appreciation, in addition to acceleration, feelings of sadness, among other things. In this scenario it is worth highlighting the manic defenses, which, dynamically, are an element that tends to mix with this disease, which is opposed to depression. These manic defenses can be considered as defenses against the depressive effect that comes from marked depression (RUFINO S, 2018).

Therefore, it is necessary to keep in mind that the characteristics such as the difficulties in determining the boundary of the poles of sadness and the disturbance of mood, which are characteristic features of depression, are events triggered as a reaction to difficult events and feelings of loss. Thus emerges the issue of depressive mood, it is worth mentioning that mood can be considered as a basic affection that varies between sadness and joy. This characteristic is widely used in the representation of mental functioning, adapting and translating how subjects feel with the outside world (RAMOS ASMB, et al., 2018).

In this scenario, depression begins to be seen as a state of mind that is occasionally experienced by most individuals due to issues such as confrontation with losses, for example, which culminates in momentary disorganization and may remain until new objectives can be determined. It can be mentioned then that depression is

reactive in the face of a conflicting situation or a loss and, even though it can manifest itself in different spheres, it adapts to the situations experienced in which phenomena considered abnormal are discussed. It is also worth mentioning that depression is a feeling that tends to occur with all subjects at some point in their lives, so, normally, depressive signs occur on some occasions (LOPES RMF, et al., 2014).

Thus, it is perceived that several authors state that the symptoms of depression are no longer considered normal and enter the pathological sphere as if its depth, intensity, the frequency with which it appears, dysfunction, the elevation of mood disturbance rise. However, to affirm that depression is pathological and not a normal sadness, all these symptoms must be analyzed jointly (MATIAS AGC, et al., 2016).

It is necessary to be attentive because it is common to develop either depression without depression or be a masked depression. In these situations, individuals tend to present other symptoms such as headache, dermal diseases, somatic symptoms, among other things, which can be easily confused with real depression. Therefore, when depression is masked, it needs to be treated as a syndrome and not a disease, because it lacks several elements of therapeutic, pathogenic evolutionary, epidemiological and etiological order for it to be considered as such (FLECK MP, et al., 2009).

Because of this, it is perceived that there is a point that raises several doubts even today about depression. This question is associated with the way of understanding depression as a clinical entity, that is, this disease should be considered serious and worrying regardless of its endogenous character or may be related to contextual and/or psychological factors for its emergence. However, the reality is that depression can be classified into two groups, endogenous and manic-depressive. Endogenous depressions are those of hereditary origin, while manic-depressive depressions are those derived from frailty and other issues related to personality or stressful external factors (COSER O, 2003).

SOCIAL ISOLATION, INDIVIDUALS AND COVID 19

Social isolation is a factor that significantly impacts the human being in the face of pandemics and with covid 2019 it has been observed that this situation is true, and this is observed in practice. COVID-19 appeared in China and after that, there were several hate speeches about these people, their origins, their customs, among other things. Therefore, it is worth mentioning that in the face of critical moments people use any action to try to justify the events, an example is that several individuals, based on common sense attributed the cause of the disease to the consumption of bat soup, which is a tradition in the country (ARMITAGE R and NELLUMS LB, 2020).

Therefore, it is known that many accusations have no scientific basis, however, the fact is that the viral disease is real and has spread throughout China and consequently to the world, becoming a pandemic. This pandemic frightened individual due to its great lethal power, especially in nations that resisted using restrictive sanitary measures, which is essential in the face of this type of public calamity (ANDERSON RM, et al., 2020)

Thus, it is stated that the pandemic impacted all nations, which had to adopt restrictive measures at their borders, in addition to restricting several flights and adopting strict entry and exit controls in the countries. As a matter of time, there were intense threats of contamination that sparked panic among the various nations, but there were situations in which several countries have adopted several exceptions about measures to combat COVID-19. Because of this, several countries for antisocial issues and government irresponsibility have cost to create actions to control the epidemic, however, these have suffered the consequences of such a measure (BROOKE J and JACKSON D, 2020).

Even affecting individuals with respiratory diseases and the elderly more severely, no person is safe from COVID-19. In this context, it is worth noting that appropriate technical procedures and prophylactic measures are the keys to combating this virus. Thus, in times of social isolation attitudes such as fabulous theories, xenophobic prejudices and ideological discourses only serve to confuse people, besides being male photo those who are acting technically for the execution of essential health care (USHER KAM, et al., 2020).

In parallel to this, it is up to the human being to have the discernment to understand the facts properly and to know how to judge them coherently to prevent contagion from being even worse. Therefore, it is up to each citizen to be aware that he can transmit the disease, and it is essential that he does his part and adopts the appropriate restrictive and sanitary measures. Thus, since the beginning of the determination of social isolation, the subjects must seek ways of informing themselves so that they can comply with the coherent technical measures urgently. Thus, it is important to believe only in scientists, leaving aside any comments and news from unreliable sources, since the media has become sensationalist, seeking only profit (HOLMES EA, et al., 2020).

In this scenario there is also the issue of social isolation, which is a nuisance, requiring that all individuals who go through this moment of home restraint have patience. It is common that in these cases several situations such as anguish, stress and anxiety emerge, and to

overcome them it is necessary to seek healthy means such as maintenance in the house, perform loving practices, pray, meditate, watch movies, read, among other things (VIEIRA PR, et al., 2020).

It is important to note that social isolation is not a media activity in a similar way to a reality show in which participants sell something surreal to viewers. This experience is also not a spa in which you acquire healthy habits, different lifestyles, among other things. On the contrary, this moment transcends these issues, because there can be no contact between people since handshakes, hugs and kisses act as an enemy of society (WILDER-SMITH AMD, et al., 2020).

In a scenario of social isolation, warm and sociable people suffer, because they miss the meetings, the hugs, the handshakes and the kisses. With this, an important question emerges that is when individuals are very close to each other, they feel uncomfortable, but when they move away the feeling of loneliness arises. Thus, what would be interesting is to ensure a balanced distance, which would be the middle ground of the two extremes mentioned above (BRISCESE G, et al., 2020).However, for less sociable subjects, social isolation can have softer impacts, and in extreme cases, such individuals may consider it as a gift from nature. But for most people, living with their families for prolonged periods is something tiring, since they are accustomed to the hectic routine of everyday life that apart from them and makes their coexistence reduced with others (COURTET P, et al., 2020).

MENTAL HEALTH AND COVID 19

The social isolation established due to COVID 19 has caused cases of depression and other types of problems associated with mental health to increase considerably. This was the conclusion of a study conducted by the State University of Rio de Janeiro in partnership with Yale-New Haven Hospital in the USA. In this survey, 1,460 individuals living in 23 Brazilian states answered an online questionnaire between March 20 and April 20, 2020. According to the results obtained, it is noticed that stress and anxiety increased by about 80%, while cases of depression practically doubled. Another point that corroborates several studies conducted previously is that women are the most likely to suffer from stress and anxiety during the pandemic period (STATE UNIVERSITY OF RIO DE JANEIRO, 2020).

However, other risk issues associated with anxiety and stress can be highlighted, such as the need to leave home to go to work, sedentary lifestyle, lack of psychological follow-up, preexisting diseases and unruly eating. Regarding depression, the main causes for its occurrence were contacting with the elderly in the home environment, low schooling, lack of children at home and advanced age (STATE UNIVERSITY OF RIO DE JANEIRO, 2020).

Thus, the increase in depression has increased considerably since the beginning of quarantine, and the results of previous studies show that symptoms of acute stress increased from 6.9% to 9.7% from the beginning of quarantine (March 20 to 25) until the date of the research (April 15-20). A similar fact was also observed in cases of depression that jumped from 4.2% to 8.0% in the same period studied. The WHO states that these rates are typically expected to be 3.9% for depression, 7.9% for anxiety and 8.5% for stress (STATE UNIVERSITY OF RIO DE JANEIRO, 2020).

Given these data, it is noticed that the increase in problems related to mental health increased along with the increase in the number of psychological treatments. It is estimated that online psychological care increased by about 200% in their demand only in March 2020, and this increase was observed when compared to February 2020. With this, individuals who resort to online psychotherapy tend to have significant improvements in anxiety and stress conditions. In addition, individuals who exercise, especially those who have practiced aerobic exercises, tend to perform better when compared to people who did not have any physical exercise (RAJKUMAR RP, 2020).

However, creating a routine of physical exercises, sleep and occupation of the mind with meditation and reading in free times is not an easy task, however, it contributes significantly to reduce stress in times and pandemic. Therefore, it is essential to determine a fixed time to wake up, as well as a schedule for performing some activity. It is worth mentioning that social pressure when one has isolated can culminate in more stress to the subjects, so at this time of the pandemic, it is not time to radically change habits, because this can cause more anguish, being essential as soon as each one respects their limits and their lifestyle (QIU J, et al., 2020).

Therefore, to reduce some of the anguish, stress and depression in a time of social isolation such as that imposed by COVID-19, some tasks such as contact with family and friends should be performed, avoid excessive news, have a healthy and regular routine, exercise, relax and, if necessary, seek the help of a specialist (WANG C, et al., 2020).

Thus, when talking about social isolation cannot be said that this is to cut the relationship with family and friends, there are several ways to communicate with people, so you can use the technologies to contact them. The interaction between the subjects can take place in various ways such as video calls, social networks, connections, among other things. Even in a moment of

distancing, it is essential to keep in frequent contact with the elderly to verify if they need some kind of help, in addition, this simple gesture will help them to feel less lonely (HUANG Y and ZHAO N, 2020).

Avoiding excessive news is something that helps maintain positive thinking since the large flow of information associated with the pandemic can increase stress and anxiety rates. Being up to date is important, however, you need to watch or read news twice a day, at most and at predetermined times. Another relevant point is that news should be obtained only from reliable sources since speculationonly tends to alarm and frighten the population (ZANDIFAR A and BADRFAM, 2020).

Creating a healthy and regular routine, as well as adopting established hygiene measures such as having a regular sleep routine, performing physical activities, having healthy eating habits and washing hands frequently also contributes to improving physical and mental health. Therefore, it is worth noting that the practice of harmful habits such as alcoholism and the use of cigarettes are not good allies to combat stress. To exercise it is necessary to seek to fill the time at home with pleasurable activities, not only with the performance of physical exercises, but it is also important to watch movies, draw, read, learn new things, among other things (LU W, et al., 2020).

About relaxation, it is worth noting that it is possible to resort to yoga, meditation and relaxation techniques to manage stress. For individuals who work from home, they should have specific working hours, and it is necessary to take breaks periodically. And, yes, if necessary, seeking the help of a specialized professional is the key to minimizing stress and anxiety. It is important to highlight that many professionals are attending online in this pandemic period, and this is a great alternative for individuals who seek to reduce anxiety due to isolation (FRANK A, et al., 2020).

IV. FINAL CONSIDERATIONS

Maintaining social isolation from COVID-19 is an arduous task, however necessary to prevent the rapid spread of the virus. However, this measure generates other problems, especially mental problems for subjects, with increased stress and anxiety. Therefore, it is up to individuals to look for ways to improve their mental health, so that this occurs it is important to seek healthy habits, read books, watch movies, not read excessive news, exercise, relax, contact (virtual) with relatives and friends, among other things. Thus, with these measures, people can live better and with more harmony what is indispensable to have a more healthy mental life.

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Sustainable Storage – Use of metallography as a solution for the development of a new device

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***Keywords*— Design and selection of materials, Product design, Rack design, 3D prototyping.**

***Abstract*—** *Wooden pallets are the most used resources in the storage of tools in the pressing area, in which components for the automotive industry are modeled. The objective of this work was to develop a metallic rack in carbon steel SAE 1020 to store the set of cutting, drilling and folding tools. The methodology used in the execution of this project was the microstructural characterization of the SAE 1020 materials by metallography techniques, hardness, mechanical modeling and simulation, development of the metallic Rack design by technical detailing in 2D via AutoCad® for the prototype, sometimes in 3D through virtual modeling Cliever Lab (Pro)® with Mock-up Create Buildings. The result achieved so far through the development of the Metal Rack has been a reduction in environmental liabilities, greater security in storage and reduction in tooling movement time.*

I. INTRODUCTION

For any type of company, logistics requires some care in relation to its costs, since storage requires basic investments for industrial operation. For Moura [1], when it comes to storage systems, racks become very important items to compose these structures. For they can be adapted for the most diverse functions, such as pallet boxes, pallets and platforms, for example, in the same way they adopt subdivisions of detachable racks, wire racks, shelves, pallet racks, among other products which facilitate transport, movement and storage of products.

It can be said that, when it comes to industrial production, the waste which can occur along the processes is diverse, ranging from raw material to financial resources. However, raw material waste can be classified as the most urgent in this sector and also the most passive to be studied, since it directly impacts the manufacturing flow in quantity of finished product.

At this juncture, a research line is inserted: Product Project of the Stricto Sensu Postgraduate Program in Design, Technology and Innovation, Professional Master's Degree from the Teresa D'Ávila University Center, the current project aims to develop an industrial rack in AISI1020 steel for storage of set of cutting, drilling and bending tools in an industry in metallurgical component sector, located in Vale do Paraíba.

The project aimed to develop an industrial metal rack in AISI 1020 steel for storing the set of cutting, drilling and folding tools. Thus, it is possible to characterize the material via optical microscopy, material resistance via 3D and real modeling; develop a set of metallic racks within product design standards and their strategic alternatives in production management; maximize the setup time in movement and change of tools in the factory environment and reduce the environmental liability (Wood) and maximize the ergonomic occupational safety of the worker in the tooling movement process.

The aim was the notorious reduction and safety in the movement of tools and the improvement in setup time, extinguishing wood residues, making the company increasingly sustainable. It has been also tried to standardize the way of storing tools in order to expand this project to other areas and, in the future, to international companies, encompassing: cutting, drilling and shaping tools, generating a maximization of results and, in the short term, a reduction in the costs of transporting and moving the tools. Would the development of a tool storage device in AISI 1020 carbon steel reduce the environmental liability with more safety in the movement and storage of tools?

II. MATERIALS SELECTIONS

Carbon steel

According to Chiaverini [2], steels have a relatively complex structure, they are not only characterized by their carbon composition or by a set of other components which make the steel have different mechanical properties. Under these conditions, for a simple classification, it is possible to establish threshold percentages of carbon (C) present in the chemical composition of the steel, ranging from 0.008% to 2.11% C.

- Low carbon steel, carbon less than 0.3%;
- Steel with medium carbon content, carbon between 0.3 and 0.7%;
- Steel with high carbon content, carbon greater than 0.7%.

According to Callister [3], steels are extremely important for the industrial sector, in the manufacture of cars, trucks, buses, buildings, electronics and throughout the production chain. He also emphasizes the choice of steel for a given task indicates success and complement of the final objective of developing a given process.

According to Chiaverini [2], the main goals of thermal and thermochemical treatments are usually to promote:

- Changes in residual stresses;
- Increase or decrease in hardness;
- Increase in mechanical strength;
- Improved ductility;
- Improve in wear resistance;
- Improve in machinability;
- Modification of electrical and magnetic properties.

SAE 1020 steel

According to Luz [4], SAE 1020 steel is one of the most common carbon steels used as steel for carburizing, with an excellent cost-benefit ratio compared to more alloyed steels for the same purpose. It has excellent plasticity and weldability.

SAE 1020 steel is indicated for screws, hard drawn, chassis, wheel discs, parts in general for machines and vehicles subjected to small and medium efforts. The highly tenacious SAE 1020 steel, particularly suitable for the manufacture of parts which must receive surface treatment to increase hardness, mainly cementation. SAE 1020 steel is still used for shafts, in general, forged. For SAE 1020 steel to have these characteristics, it must follow specific chemical compositions. SAE 1020 Steels have Low hardenability, excellent forgeability and weldability, nevertheless its machining is relatively poor.

It can be applied in cementation. SAE 1020 Steels have, as ideal application, products such as: Screws, nails, shafts, components forged without greater requirements, distribution bar, case-hardened part and welded tubes [5].

Chart 1: Composition of SAE 1020

SAE/AISI	c	mn	P Max.	S Max.
1020	0.18-0.23	0.30-0.60	0.040	0.050

Source: Majewski [5]

Metallography

According to Colpaert [6], metallography is a method of studying materials in their smallest details, in order to observe their structures, in particular their physical properties, process and composition, in order to show how the material behaves under a certain force or application.

Marmontel [7] mentions that properties such as toughness, fragility and resilience are characterized in the material and can be seen and analyzed by means of metallography.

According to Fasano [8] and Rohde [12], metallography seeks to associate the structure of material with its function, showing its real performance, in the midst of its process and purpose in the productive sector, in which a certain force is exerted on this material.

These authors demonstrate metallography aims to analyze the material before its process so that it can have a favorable performance in the process it is performing. Thus, metallography has the role of bringing security and confidence in the search for the appropriate basis for choosing and analyzing material for process of production, creation, etc.

For Silva and Avanzi [10], Metallography is the study of structural characteristics or constitution of metals and their alloys, in order to relate them to their physical, chemical and mechanical properties.

According to Coutinho [11], metallography makes it possible to analyze the real property of material for purposes of material reduction, in order to make the product lighter so that it reduces gases that damage the atmosphere.

Such a detailed analysis of the material's structure with the naked eye would be practically impossible. In this case, it is necessary to have the aid of a microscope for a more specific analysis of the material, which is known as a micrograph. By means of macrography and micrography, it is possible to analyze and observe several characteristics of material, such as cracks, failures, strengths and weaknesses, discrepancies and ruptures [6].

Coutinho [11] says that by means of metallography it was possible to select possible materials to be used in automotive area, such as high resistance and no corrosion. The most used elements are Cu, Mg, Si, Mn, Fe, Ti and others, forming sustainable and resistant systems.

According to these authors, macrograph and micrograph analyzes are extremely important for elaboration of a product, with the purpose of providing the maximum quality possible in obtaining a satisfactory quality result in the finished product.

Macrographic Essay

According to Colpaert [6], micrography is the study of metals with the aid of a microscope, aiming at a detailed analysis of their composition and texture. In this process, it is necessary to clean the area to be examined and use a chemical reagent.

According to Colpaert [6], in the macrographic process, the sample to be analyzed is defined; selects the flat and sanitized part in the process; the use of chemical reagent in the area to be used; use of the microscope to observe the material by means of photographs.

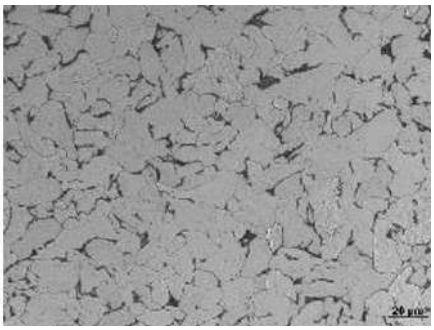

Fig.1 - Micrograph of a hot rolled 1010 Steel.

Source: Rohde [12]

Rack Design and Development

According to Fascioni [13], the word Design was created in the period of the industrial revolution, with the purpose of creating new products and packaging for the large-scale production of prominent artisans at that time. Through this thought, several artists came together in order to conceptualize the term Design, with the purpose of transporting the largest number of products in a simple and efficient way.

For Mozota [14], the word design comes from the Latin "designare", which means to draw or designate. No Inglês, o termo tem dois significados que pode ser intenção, projeto, plano, modelo, motivo, decoração, motivo, composição visual dependendo do contexto. Professional training in Brazil takes place by means of training in the Graduate Course in Design, in accordance with the curricular guidelines of the Ministry of Education and Culture (MEC), which requires a profile: The professional who is in charge of designing systems of visual information, objects and systems of use objects by means of a disciplinary approach, considering the characteristics of the user and his socio-economic-cultural context, as well as the potential and economic and technological limitations of the productive units in which the information systems and objects of use will be produced [15].

According to Fascioni [13], in design thinking, ergonomics plays a fundamental role in the development of new products, and ergonomics is the Science which studies the behavior of man by means of his workplace, and bionics is also taken into account, which is the science that studies living systems in order to create new techniques and technological principles, it is also necessary to consider proxemics, which is the science that studies the theories and observations of human beings in their environment, besides the techniques of product development and lighting in the process.

III. METHODOLOGY

The development of this product project is based on Baxter's methodology [16], which proposes that the product development process is characterized by visual aspects, prototypes, market needs, ecological concern, reliability and cost reduction. It aims to integrate marketing points of view with engineering, as well as the identification and satisfaction of consumer needs. Therefore, the search for four steps in product development are:

- Preliminary ideas: generating ideas;

- Specifications: define opportunities and specify the project;
- Configurations: run tests, analyze change alternatives, structural calculation, material analysis, manufacturing process and adjustments;
- Production: detailing of product process, elaboration of technical drawing of a product ready for production.

Product design

The project setup starts with the chosen concept and ends with the prototype developed and tested. The proposal for the new product must start with the generation of ideas, in which all possible forms of manufacturing are explored. For the generation of ideas, Baxter [16] defines elements for the creative process:

- Thinking only about ideas: forgetting practical restrictions;
- Look for ideas outside the normal problem domain.

Baxter [16] suggests using techniques for problem reduction, problem expansion and problem digression, such as function analysis, morphological analysis, analogies and metaphors, clichés and proverbs.

In the technique of developing Metal Rack, several Sketchings were made, to start the creative process for the elaboration of the prototype. After an idea formed, a drawing was created in AutoCAD 2016® which develops a 2D drawing to visually aid the perspectives of the project.

The activities were carried out in the Materials, Modeling and Textures Laboratory "Prof. Wilson Kindlein Junior" at UNIFATEA, Figure 2.

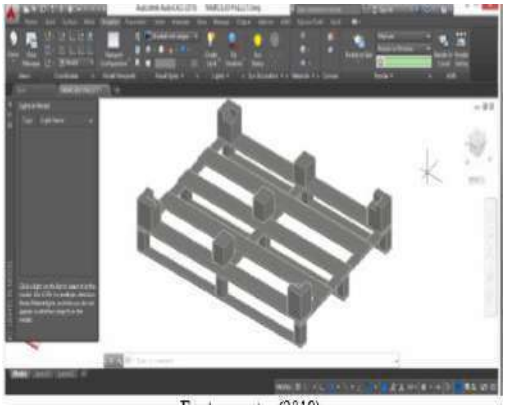

Fig.2: AutoCAD 2016 interface.

Source: The authors (2018).

A mark-up was developed using the 3D printer in the laboratory which used the Cliever Lab (pro) software on X, Y and Z axes.

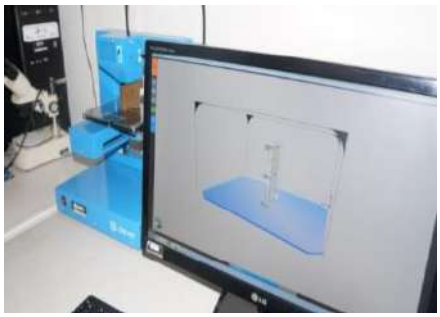

Fig.3: Software Cliever Lab (pro).

Source: The authors (2018).

To develop the mark-up, a 3D printer of the Cliever® model was used in order to establish a pre-project view in relation to ergonomics, shape, geometry, interchangeability, usability and the arrangement of the tooling on a reduced scale.

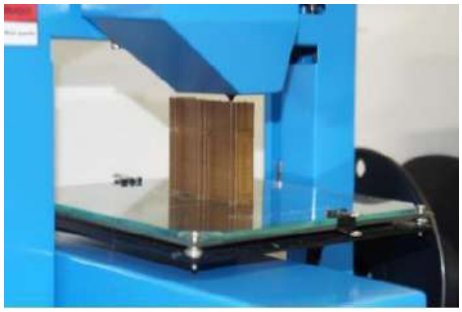

Fig.4: 3D Printer Cliever.

Source: The authors (2018).

IV. RESULTS AND DISCUSSION

Economic and Technical Feasibility

The wooden pallet exchange time is approximately 6 months, the average cost of wooden pallets is US$ 10.00 (ten dollars), totaling an annual cost of US$ 20.00 (twenty dollars). The Cost of Metallic Rack in steel 1020 is approximately US$40.00 (forty dollars), this value was defined by adding the value of the steel that was made available from the partner company and also the value of labor in the manufacture of the Metal rack.

With the use of the wooden pallet for 3 (three) years, the company accounts for an expense of US$59.00 (fifty nine dollars) and the cost of the wooden pallet was higher than the one of the metallic rack. It is noted that the metal rack can have a useful life of approximately 15 years, with proper maintenance and the partner company will have a

cost reduction in the amount of US$293.00 (two hundred and ninety-three dollars) in this period.

Chart 02: Comparativo de custos

MATERIAIS	1 ano	15 anos
Pallet	R$ 104,00	R$ 1.560,00
Rack aço AISI 1020-sucata	R$ 206,00	**

Source: The authors (2018).

The partner company has approximately 1,000 (one thousand) tools. This information gives the company a cost reduction of approximately US$292,135.00 (two hundred and ninety two thousand one hundred and thirty-five dollars) already accounted for, in this amount, the value of the metallic rack. Costs indexed to the steel rack construction factor represent the manufacturing cost and direct labor of the company, Chart 3.

Chart 3: Development costs with reused material AISI 1020

LISTA DE MATERIAL

ITEM	DENOMINAÇÃO	QUANTIDADE	MATERIAL	DIMENSÕES ESPESSURA	LARGURA	ALTURA	COMPRIMENTO	PESO	R$/KG	VALOR R$
1	VIGA LONGITUDINAL	3	SAE 1020	3	45	76	1300	16,55	R$ 0,80	R$ 14,84
2	VIGA TRANSVERSAL	6	SAE 1020	3	45	76	1080	30,83	R$ 0,80	R$ 24,66
3	VIGA DE REFORÇO	3	SAE 1020	3	45	76	1080	15,41	R$ 0,80	R$ 12,33
4	PLACA DE FECHAMENTO	24	SAE 1020	3	37	-	74	1,55	R$ 2,20	R$ 3,40
5	ALÇA	6	SAE 1020	8	37	-	447	6,23	R$ 2,20	R$ 13,71
								72,57		R$ 68,95

CUSTO DE FABRICAÇÃO

ITEM	OPERAÇÃO	TEMPO "h"	Valor hora maquina	Valor hora homem	Valor Operação
1	DESMONTAR 03 RACKS (SUCATA)	1	-	R$ 22,73	R$ 22,73
2	CORTAR VIGAS NA MEDIDA	1	-	R$ 22,73	R$ 22,73
3	DESEMPENAR VIGAS	1,5	-	R$ 22,73	R$ 34,09
4	CORTAR PLACA DE FECHAMENTO E ALÇA (TESOURA)	0,25	R$ 75,00	-	R$ 18,75
5	MONTAR PALLET	1	-	R$ 22,73	R$ 22,73
6	SOLDAR PALLET	1	-	R$ 22,73	R$ 22,73
					R$ 143,75
				VALOR TOTAL	R$ 212,70

Source: The authors (2018).

Microstructural characterization of material used in construction of metallic rack

For microstructural characterization, the optical microscopy technique was used, it was observed that micrographs with a magnitude of 500x in AISI 1020 steel show, in the light regions, the presence of ferrite, and in the dark regions, the presence of perlite in its grain contour.

These micro-constituents translate, to the material and structure of the Rack, ease in workability, in the manufacturing process and in ductility.

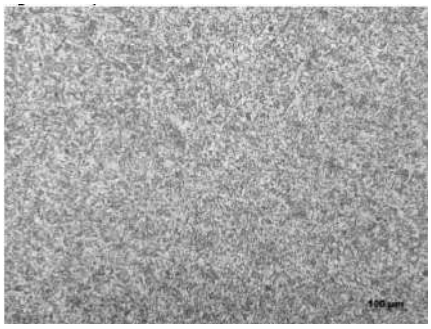

Fig.5: AISI 1020 Carbon Steel with Nital, 500x

Source: The authors (2018)

Product Design and Metallic Rack Design

In the Rack development process, the dimensional of the tooling was analyzed, in which it has a length of 1300 mm, width 1100 mm and height 215 mm.

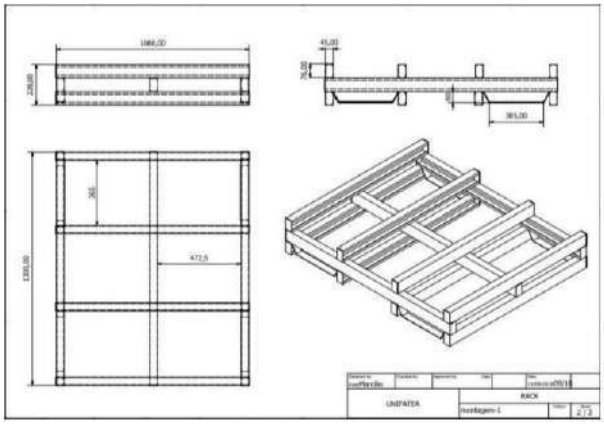

Fig.6 - Technical drawing of metallic rack.

Source: The authors (2018).

The metallic rack was produced from the technical drawing to perform the task analysis and to be tested in a real situation in the factory environment, Figures 7 and 8.

Fig.7 - Finished metal rack in AISI 1020 steel

Source: The authors (2018).

Fig.8 - Metal rack with set of cutting, drilling and bending tools

Source: The authors (2018).

V. CONCLUSION

With this work, the feasibility of storage and logistics systems can be analyzed. For research development, besides the use and bibliographic research with the theoretical foundation of pioneer and contemporary authors in several covered sectors, it is characteristic of this product creation method according to Baxter's methodology.

With the development of the Metal Rack, it was possible to reduce the movement and setup time by around 10 minutes, maximizing production time and removing the bridge from the process, bringing greater convenience to forklift truck drivers and employees who change tooling.

According to results obtained by means of this project, it was raised, in a quantitative way, indices of improvement of productive activities, logistics and warehousing. It can be seen that the company, which is the focus of the study, will be able to maximize productivity and, consequently, its profits, using the storage device, being of the Metallic Rack type, in which, by means of the application of design concept, it provided and improved several aspects which affect production, logistics and the product's value chain.

It is concluded that the objective of this project was achieved, since the model presented, when compared to the current concept of storage devices, presents numerous productive, logistical, occupational, environmental and financial advantages, in which the income from the use of the Rack Metallic impacted great savings for the company. Results were obtained by reducing environmental liabilities, standardizing the tooling storage sector, maximizing setup time and reducing cost estimating.

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Gastronomy: Flavors and Knowledge of Quilombos in the State of Rio de Janeiro - Brazil

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***Keywords*— Brazilian Cuisine. Gastronomy. Gastronomy Slavery. Quilombo.**

***Abstract*—** *The history of Brazilian slavery goes beyond forced labor and suffering. The new historiography on the subject informs about the resistance, sprouted from the fruits of the Quilombos. The objective of this work was based on the search for an association between cuisine and history, of a State that has an important role in Brazil. Literature review method. Conclusion: The great importance of quilombola communities, which seek to maintain the traditions of regional and temporal cuisine, are fundamental.*

INTRODUCTION

A dark period in world history was slavery, which goes beyond forced labor and suffering. In Latin America, especially in Brazil, this dreadful period left a deep mark, not very enriching, but also left a culturally important legacy with miscegenation and a cuisine.

During the period of slavery in Brazil (17th and 18th centuries), the blacks who managed to escape took refuge with others in the same situation, in well-hidden and fortified places in the middle of the woods. There, they developed a subsistence culture and the food grown by quilombo families was corn, cassava, beans, tobacco, sweet potatoes, and they also kept chicken farming (SCHWARCZ, 2015) and the recipes were those of cultural memory kept in the slave quarters in order to preserve its origins.

Before the abolition, reports point to the existence of a quilombo established in the region between the mediations of Morro do Arpoador, Praia dos Negros and Praia Rasa, on the border with the city of Cabo Frio. Some residents of Praia Rasa describe these spaces as places where enslaved blacks went: both those who managed to flee when the slave ships landed, and those who escaped the surveillance of the overseers.

Cultural preservation is currently allied with gastronomy, which despite being a vast field of study within the universe of scientific research, values typical foods and even keeps alive the history of the quilombos, which are more determined by the region where they are from than by an ethnic unity. (Porfirio, 2021).

Eating habits are of great interest to those who want to know the place and time, as they provide essential information to understand the moment, what characterizes it and even the survival strategies of different groups and social categories. (SCARANO, 2002, p. 38)

This association: flavors and knowledge, solidifies the Brazilian gastronomic pillar. Therefore, this article is based on the search for the association between cuisine and history, of a State that plays an important role in Brazil.

General objective

Search for the association between cuisine and the history of quilombos, in the State of Rio De Janeiro.

Specific Objectives

Describe the introduction of some foods in the Brazilian cuisine menu.

2. CASA GRANDE and SENZALA (The Master and Slaves),

The food in traditional communities remaining from quilombos has its own characteristics, with little or no capital accumulation, most of the time using family subsistence farming and selling only the surplus. Its production is made from the use of natural, renewable resources present in the local ecosystem. (MATTOS, and ABREU, 2013).

In the State of Rio de Janeiro, manioc flour was the food that constituted the basis of slave feeding. It was complemented by corn, beans, rice, bananas, and oranges. In the countryside they could count on their gardens. The bacon and the lard were common complements in the slaves' diet. Fresh fish and green meat had a high price, with dried meat, bacon and dried fish being cheaper, as Mary Karasch informs (2000, p. 205).

Approximately 30 remnants of quilombos still remain in the State of Rio, like an ember that burns in a wood stove and maintains cultural traditions, already very mixed, but bravely resisting the social and psychosocial conditions imposed. This thought is reaffirmed when Cascudo in 2004 talks about feijoada, “the most gloriously national dish in Brazil”, it is taken as an example of this mestizaje, carried out within “a Portuguese acculturation model” (CASCUDO, 2004).

Although flour, considered as a hydrocarbon food, with second-class protein and poor in vitamins and minerals, and forming gastric pathologies, even when ingested dry, it was picturesquely observed, in 1909, as a second-class food, distributed in slave quarters. (SOUSA,1909)

When we observe the reports of Câmara Cascudo (UMUARAMA, 2010) the idea of miscegenation as a national identity, mapping the contributions of the “indigenous menu”, the “African diet” and the “Portuguese menu” as sources of Brazilian cuisine, a native interpretation of what can be called the Brazilian popular “culinary system”. (CASCUDO, 1977)

Starting from this mix of flavors, the contribution of the quilombos lands on a monumental journey of feelings and nostalgia, forgetting the pain of the time.

The free research methodology allowed us to have access to various information about its historical importance, in which it was elaborated.

2.1 Gastronomy in Quilombos

Cooking is the set of techniques created by man to transform possible edible objects into food, not necessarily food (MONTANARI, 2008). It can be derived from an adaptive need, and by this reason may not be the only indication of the beginning of the cultural man, as defended by Levi Strauss (2010). Several techniques were created to turn an inedible food into an edible one, such as tucupi.

In the past, the cultivation of cassava, wild cassava (to produce flour), corn, beans, potatoes, bananas, oranges, sugar cane and annatto, as well as animal husbandry small, were the main means of livelihood among the residents. The surplus production was sold nearby or exchanged for other products of collective need. Talking about the cuisine and gastronomy practiced over time is an agency about the present moment.

Cooking and gastronomy are arts of connection. Often, in the kitchen, around the table, significant stories emerge for those who share them. From the period prior to the abolition of slavery to the present day, quilombos are remembered through enslaved Africans, black quilombos, and quilombo remnants.

A classic example of this “devotion to the past” can be seen in the Quilombo de Maria Romana in the State of Rio de Janeiro, where knowledge about these practices has favored the construction of links between people and the group's historical trajectory. In times of transformation that maintain the continuity of rural practices, eating habits, despite incorporating changes inherent to cultural dynamics, work as anchors for the maintenance of customary values. Equally handcrafted, working with the land requires patience and dedication.

In a past lived with difficulties, the vegetables in the backyard need to be widely used for survival. Among them, the Bahiano stands out, a vegetable with a dark green coloration that, according to the customs and habits of the region, was prepared pure or accompanied. (SANTOS, 2008) Similarly to corn, papaya, available in the backyard of the casa grande, banana, biju, tapioca and polvilho, often made in a pestle, or at Casa da Farinha, whereas in the colonial period, manioc flour was used to feed slaves, servants on plantations and plantations, as well as serving as a travel supply for the Portuguese (travelers' farnel). (CASA DA FLOUR, 2019)

Tradition reinforces feijoada and other typical dishes from quilombola communities thicken the cultural melting pot. The Portuguese were responsible for bringing to Brazil the technique and the combination of stew and meat, which over time and the evolution of customs, had our beans added, becoming "The Brazilian Feijoada." It lives on in

the memory of those who tried it and has the specifics of Brazilian cuisine. In the world of gastronomy there are several hypotheses about the emergence of feijoada. One of them says that the feijoada we know had its origins in the 19th century and has already become a national symbol at the same time. Another hypothesis says that the dish was created in the slave quarters, by slaves, using leftovers from Portuguese noblemen. (DUTRA, 2005)

Black beans originate from South America and were called by the Guarani comanda, comaná or cumaná. Cassava flour is also a basic component of food for Africans and Europeans who came to Brazil. Bean and cassava swiddens were planted in various places, including in domestic spaces, around homes, mainly for the popular classes.

During slavery, many African plants were brought, such as the oil palm from Angola or okra, which were incorporated into gastronomic dishes, maintained by quilombola traditions. The basil (Ocimum gratissimum L.) with a marked flavor and aroma remains in unaltered use. The seasoning of the farm has basil, it tastes like history. Therefore, in the quilombos, the use of medicinal herbs such as fennel, lemon balm, mint, among others, were also used as a seasoning.

The Santa Rita do Bracuí quilombo, (Fig1), in Angra dos Reis, in the Costa Verde region, whose residents descend from the former slaves of the farm of the same name, which belonged to Commander José Joaquim de Souza Breves, maintains the tradition of use of flour and cornmeal, which had an importance in the daily lives of quilombos. They use angu, made in an artisan way, accompanied with a recipe for chicken with okra, it also took on the taste of the casa grande and do. Pumpkin blossom and sprouts are used in the omelet, in an enriching way, through calcium and iron.

Slaves played an important role in the dissemination of various plants, introducing different species in many regions of Brazil, with the aim of preserving traditional African medicine and gastronomy.

Thus, we can say that Cascudo, (1977), in his reflections on Brazilian cuisine or cuisine, fully demonstrates the consecration of the native product, which recalls the mixing of Brazilian culinary tradition, explained by our colonial historical experience.

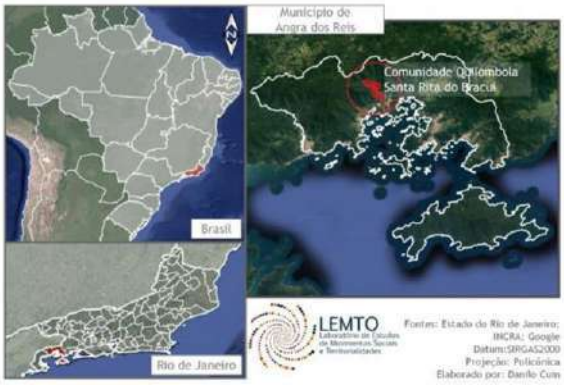

Fig 1. Quilombo do Bracuí location. Source: INCRA (2000, 15)

CONCLUSION

The appreciation of traditional cuisines is linked to the recognition of their identities and ways of life. Keeping history alive, showing the importance of the community and its culture, through cooking, becomes an identity marker, which quilombola groups use as markers of a claimed identity.

Gastronomy which historically marked Brazilian cuisine, is much more than a list of specific recipes crystallized in time, but a whole way of dealing with food.

Before this whole process of culinary restoration by the descendants of Quilombos, where the first free blacks came from, the kitchen is a unit of belonging, which follows different paths specific to its historical social context, with the addition and subtraction of foods and techniques. It can also be said that food at the table is a demarcation of identity, with an expressive importance of the land for the cuisine of past generations, as they are updated by new generations.

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Ecophysiology of pumpkin cultivars submitted to two soil managements

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Keywords*— *Agricultural sustainability, Conventional cultivation, Cultivation in alleys.

Abstract*—*In order to obtain subsidies for the establishment of promising management and agricultural sustainability, this study aimed to evaluate the physiological responses of pumpkin cultivars submitted to different agroecological management. The study was carried out on a property located in the municipality of Acarape, Ceara. The experimental design adopted was in split plots, with the plots referring to the two cultivation systems (conventional and in alleys) and the subplots to the three pumpkin cultivars (Jacarezinho, Moranga, and Sergipana), with four repetitions. Biometric and gas exchange variables were assessed in the vegetative and pre-flowering periods. The analysis of variance showed significant responses only for cultivars in which an influence on plant height and stem diameter was observed. Regarding the interaction between environmentand cultivars, the variable height exhibited a significant response. The other variables analyzed in this study were not influenced.

I. INTRODUCTION

In the old societies, the relationship between man and nature was harmonious, where the aim was only to meet the needs of individuals. With the beginning of domestication of plants and animals, humans began to neglect environmental issues, and over the years, the dynamics of the natural environment underwent grand changes as a result of these activities[1].

The expansion of environmental degradation resulting mainly from agricultural practices has occurred exponentially worldwide. This growth is a worrying factor resulting from the negative anthropic action, which alters and modifies the environment[2]. Agriculture activities are one of the factors that contribute to the impoverishment of the soil, modifying its chemical, physical and biological characteristics, which could lead to infertility.

Caatinga biome, which distribution is exclusive to Brazil, covering approximately 800,000 km² of Brazilian territories (11%), has been severely affected by inadequate management and unsustainable use of natural resources[3]. This biome has been intensively deforested for the introduction and expansion of agricultural products.

The impacts of agricultural production can be minimized according to the techniques and inputs used in cultivation, for that it is necessary to adopt sustainable agriculture practices. To make a better exploit use of the natural potential of soils, it is necessary respecting the local environment characteristics and using practices that provoke as small change as possible, in other words, adopting adequate agricultural management[4]. Based on that, one of the approaches of agroecology is agroecological management, which is based on agricultural sustainability through mainly the conservation of natural resources and the increase of biodiversity in the cultivated fields[5].

In general, traditional and conventional agricultural methods are considered unsustainable. To promote more sustainable land use planning, given the diversification of existing agricultural and forestry exploitation, one of the alternatives that have been proposed is the use of agroforestry systems[6]. Moreover, the knowledge of the determining factors, resources, and interactions between the components of the agroecosystem may lead to optimizing agricultural production sustainably, even in agroforestry systems. The awareness of the permanent use of forest resources in a given ecosystem is of great importance[7]; such use must be planned based on studies of biological dynamics and knowledge of natural regeneration processes in the face of human actions.

There are several studies on the scientific literature investigating the physiological processes of plants as a function of environmental changes. Knowing these interactions makes it possible to understand the behavior of the plant in different environments. This type of study is important in agricultural systems and forestry cultivation, as it can contribute to the selection of genotypes, as well as helping to define management practices for cultivated areas[8].

These investigations generate new knowledge and allow plant species to be cultivated in different types of management. Thus, it is possible to verify which is the most suitable environment for the best development of the plant and also to be able to adopt practices aimed at sustainable development for both agricultural systems and forest crops.

Hence, it is believed that one possibility to practice agricultural sustainability is to carry out the cultivation of vegetables associated with native forests, such as species of the Cucurbitaceae family. Therefore, this study aimed to evaluate the biometric and gas exchange responses of three pumpkin cultivars submitted to different agroecological management, which may lead to subsidies for the establishment of promising management of this vegetable under field conditions.

II. METHODOLOGY

2.1 Experient location

The experiment was carried out in an area located in the municipality of Acarape, Maciço de Baturité – CE, Brazil (04º13’16.2"S, 38º41’55.6"W, and average altitude ranging from 70 to 100 m). The climate in this region is classified by Köppen as Bsh, warm and semi-arid, characterized by shortage and irregularity in rainfall distribution.

2.2 Experimental design and treatments

The experimental design adopted was in split plots, with the plots referring to the two cultivation systems (conventional and in alleys) and the subplots to the three pumpkin cultivars (Jacarezinho, Moranga, and Sergipana), with four repetitions.

Each cultivation system was implemented in an area of 50 x 24 m. The spacing between tree lines was 10 m, with five tree lines per system. The space between two lines of trees was considered as a block. The pumpkin cultivars were sown in a spacing of 2.5 x 0.5 m, with four planting rows eight meters in length each. Each treatment consisted

of four repetitions. The four central meters of the two middle lines of each subplot were considered in the evaluations.

2.3 Floristic survey

Before starting the experiment, vegetative and or reproductive branches 30 cm in length of shrub species belonging to each studied area were collected. For the sample collection, pruning shears were used. The botanical collection was carried out as recommended[9]. The botanical material was used to preparing plant exsiccates (sample of dried and pressed plant in a greenhouse, fixed on a standard size cardboard, properly labeled with information about the plant and the place of collection, for botanical study purposes). Thus, the botanical material was deposited in the Herbarium PriscoBezerra (EAC) of the Federal University of Ceara for proper identification.

2.4 Choosing the area, setting up and conducting the experiment

Initially, two adjacent areas (area 1 and area 2) with dimensions of 50 x 24 m each were separated in the vegetated area of the property. These areas had the same soil and vegetation characteristics.

2.5 Irrigation system

For irrigation of areas 1 and 2, the drip system was adopted. The water used came from a dam located on the property where the experiment was performed. The water flowed from the source to the plants through tubes, eliminating conduction losses and minimizing percolation losses. It is worth mentioning water is only applied in part of the area and upon plant canopy, in micro basins. Another reduction in water losses occurs due to the non-existence of a device at the end of the microtubules to dissipate water and pressure, which would contribute to the evaporation process[10].

2.6 Seedling production and Planting

The seedlings of the three pumpkin cultivars were produced in polystyrene trays having as substrate a mixture of sand and cattle manure in the proportion (2:1). The seedlings arranged on the trays were stored in a greenhouse, made of a wooden frame, and covered with plastic to create a pleasant microclimate to provide better rooting. At 20 days after sowing (DAS), when the seedlings presented a definitive leaf, transplanting to the field was made.

2.7 Crop management

The cultural treatments carried out during the execution of the project were those indicated for the cultivation of pumpkin in the Northeast region[11].

2.8 Biometric Variables (Vegetative phase)

At 15, 25, 29, 36, and 41 days after transplanting (DAT), the parameters of plant height and stem diameter were measured using a graduated ruler and a digital caliper, respectively. Leaf area was determined by multiplying the length and width of the leaf by the correction factor.

2.9 Gas exchanges (Vegetative and pre-flowering phase)

At 42 DAT (vegetative development) and 57 DAT (pre-flowering) of pumpkin plants, the parameters of stomatal conductance (gs), transpiration rate (E), and photosynthetic rate (A) were measurements in fully expanded leaves. All measurements were conducted between 8:00 and 12:00 AM using an IRGA (LI 6400XT, Licor, USA).

During the gas exchange measurements, the relative index of chlorophyll (RCI) was determined. A portable meter SPAD 502 (Minolta) was used. Then, the water use efficiency (WUE) (W/gs)/USA was calculated.

2.10 Statistical analysis

Data obtained were submitted to analysis of variance by the F test at the level of 5% probability using the software "ASSISTAT 7.5 BETA". The regression analysis was performed for the data in which there were significant effects.

III. RESULTS AND DISCUSSIONS

3.1 Floristic survey

The floristic survey was carried out for the two areas selected for the cultivation of pumpkins. Area 1, where the conventional cultivation of pumpkins was carried out, was less dense. In this area, 48 specimens of the plant commonly known as "*sabiá"* (*Mimosa caesalpiniaefolia*) were identified. Whereas, in Area 2, where pumpkins were grown in association with native species, 68 specimens of the same plant were identified. In order to confirm the identification of the plant, the vegetative and reproductive branches of the species were collected. The plant exsiccates was made at the Herbarium PriscoBezerra (EAC) of the Federal University of Ceara, where it remains deposited for possible studies under the code EAC 62604.

3.2 Biometric variables

The results of the analysis of variance are shown in Table 1. The variables plant height (PH), stem diameter (SD), number of leaves (NL), and leaf area (LA) did not present significant responses with regard to the environmental factor (A). Regarding cultivars (C), it is observed that only height and stem diameter exhibited

significant responses at the level of 1% and 5% probability by the F test, respectively. While for the interaction between environment and cultivars (A x C), the variable H was the unique that showed a significant response at 5% probability.

Table.1: Analysis of variance for plant height (PH), stem diameter (SD), number of leaves (NL), and lead area (LA) of three pumpkin cultivars, cultivated in conventional and alley systems, at 41 days after transplantation.

Sources of Variation	DF	Mean square			
		PH (m)	SD (mm)	NL	LA (cm^2)
Blocks	3	0.23138	3.39458	17.22222^{ns}	3204762
Environment (A)	1	0.07763^{ns}	0.10667^{ns}	433.50000^{ns}	22516613^{ns}
Residue (a)	3	0.84631	7.67583	245.16667	1327280
Plots	7	-	-	-	-
Cultivars (C)	2	1.57094**	10.09969*	345.04167^{ns}	4026974^{ns}
Int. A x C	2	0.77800*	0.10135^{ns}	962.37500^{ns}	523412^{ns}
Residue (b)	12	0.1273	2.4926	249.48611	1801580
Total	23	-	-	-	-
CV% (A)	-	59.54	26.23	51.06	30.39
CV% (C)	-	23.09	14.95	51.51	35.41

DF = Degree of freedom; CV = Coefficient of variation; ** Significant at the 1% probability level ($p<0.01$); *Significant at the 5% probability level ($p < 0.05$); ns not significant ($p \geq .0.05$).

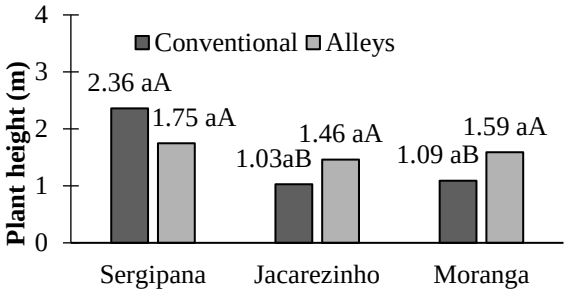

Fig. 1: Plant height of three pumpkin cultivars, cultivated in the conventional system and alleys, at 41 days after transplanting. Lowercase letters represent the environment and uppercase cultivate.

The analyses of Plant height (Figure 1) indicated that there was a significant interaction of Environment x Cultivars, showing that the Sergipana cultivar was superior in the conventional system compared to the other cultivars tested. Statistically, the results were equal in the cultivation in alleys. Also, by comparing the results from the plant height of the Sergipana cultivar to conventional cultivation, an increase of 56.36% and 53.81% on Jacarezinho and Moranga cultivars was observed, respectively. When assessing the cultivation system, it was verified that the Jacarezinho and Moranga cultivars presented greater plant height when cultivated in the system in alleys.

A conclusion section must be included and should indicate clearly the advantages, limitations, and possible applications of the paper. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

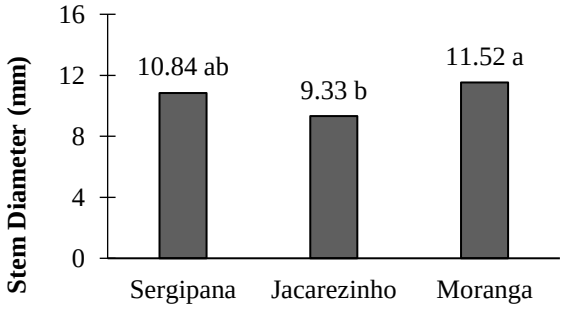

Fig. 2: Stem diameter of three pumpkin cultivars at 41 days after transplanting. Means followed by the same letter do not differ statistically from each other.

Regarding the stem diameter, it can be seen in Figure 2 that the Moranga cultivar had a mean superior to the other

cultivars; however, it did not differ statistically from the Sergipana cultivar, which in turn did not differ statistically from the Jacarezinho cultivar. When comparing the Sergipana cultivar, which had a higher mean, with the Jacarezinho cultivar, which had the worst results for CD, there is a difference of 19.01%.

From the results of stem diameter, it is clear that the analysis of this variable provides practical knowledge and accurate information related to the growth and performance of pumpkin cultivars in different cultivation environments. Such information can be effective for rural producers who can use them to find out which cultivar best adapts to the cultivation environment or even to the region.

The knowledge about the plant's adaptation and new technologies is important for minimizing environmental impacts from agricultural activities. The cultivation system in alleys, presented in this study, is indeed the most suitable for preserving the environment and guaranteeing agricultural production.

Plant growth analysis allows evaluating the plant's behavior adapting to established management conditions. This analysis also allows inferring the contribution of physiological processes to plant growth and productivity. Thus, the growth of plants of horticultural and arboreal species cultivated in an agroforestry system[12]. These authors assert that the location of the beds influenced the higher eucalyptus plants' growth and attributed this result to a higher incidence of light, which favored the higher photosynthetic rate and provided greater plant growth.

Although the plant growth process is complex, it is important to evaluate their development and competitive capacity. Growth analysis is a technique that, besides providing such information, allows us to understand the productive potential of specimens and identifies more tolerant and productive cultivars in certain cropping systems[13].

The increase in leaf area is one of the mechanisms used by the plant to increase the photosynthetic surface[14]. As a result, it provides a more efficient photosynthetic performance in an environment with lower light intensity. Thus, the low photosynthetic rate is compensated for per unit of leaf area, which is a characteristic of shaded leaves. It is worth highlighting that most of the time, the leaf area increases to a maximum, then due to the senescence of the older leaves, it gradually decreases.

By analyzing the results obtained in the evaluation of growth characteristics, both types of management used did not significantly affect the growth of pumpkin plants. Based on that, the cultivation of cucurbits associated with native forest species could work as an important alternative for the pursuit of agricultural sustainability, especially nowadays, in a society with hyper-consumerist habits. Meet the food demands in an unsustainable way implies more damage to ecosystems caused mainly by the removal of natural vegetation in search of new territories for agricultural plantations.

The use of alley cropping systems in tropical regions has gained more prominence since this practice fit out as a proper management alternative for modified areas, especially by small farmers[15]. There are several advantages that cultivation in alleys can provide, such as the increase in biodiversity; protection of natural habitats for predators, thus providing ecological balance; biological fixation of C and N for the system; and windbreak function, with improved microclimate[16].

3.1 Physiological variables

3.1.1 Gas exchange in the vegetative and pre-flowering period

Gas exchange analysis in the leaves of the three pumpkin cultivars during the vegetative period was carried out. The results of this analysis showed that the photosynthetic rate (A), the stomatal conductance (gs), and the transpiration were not significant for the analyzed factors (Table 2). A similar response was obtained for the Relative Chlorophyll Index (RCI) and Water Use Efficiency (WUE).

Table. 2: Summary of analysis of variance for photosynthesis (A), stomatal conductance (gs), transpiration (E), water use efficiency (WUE) and relative chlorophyll index (RCI) in pumpkin plants submitted to two managements of soil during the vegetative growth period.

Sources of Variation	DF	Mean Square				
		A	gs	E	WUE	RCI
Blocks	3	2.01168	0.68989	2.86879	1.22720	76.85229
Environment (A)	1	5.64540 ^{ns}	0.28733 ^{ns}	0.17510 ^{ns}	0.82645 ^{ns}	513.00507 ^{ns}
Residue (a)	3	14.54123	0.17743	0.31905	0.58026	62.78973
Plots	7	-	-	-	-	-
Cultivars (C)	2	16.43679 ^{ns}	0.16300 ^{ns}	0.35205 ^{ns}	0.12440 ^{ns}	18.64565 ^{ns}
Int. A x C	2	2.46121 ^{ns}	0.04164 ^{ns}	0.27862 ^{ns}	0.29187 ^{ns}	6.30782 ^{ns}
Residue (c)	12	11.74326	0.12840	0.28343	0.71587	67.84051
Total	23	-	-	-	-	-
CV% (A)	-	18.63	31.65	11.38	18.14	18.88
CV% (C)	-	19.63	16.74	26.92	10.73	20.15

DF = Degree of freedom; CV = Coefficient of variation; ** Significant at the 1% probability level ($p<0.01$); *Significant at the 5% probability level ($p < 0.05$); ns not significant ($p \geq 0.05$).

Similar effect to vegetative growth period were observed for the flowering period of the pumpkin plants. The results (Table 3) show that the established management conditions have not significantly influenced the photosynthetic rate (A), stomatal conductance (gs), and transpiration of the plant. Likewise, Water Use Efficiency (WUE) and Relative Chlorophyll Index (RCI) did not exhibit meaning results.

Table. 3: Summary of analysis of variance for photosynthesis (A), stomatal conductance (gs), transpiration (E), Water use efficiency (WUE) and relative chlorophyll index (RCI) in pumpkin plants submitted to two managements of soil during the flowering period.

Sources of Variation	DF	Mean Square				
		A	gs	E	**WUE**	RCI
Blocks	3	53.88113	0.41317	12.73484*	0.18064	20.83722
Environment (A)	1	63.89607 ^{ns}	0.03840 ^{ns}	2.03584 ^{ns}	1.03368 ^{ns}	45.37500 ^{ns}
Residue (a)	3	7.17522	0.23872	0.55508	0.34665	33,35278
Plots	7	-	-	-		-
Cultivars (C)	2	16.97514 ^{ns}	0.33018 ^{ns}	1.13830 ^{ns}	0.47705 ^{ns}	18.01042 ^{ns}
Int. A x C	2	7.66018 ^{ns}	0.38304 ^{ns}	1.47196 ^{ns}	0.04193 ^{ns}	10.57875 ^{ns}
Residue (c)	12	18.25222	0.23902	0.58534	0.64629	34.72958
Total	23	-	-	-	-	-
CV% (A)	-	27.32	118.69	15.24	29.83	19.70
CV% (B)	-	43.57	118.76	15.65	40.73	20.11

DF = Degree of freedom; CV = Coefficient of variation; ** Significant at the 1% probability level ($p<0.01$); *Significant at the 5% probability level ($p < 0.05$); ns not significant ($p \geq 0.05$).

Photosynthetic activity evaluation is of great importance. As it is known, one of the major processes for maintaining life on Earth is photosynthesis. Life is powered by sunshine, and photosynthesis is the only

biologically important process that can capture this energy. The sun releases radiant energy that can boost the photosynthetic apparatus of the plants, which produce carbohydrates that will be used in the respiration process[17].

The findings of this study differed from the observations made by the authors in 2005[18].These authors investigated the stomatal conductance rates and observed that the highest rates occurred in leaves grown under full sunlight. The increase in stomatal conductance occurs when, during heat stress, plants cool their leaves through transpiration[19]. Whereas, about the photosynthetic rates presented in this study, the highest values were observed in a full sunlight environment.

When the stomata are open, CO_2 absorption is more limited than water loss due to the physical characteristics of the gases[20]. However, when in low water conditions, the reduction in stomatal temperature causes a greater disadvantage on the water output. Thus, with the stomatal decrease, transpiration decreases faster than photosynthesis since the water loss through transpiration through the stomata depends more on stomatal conductance than on photosynthesis.

Studying gas exchange in eggplant plants, found that stomatic behavior determines the transpiration demand to which the leaves are potentially subject, controlling their loss of H_2O to the environment in the form of water vapor[21]. For these authors, plants submitted to optimal water availability generally have high transpiration rates. However, as the soil water decreases, the plant tends to reduce its transpiration rate as a way to reduce water loss and save water available in the soil.

Although the relative chlorophyll index variable evaluated in this study did not present significant responses to the conditions submitted, it is important to emphasize that chlorophylls are photosynthetic biological pigments found in greater abundance on Earth. The evaluation of chlorophyll contents in leaves is normally one of the methods most used by agricultural producers to monitor crop development. This evaluation provides information on the physiological state, nitrogen contents in leaves, and photosynthetic potential of plants[22].

Studying the influence of luminosity on the chlorophyll content of tomato plants, has been verified that the amount of chlorophyll increased as the luminosity increased[23]. It occurred because light stimulates the synthesis of chlorophyll by the plant, increasing the light absorption, thus producing a higher amount of photoassimilates.

FINAL CONSIDERATIONS

It is concluded that the planting system did not interfere in the development of pumpkin plants.

The Alleys-cropping system is considered promising agroecological management for pumpkin production under fieldconditions since it allows for quality and sustainable production.

The planting system in the pumpkin crop did not affect gas exchange in both periods analyzed.

An alley-cropping system presents as a good alternative to eradicate the use of synthetic input and in natural resources' preservation in the Caatinga.

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Application of the Method of Characteristics in the Analysis of Transient Events in Natural Gas Distribution Networks

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Abstract*—*In this paper we present the development of a mathematical model for the numerical simulation of one-dimensional compressible transient flows in natural gas distribution networks, based on the method of characteristics. This model was developed to validate transient phenomena in distribution networks of piped natural gas, which is why it was decided to build an experimental network with carbon steel pipe, 140 meters in length and two inches in diameter, in order to simulate situations involving localized ruptures. To achieve the safety conditions and calibration of the instruments, the experiments were initially conducted using compressed air, with subsequent use of natural gas. The study included several cases of leakage in the experimental network, which provided evidence that the results obtained show good agreement with the experimental values, thus justifying the use of the model for real cases.

I. INTRODUCTION

Mathematics plays an important role in several areas of study — for example, economics, engineering in general, and biological sciences — because through this knowledge it is possible to describe the behavior of some specific systems or phenomena in mathematical terms. Most mathematical formulations for these phenomena lead to rates of change of two or more independent variables, translating these formulations into partial differential equations. The mathematical modeling of these formulations may result in distinct approaches, namely: experimental, analytical, and computational, which can be evaluated jointly or individually. The experimental approach requires a physical model that can facilitate studies involving the analysis of the direct or indirect measurement of the determinant parameters of the evaluated problem, which may, in certain circumstances, be impractical due to the costs and time involved. For the analytical approach, in most cases an adequate solution cannot be obtained because the mathematical techniques available are not always suitable for determining such solutions. And finally, the computational approach has proven to be an important tool because certain simplifications allow one to obtain a consistent computational model that can be solved using numerical methods.

This work presents a computational mathematical formulation that enables the evaluation of transient events in distribution networks of piped natural gas, by applying the numerical technique based on the method of characteristics, which ensures accurate results with consistent computational times. To validate the said algorithm, we chose to build a corresponding experimental model, through which it became possible to simulate leakage conditions located in a straight section of piping.

II. PARTIAL DIFFERENTIAL EQUATIONS AND THEIR CLASSIFICATION

In engineering, many conventional problems can be described by a partial differential equation (PDE) which can be classified as elliptical, parabolic, or hyperbolic, depending on the category into which the physical phenomenon falls (Lax, 2006). Thus, considering a general PDE in the following form:

$$a\frac{\partial^2\phi}{\partial x^2}+b\frac{\partial^2\phi}{\partial x\partial y}+c\frac{\partial^2\phi}{\partial y^2}+d\frac{\partial\phi}{\partial x}+e\frac{\partial\phi}{\partial y}+\cdots \\ \ldots f\phi+g=0 \quad (1)$$

in which a, b, c, d, e, f, and g may be functions of the independent variables x and y and of the dependent variable which is defined within a region R of the plane "xy", can consider that:

$$\Delta = b^2-4ac \quad (2)$$

and the PDEs are classified as three distinct types, namely:

if <0, the equation is said to be elliptic;

if =0, the equation is said to be parabolic; and

if >0, the equation is said to be hyperbolic.

In terms of problems involving compressible flows, there are two distinct evaluation approaches: stationary flows and transient flows. In the general stationary problems, the differential equations involved are elliptical, similar to Laplace's equation. Transient problems include the temporal variation of the magnitudes involved, which is why they are represented by hyperbolic or parabolic differential equations, corresponding to the wave equation and the diffusion equation, respectively. The solution for these systems can be achieved either by numerical methods or by analytical methods — the method of characteristics is both a numerical and analytical method, according to Rodrigues (2010). This method is classically used in the solution of hyperbolic equations, being a good alternative for solving this type of problem, which is why it was chosen for the development of this present work.

Since the PDEs that model physical systems usually have many solutions, it is necessary to impose auxiliary conditions which may characterize a function that represents the solution to the physical problem. Such auxiliary conditions correspond to the boundary conditions and the initial conditions of the problem.

III. MATHEMATICAL FORMULATION FOR THE FLOW OF THE GAS

The transportation of the natural gas along the pipeline can be analyzed as follows (Lurie, 2008): the flow is compressible and transient; the flow is continuous, causing the whole cross-section of the pipe to be filled; the flow can be considered to be one-dimensional (i.e., all the parameters involved depend only on the x coordinate measured along the axis of the pipe and the time t); the cross-sectional area of the pipe can vary along the length; and the piping can be considered to be indestructible, with the interaction between the fluid and the pipe due to vibration problems being negligible.

The mathematical models for fluids and gas flows along the pipes are based on physics principles (mechanics and thermodynamics) of the continuum and are obtained from the following fundamental principles: conservation of mass, conservation of momentum, conservation of energy, and a corresponding equation of state.

3.1 – Conservation of mass

The conservation of mass, or continuity equation, in the context of mass flow along a pipe, corresponds to the condition in which the mass of the fluid considered can neither be created nor destroyed. This condition affects the fact that the mass accumulation rate within the control volume (CV), outlined in Figure 1, is equal to the net mass flow in the control surface; that is:

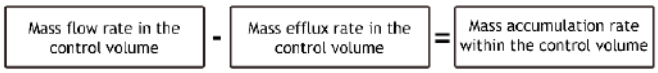
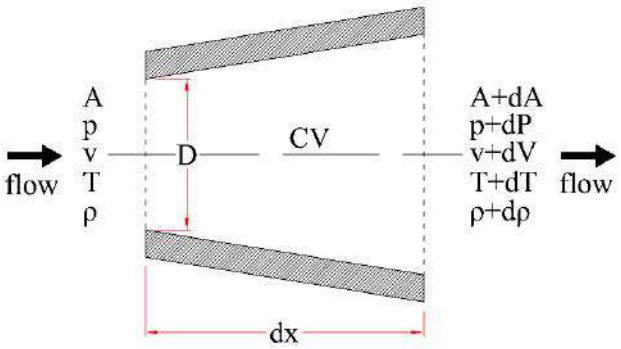


Fig. 1: Control volume with variable area in a straight pipe section (Almeida et al., 2013)



Mathematically, one can write:

$$\frac{\partial\rho}{\partial t}+v\frac{\partial\rho}{\partial x}+\rho\frac{\partial v}{\partial x}+\rho v\frac{1}{A}\frac{\partial A}{\partial x}=0 \quad (3)$$

given: A = sectional area of the duct;

v = velocity of the fluid;

p = pressure of the fluid;

T = temperature of the fluid;

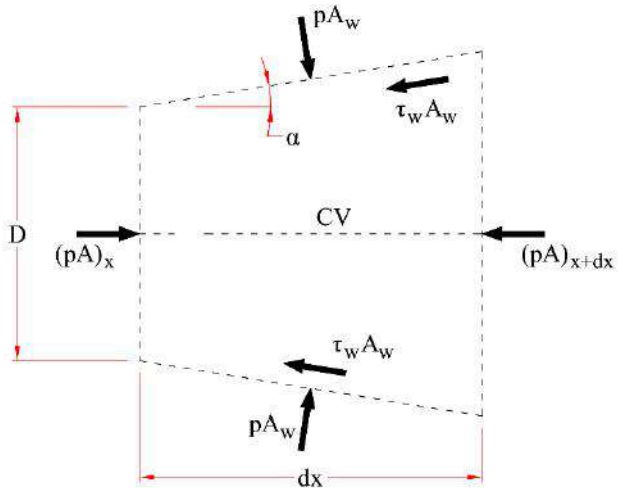
ρ = fluid density.

3.2 - Conservation of momentum

The principle of the conservation of momentum corresponds to the application of Newton's second law of motion to a fluid element. Thus, the net force acting, in the x direction, on the gas within the control volume, corresponds to the algebraic sum of the individual forces present in this system in relation to the same reference volume (Figure 2); that is:

Sum of forces = Momentum variation rate within the control volume - Net rate of momentum due to fluid flow across the boundary

Fig. 2: Forces acting on the control surface (Almeida et al., 2013)



For the present case, due to the symmetry of the control volume it becomes possible to neglect the radial force components, thereby featuring only the presence of forces due to the fluid pressure and shear forces (friction). Electromagnetic and electrostatic forces are negligible and are consequently ignored. Mathematically, this results in:

$$\frac{\partial v}{\partial t} + \frac{1}{\rho}\frac{\partial p}{\partial x} + v\frac{\partial v}{\partial x} + |v|\frac{2f_D v}{D} = 0 \qquad (4)$$

given: A_w = lateral area of the duct;

$_w$ = shear stress;

D = diameter of the local duct;

f_D = friction factor.

Designating the last component of this expression as Fa (Darcy friction force), one can also write:

$$\frac{\partial v}{\partial t} + v\frac{\partial v}{\partial x} + \frac{1}{\rho}\frac{\partial p}{\partial x} + F_a = 0 \qquad (5)$$

3.3 Conservation of energy

The equation for conservation of energy is derived from the application of the first Law of Thermodynamics which, when formulated for an open system in terms of rates, corresponds to:

$$\frac{\partial E}{\partial t} = \dot{Q} - \dot{W} + \Delta h \qquad (6)$$

that is, the rate of change of the energy within the control volume is equal to the rate of heat transfer into the same ($\dot{Q}$), minus the work production rate via the control surface ($\dot{W}$) and, furthermore, added to the net flow of the stagnation enthalpy (h).

Since the term corresponding to the work production rate can be considered to be zero due to the walls of the ducts being rigid, one can obtain the conservation of energy equation (explained in terms of the entropy) in the final form:

$$\frac{\partial s}{\partial t} + v\frac{\partial s}{\partial x} = \frac{kR}{c^2}\left(\dot{q} + F_a v\right) \qquad (7)$$

given: s = entropy;

k = ratio of specific heats;

R = the gas constant;

c = local speed of sound in the fluid;

$\dot{q}$= heat transfer rate per unit mass.

3.4 Differential equations in matrix form

By specific simplifications, with the corresponding application of the equation of state for the ideal gas case, the group of equations (3), (5), and (7) enables us to write the following system of differential equations:

$$1\frac{\partial p}{\partial t} + 0\frac{\partial v}{\partial t} + 0\frac{\partial s}{\partial t} + v\frac{\partial p}{\partial x} + c^2\rho\frac{\partial v}{\partial x} + 0\frac{\partial s}{\partial x} \cdots = \rho(k-1)(\dot{q} + vF_a) - \frac{\rho v c^2}{A}\frac{dA}{dx}$$

$$0\frac{\partial p}{\partial t} + 1\frac{\partial v}{\partial t} + 0\frac{\partial s}{\partial t} + \frac{1}{\rho}\frac{\partial p}{\partial x} + v\frac{\partial v}{\partial x} + 0\frac{\partial s}{\partial x} \cdots = -F_a$$

$$0\frac{\partial p}{\partial t} + 0\frac{\partial v}{\partial t} + 1\frac{\partial s}{\partial t} + 0\frac{\partial p}{\partial x} + 0\frac{\partial v}{\partial x} + v\frac{\partial s}{\partial x} \cdots = \frac{kR}{c^2}(\dot{q} + vF_a) \quad (08)$$

or in the matrix form:

$$\frac{\partial U}{\partial t} + B\frac{\partial U}{\partial x} = f \quad (09)$$

where:

$$U = \begin{pmatrix} p \\ v \\ s \end{pmatrix}$$

$$B = \begin{pmatrix} v & c^2\rho & 0 \\ \frac{1}{\rho} & v & 0 \\ 0 & 0 & v \end{pmatrix}$$

$$f = \begin{pmatrix} \rho(k-1)(\dot{q} + vF_a) - \frac{\rho v c^2}{A}\frac{dA}{dx} \\ -F_a \\ \frac{kR}{c^2}(\dot{q} + vF_a) \end{pmatrix}$$

$$F_a = f_D\frac{4}{D}\frac{|v|}{v}\frac{v^2}{2}$$

The matrix of coefficients B exhibits real eigenvalues, which are different to each other, thus characterizing a hyperbolic equation set (Godunov, 1994). Among the several methods that can be used to solve hyperbolic problems, finite difference techniques based on the Lax-Wendroff scheme and the method of characteristics are probably the most used. According to Ames (1965), Lax-Wendrof finite difference methods are adequate for problems that have a well stated solution within the calculation domain. Kruglov et al. (1988), on the other hand, pointed out that in the case of flows that may exhibit abrupt variations in their properties, the method of characteristics can be used to obtain accurate solutions.

The characteristic curves represent the natural coordinate system for solving hyperbolic problems. In this coordinate system, the equations in partial derivatives defined throughout the entire domain can be expressed as ordinary differential equations defined along the characteristic curves. These curves are obtained by solving the equation set, $det(B - dx/dt\ I) = 0$, where I is the identity matrix. This equation set expresses the necessary condition for the existence of singularities in the solution of the problem described by Equation (9) (Velásquez et al., 1995). Therefore, the equations of the characteristic curves are:

$$\frac{dx}{dt} = v + c$$

$$\frac{dx}{dt} = v - c$$

$$\frac{dx}{dt} = v$$

The first two characteristic curves in the above equations are called *Mach lines*, while the third one is the trajectory of the fluid particles (path line). The necessary condition for Equation (9) to have a solution along the characteristic curves is expressed by the socalled *compatibility equations*:

Mach line compatibility equations:

$$(dc)_{mach} \pm \frac{k-1}{2}(dv)_{mach} = \frac{k-1}{2}\frac{c}{kR}(ds)_{mach} + \frac{k-1}{2}\left[-\frac{\mathrm{vc}}{A}\frac{dA}{dx} + (k-1)\frac{1}{c}(\dot{q} + vF_a) \mp F_a\right]dt \quad (10)$$

Path line compatibility equation:

$$(ds)_{path} = \frac{kR}{c^2}(\dot{q} + vF_a)dt \tag{11}$$

It should be noted that the compatibility equations for the Mach lines in Equation (10) are expressed in terms of the differentials of v, c, and s. However, these equations can be expressed in terms of only two of these differentials by introducing the Riemann variables and , defined according to:

$$\lambda = c + \frac{k-1}{2}v$$
$$\beta = c - \frac{k-1}{2}v$$

By doing so, the following compatibility equations result:

$$(d\lambda)_\lambda = \frac{c}{c_A}(dc_A)_\lambda + \frac{k-1}{2}\left[-\frac{\mathrm{vc}}{A}\frac{dA}{dx} + (k-1)\frac{1}{c}\left(\dot{q} + vF_a\right) - F_a\right]dt \tag{12}$$

$$(d\beta)_\beta = \frac{c}{c_A}(dc_A)_\beta + \frac{k-1}{2}\left[-\frac{\mathrm{vc}}{A}\frac{dA}{dx} + (k - 1)\frac{1}{c}(\dot{q} + vF_a) + F_a\right]dt \tag{13}$$

$$(dc_A)_{path} = \frac{k-1}{2}\frac{c_A}{c^2}(\dot{q} + vF_a)dt \tag{14}$$

In Equations (12), (13), and (14), a variable called entropy level (c_A) was introduced instead of entropy s. It is related to the former by the following definition (Benson et al., 1964):

$$c_A = exp\left(\frac{k-1}{2k}s\right) \tag{15}$$

IV. THE COMPUTATIONAL ROUTINE

The computational model uses two numerical grids — one of them is Eulerian and the other is Lagrangian. The Eulerian grid was built by dividing the pipe length into (n - 1) equal parts, thus identifying nnodes, with two of them at the corresponding duct ends. Furthermore, mpoints were chosen along the duct, with two of them at the duct ends, thus defining mfluid particles whose positions define the Lagrangian grid.

From initial conditions, the fluid velocity and thermodynamic properties of the fluid are known along the pipe, and starting from these data at (x, t), the compatibility equations should be integrated along the corresponding characteristic curves, thus giving the solution at (x, t + t). The time t is chosen in order to satisfy the Courant-Fredrich-Lewy stability criterion (Courant et al., 1928), which expresses the necessary condition so that the largest displacement of a perturbation wave does not exceed the distance between neighboring nodes x.

V. THE EXPERIMENTAL SETUP

Experimental data were obtained from a pilot network approximately 140meters long, which was built of carbon-steel piping of 2 inches nominal diameter. In this setup, hypothetical transient events were generated by simulating localized leaks and using both compressed air and natural gas. The experimental apparatus included: five pressure sensors installed along the extension of the pipeline in order to provide records of the pressure variations occurring in the course of each test; a system for regulating pressure at the entry of the experimental network to maintain the pressure of the system within the limits previously established; and, for the test with compressed air, a reservoir (pressure vessel) installed at the beginning of the network. Figure 3 illustrates an isometric schematic of this apparatus, identifying its main components, while Figures 4 and 5 depicts specific details such as the vessel used during the tests, and the main pipeline.

It is worth mentioning that, in order to check the repeatability of the measurements, each test was performed at least three times. Although the opening of the valve was performed manually and without the use of any control device to guarantees the repeatability of this process, all the tests sought to make this opening as quickly as possible. By doing it this way, a delay of about 0.5 s was observed from the moment of activation to the moment that the maximum opening of the valve was reached.

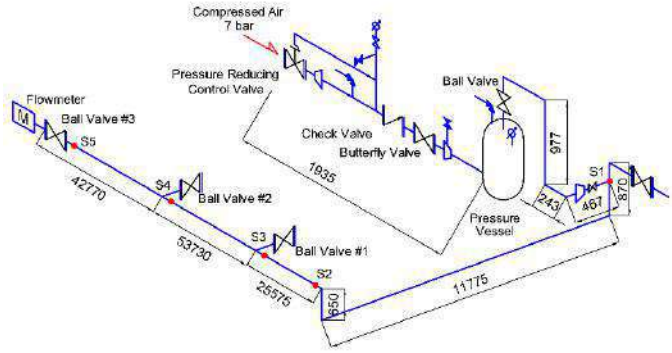


Fig. 3: Schematic of the experimental network

Fig. 4: The pressure vessel

Fig. 5: The main pipeline

VI. RESULTS AND DISCUSSION

Prior to the comparison of numerical and experimental results, a study was conducted to verify the results obtained after a given number of tests performed in the field under localized leakage conditions. Such tests were initially performed using compressed air as the test fluid and then the gas itself derived from the existing local distribution network.

In Figure 6 it is observed that at the beginning the velocity is zero throughout the whole duct and, after opening the valve located at x = 137.8 m, which simulates the rupture that causes the leakage of the air, this velocity increases rapidly at the end of the duct, reaching the sonic condition at the throat section of the valve (Figure 8). In turn, Figure 7 shows that a fall in pressure at the end of the valve occurs simultaneously with the increase in velocity, thus generating a depression wave that propagates in the direction of the tank and reaches it at approximately t = 0.45 s. As the depression wave sweeps through the length of the duct, the local pressure decreases and causes the mass of fluid that lies ahead to begin flowing. The depression wave generated at the end of the valve is reflected at the other end as a compression wave which, upon passing through a point, provokes a reduction in the rate at which the local pressure decreases due to the gas leakage. This compression wave reaches the end of the valve at approximately t = 0.8 s and returns to being reflected as a depression wave. This process of depression and compression wave propagation causes gas leakages to occur as jets, the intensity of which decreases over time.

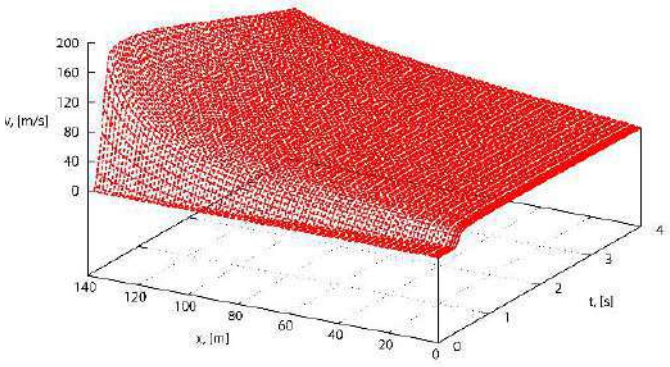


Fig. 6: Velocity of the fluid during emptying of the vessel

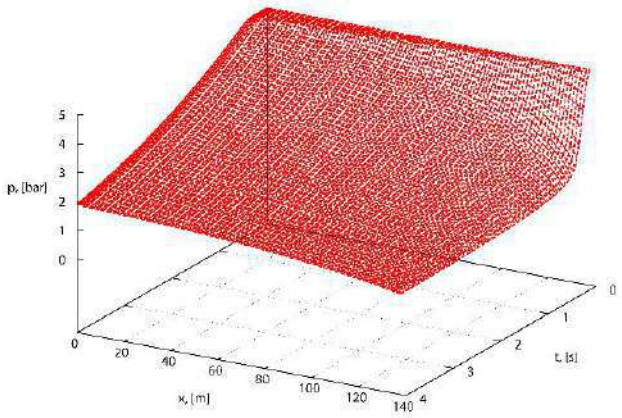


Fig. 7: Pressure of the fluid during emptying of the vessel and pipeline

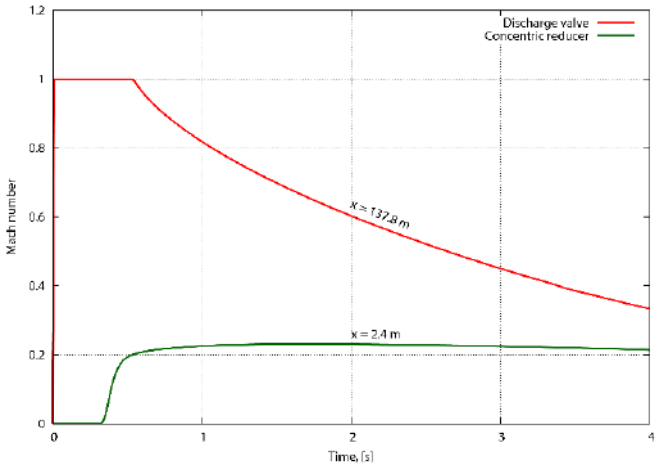


Fig. 8: Mach number at throat sections of the discharge valve and concentric reducer

In Figures 9–10, the experimental data are compared with the results of the simulation for the two cases studied. As can be seen in these graphs, the calculated values show good agreement with the experimental data, despite the final ones displaying noise in the data acquisition system. It should be noted that, despite not using any control device during testing that would guarantee the repeatability of the process of opening the discharge valve, in the computational model the flow area in the valve was considered to vary according to a sinusoidal function and the opening is completed in 0.5 s. It is expected that such an approach would be one of the sources of discrepancies observed between the numerical results and the experimental data.

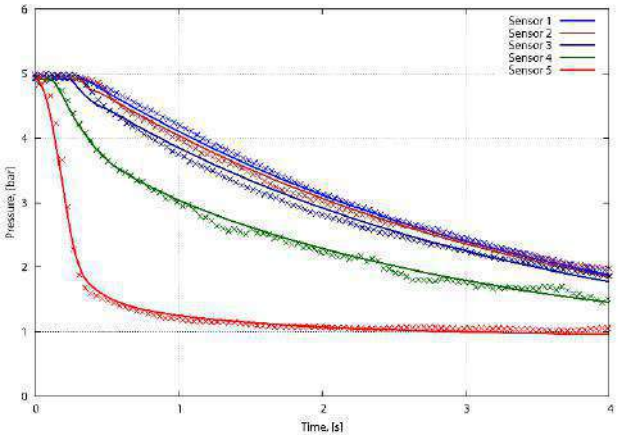


Fig. 9: Numerical and experimental pressure data to a generic test

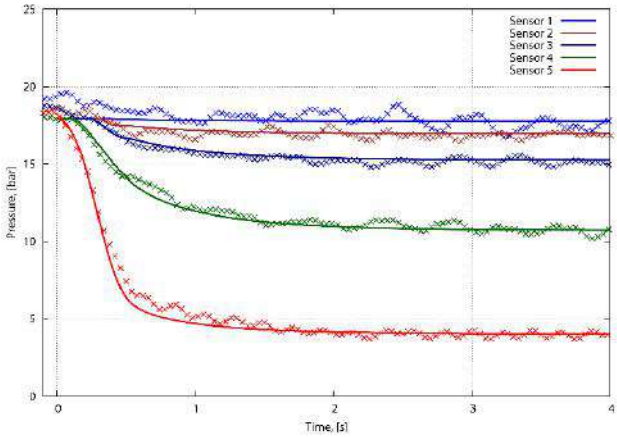


Fig. 10: Numerical and experimental pressure data to a generic test

VII. CONCLUDING REMARKS

A specific mathematical model to describe transient events in natural gas distribution networks, based on the method of characteristics, was presented in this work. Additionally, tests were performed in a pilot pipeline system in order to compare numerical and experimental data. The comparison showed good agreement, thus encouraging the use of the mentioned method for solving problems of this nature.

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Blast Furnace's Replacement Rate Calculation for Biomasses based on chemical and Thermal Properties

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***Abstract*—** *The injection of pulverized materials in blast furnaces is a technique that has been used in iron making for reducing costs with reducing fuels and allows greater operational control. To be injected, the material needs some chemical, physical and thermal characteristics for the process. However, biomass presents as an economical and environmentally viable alternative to replace part of the coal used in this process. One variable analyzed in the reduction process is the replacement rate (RR), which is the amount of coke saved loading on the top of the reactor per quantity of material injected. There are some mathematical models for calculating the replacement rate based on properties, which are results of studies in determined blast furnaces. This work will show some calculations for replacement rate of biomasses using formulas from the literature. Some results show the technical feasibility for the use of biomass in blast furnaces.*

I. INTRODUCTION

The earliest records of using iron ore for extraction metallic iron and produced weapons and other utensils date from years before Christ and even today it continues to be evolved to obtain iron and consequently steel. According to RICKETTS (2000), liquid iron was accidentally noticed when iron ore placed in a fire, with reducing fuels, and eventually melted. It was found that the ore together with a fuel, when heated, would melt and could be molded to produce weapons, tools and other utensils. The earliest historical documents showing human work with cast iron date from 1500 BC, written by the Egyptians. Only in the middle ages, there were a considerable production, due to the great demand for swords, shields and armor. From the second half of the nineteenth century investments made in steel and blast furnaces, which could produce 180 tons per day, began to appear. From 1940, steel industry starts to grew driven by increased demand for steel and new techniques and studies have being developing until today when some blast furnace can produce around 10,000 tons of hot metal per day.

The Blast Furnace is a counter-current metallurgical reactor where solid raw materials is charged in the top and reduced by rising gases came from the lower part. Blast furnaces with these concepts began to appear in the fourteenth century in France, Belgium and Germany. From then, reactors evolved to gain productivity and decrease the energy required for hot metal produces. Today, most of the hot metal produced in the world comes from blast furnaces. The large increase in productivity of these metallurgical reactors can be attributed to the fact that the continuous developments occurred mainly after 1970.

Blast furnace pulverized materials injection process is a consolidated technique that has been used in steel mills since the third part of the last century and is known worldwide, being applied in more than 500 blast furnaces around the world. In this process, the fuel is injected into

the blast furnace by the tuyers, which is located in the lower part of the reactor, providing energy and reducing gases for the process of obtaining hot metal that is the basic raw material for the production of steel. The main advantage of this process is reducing the amount of solid fuel charged in the top of the furnace as coke and charcoal. The most commonly used fuel in the injection process is coal, which is a non-renewable fossil fuel. In addition, coal is responsible for almost all CO_2 emitted in the atmosphere by steel production and it is restricted to some countries that does not have quality reserves. Various materials such as plastics, tires and biomasses have already been tested, but, for some authors, it is necessary to have high injection rates (from 150 to 200 kg / t of hot metal) to have the maximum benefits that this technique can provide. Waste has been an alternative route, most often for the cost and environmental issues involved while industries are looking for more sustainable ways of producing and generating carbon credits.

Agribusiness waste can also become viable due to their low cost, and often do not have an adequate route leading to storage and disposal problems. In addition, carbon dioxide captured during photosynthesis during cultivation may compensate for its burning, what make these materials neutral in CO2 emissions. In general, biomasses have a high content of volatile materials; *in natura* have high moisture content and low fixed carbon content. These properties greatly influence the process of injecting pulverized materials in blast furnaces, which suggests a pretreatment of this material prior to use. In the literature, is possible to find several heat treatments for the use of biomass as fuel. These include gasification, pyrolysis, torrefaction and carbonization, these treatments heats biomass in predetermined temperatures, often without oxygen, and thus can have a fixed carbon increase by eliminating excess volatile materials.

An index widely used in the blast furnace operator is the replacement rate (RR) defined as the amount of coke saved (kg / t hot metal) for each kg of coal injected by ton of hot metal. Summarizing, the replacement rate represents the relationship between coke and coal consumption, which is economically important. Some researchers developed some methods to calculate the RR based in the chemicals and thermals properties of the materials, most of them for determinate blast furnace.

The rising cost of raw materials, such as coal, and the high charges of the steel industry make steel production have a high cost. Steel companies should look for alternatives to minimize spending, particularly in the area of energy, alternative raw materials and waste disposal. This requires a strong incentive in the area of research and development to find the best way to increase production and consumption in a sustainable way. In this sense, biomass, especially agribusiness tailings, becomes a viable alternative not only for the lower cost of these materials compared to coal, but also for the possibility of reducing the CO2 emission in the process and eventual carbon credit generation.

This paper aims to review the injection of pulverized materials in blast furnaces and the replacement rate (RR). Here, some methods, found in the literature, to calculate the replacement rate taking into account properties such as calorific value, ashes, carbon content and others will be shown. Thus, the use of these methods to calculate the replacement rate for some biomasses, studied at the Federal University of Ouro Preto and that they can be used in the PCI, will be presented. It will be notice that the replacement rates found are lower than that of commonly used coals, but biomass may be feasible depending on their cost for mills.

II. REVIEW

2.1 Pulverized Coal Injection

Pulverized Coal Injection (PCI), has been very important for the steel sector survival because of the productivity and less cost with reduction raw materials, associated with the possibility of enriching the air with oxygen, producing more with low consumption of coke or charcoal (Oliveira, 2007). However,, the greatest benefit of this technique is the replacement of part of coke or charcoal loaded by the top of the blast furnace, which has a higher cost, with a fuel injected directly through the tuyers.

This technique had its origin documented in the 19th century, in France and later patented in Germany. There has been an evolution over the years, driven mainly by the economic aspect; Figure 1 shows the evolution of the number of blast furnaces that use injection. Over the years, several studies also pointed out that the method had a great influence on the reactor's behavior and productivity (Oliveira, 2007).

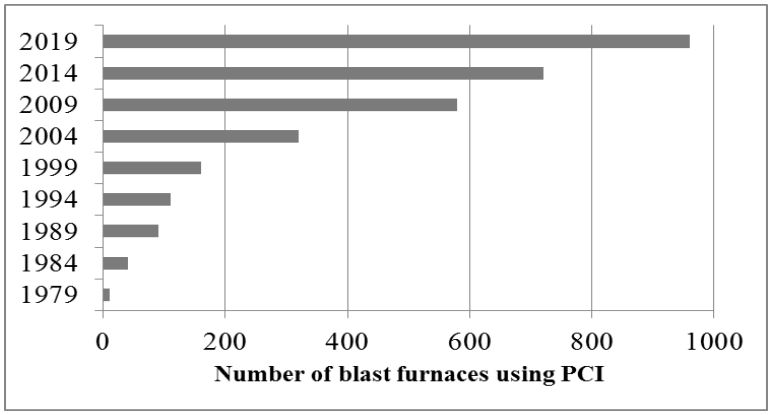

Fig.1: Evolution of the number of blast furnaces that use injection in the world.

Today the number of blast furnaces using the injection technique is around 900 and some reach injection rates above 200 kg / hot metal, which can generate significant savings in coke consumption.

The injection of auxiliary fuels is one of the main thermal control variables in blast furnaces and is used due to short response time. Its availability is limited in the lower range by the minimum injection rate and in the upper range by the minimum acceptable flame temperature, that is, there is a minimum quantity to be injected and a maximum quantity so there is no significant decrease in the flame temperature (Mourão, 2011).

For material being injected into the blast furnace it is necessary pass through some processes that will adapt it for injection in the combustion zone. First, grinding is carried out to achieve the ideal granulometry and drying to eliminate moisture. Then the material must be fluidized by mixing it with a gas, air or nitrogen, and transported pneumatically in pipes distributed by the tuyers (Assis, 2014). Figure 2 shows the preparation steps for the injection of pulverized materials in blast furnaces.

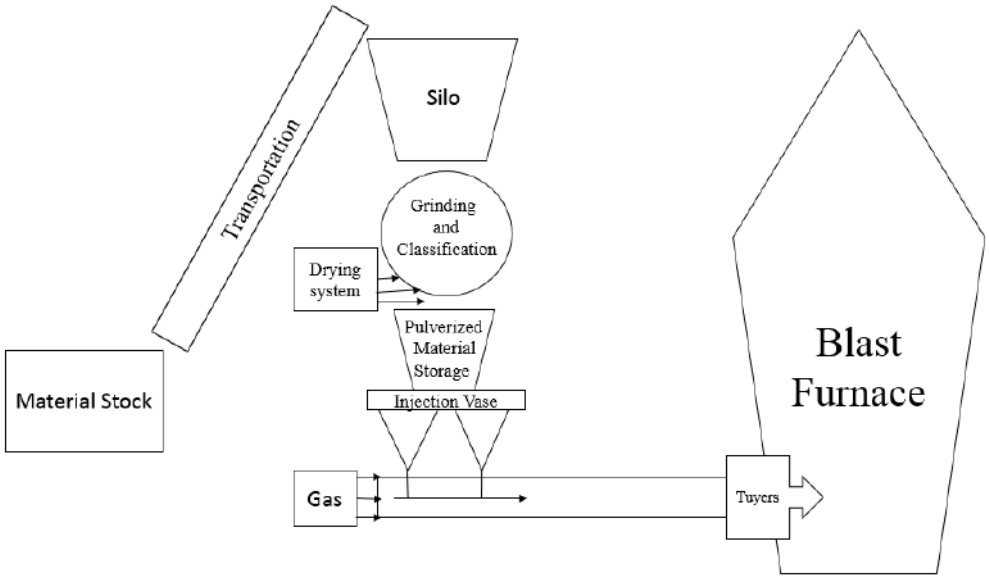

Fig.2: Steps for preparing materials for injection in blast furnaces (Assis, 2008).

The material is injected into the blast furnace inside the so-called raceway where it undergoes devolatization and burning, generating energy and gases necessary for the process. These phenomena start from the principle of the behavior of a particle of coal, which take place in three phases. First, the particle is heated, causing the degassing and ignition of the volatiles, which happens through the convective heat exchange with the blown air and radiant with the combustion zone. Second, there is the burning of volatiles, the pyrolysis that releases volatile material with

high hydrogen content. Finally, the residue in the particle that is practically carbon, called char, is burned. These steps can occur in sequence or simultaneously depending on factors such as particle size, composition, heating and the amount of oxygen available.

The main benefits of this technique are listed below:

• Cost reduction by replacing reducer (coal and coke) with low-cost materials, in addition to reducing energy consumption;

• Increased productivity, due to the possibility of enriching the air blown with oxygen together with the injected materials;

• It can increase the useful life of the coking batteries due to the reduced demand for coke;

• Helps in the stability of the hot metal quality and in the control of the silicon content;

• Possibility of biomass injection, generating a reduction in the emission of greenhouse gases (GHG).

Aspects related to the quality of the injected material also influence the operating parameters of the blast furnace, not only in thermal control, but in other conditions such as permeability, load distribution and others.

2.2 Replacement Rate

The replacement rate is no more than the amount of coke replaced by the amount of material injected. In other words, it can be said that the replacement rate measures the efficiency of the injection process and can be calculated as follows (Fernandes, 2007):

$$\gamma = \frac{CECR - CECA}{TIP} \quad (1)$$

where CECR is the specific consumption of reducer charge in the top without injection (kg / t of hot metal), CECA is the specific consumption of reducer charge in the top with injection (kg / t of hot metal) and TIP is the injection rate (kg/t of hot metal).

In the early 1990s Hunty et al. (1990) proved in his studies that the replacement rate varies with the rank of coal. Brouwer et. al. (1992) proposed the calculation of the corrected replacement rate for the KNHS blast furnace in Hoogovens, a Dutch steel company, which is presented as:

$$RR = \frac{(2x\%Carbon + 2{,}5x\%Hydrogen + 0{,}9x\%ash - \%moisture - 86)}{100} \quad (2)$$

In addition to this study, Brouwer and Troxopeus (1991) also evaluated the operational results of injection into the Ijmuiden blast furnace, of the same company, reaching the following ratio of the replacement rate and the properties of the coal:

$$RR = \frac{(-118{,}9 + 2{,}3\%Carbon + 4{,}5\%Hydrogen + 0{,}97\%Ash)}{100} \quad (3)$$

Other authors, later, developed other formulas to predict the corrected replacement rate for the blast furnaces in which they studied, taking into account other factors such as calorific value, volatile content and others. Table 1 shows some data of different coals and mixtures of coals injected in the blast furnace of a company.

Table 1. Characterization of coals usually used for blast furnace injection (Campos, 2017)

Coal	% ash	% Volatile	%C	%H	Injection Rate (Kg/t of hot metal)	Replacement rate
Monopol EB	6.60	15.30	83.30	4.20	52.00	0.94
Achenbach	7.80	23.10	81.20	4.70	78.20	0.84
Lohberg	6.60	32.30	79.00	5.00	122.20	0.88
Monopol GFI	11.30	31.20	72.70	4.80	79.00	0.82
Linhito	6.40	51.30	58.30	5.30	97.30	0.47
Carborat	10.00	9.10	81.20	3.60	115.20	0.87
50% Antracito+50% Lohberg	6.90	19.10	81.80	4.40	140.00	0.84
Furst Leopold	6.20	33.30	77.90	5.20	135.00	0.73
Hew-Acken	7.50	25.20	30.60	4.70	128.00	0.79
50%Hew-Acken +50%Monopol GFI	9.40	27.10	77.50	4.70	141.70	0.75

70%Hew-Acken+30% Furst Leopold	7.50	26.80	80.80	4.80	109.30	0.88
30% Hew-Acken+70% Monopol CK	8.60	29.60	77.00	4.90	114.30	0.84

An important factor to be analyzed in the injection of pulverized materials is the combustion rate. This rate is given in percentage and represents the amount of material that burns completely in the combustion zone of the blast furnace. This measurement can be done experimentally in an injection simulator or in computer simulation systems.

Generally, coal injection rates range from 100 to 180kg / ton of hot metal and no changes are required in blast furnace operation. However, for higher rates, some changes in the operation are necessary, for example, the load distribution and the enrichment of the gas with oxygen, among other criteria that will ensure the quality of hot metal produced.

2.3 Pulverized Biomass Injection

A variety of research has been published in which the impact of using biomass in blast furnace injection is assessed using approximation models. These models range from models of simulation of nozzles - blast furnace combustion zone, static models in one dimension, models in three dimensions, in addition to numerical models. The laboratory results suggest that the use of biomass in blast furnace injection can increase the degree of reduction of iron ore, when compared to coal (Suopajärvi, 2017).

There are several biomasses that can be used for blast furnace injection, and many have already been studied, such as sawdust, sawmill residues, agribusiness residues, wood, charcoal, roots and others. The carbon content in these biomasses is lower when compared to that of fossil fuels. Oxygen revolves around 40%, which reduces the energy contained in these materials. The fixed carbon is low, while the content of volatile materials is high. The amount of sulfur is also low, which is an advantage for blast furnace production. The moisture content of biomass is considered high and can be a problem, but drying treatments, and even roasting and carbonization, can mitigate this fact (Suopajärvi, 2013).

According to Wei (2017), biomass can be injected into blast furnaces in three ways: pulverized solid, bio-oil or biogas. The most common studies are the use of pulverized solids, mainly fine charcoal, and the injection of 200-225kg / ton of hot metalin large blast furnaces may be viable.

Assis (2014) performed several combustion tests with pure pulverized biomass and mixed with mineral coal. In its results it was possible to notice that many biomasses have a higher combustion rate than mineral coal. This fact was related to the high reactivity of the biomass, as well as the larger specific surface compared to coal, which influences the combustion process. Figure 3 shows the results of the combustion rate of several biomasses compared to mineral coal.

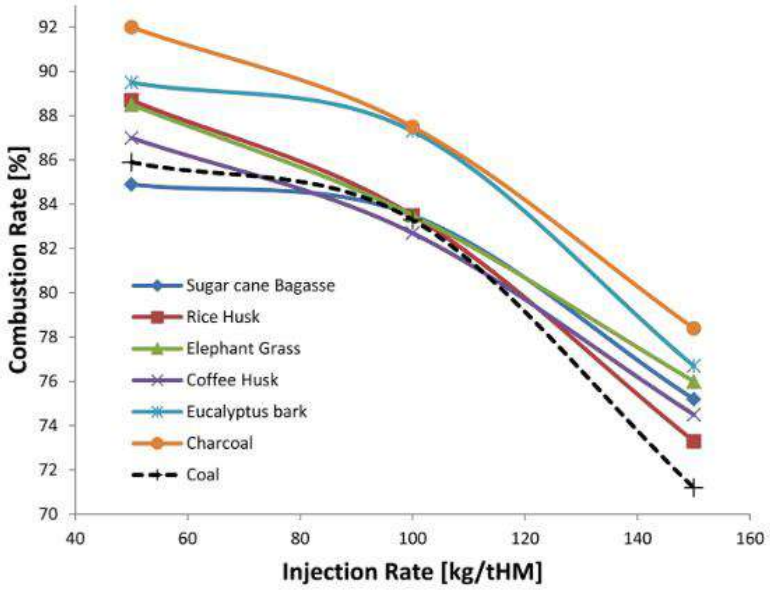

Fig.3: Injection simulation of some biomass in Federal University of Ouro Preto (Campos, 2018)

Some physical and chemical properties of biomass are essential to know for a good operation of blast furnaces, which influences the replacement rate and injection rate. Others characteristics that is possible to highlight is: humidity, granulometry, fixed carbon, volatile materials, ash content, sulfur, among others. In addition, some advantages and disadvantages of using biomass in conjunction with other primary fuels, is list below:

- Biomasses have a small amount of sulfur and nitrogen compared tocoal, they reduce the emissions of gases formed by these elements;

- CO_2 emissions are also reduced, as biomass can be considered CO_2 neutral;

- Ash content of biomass is generally lower;

- Because it has a density generally lower, transport can be facilitated from the silo to the tuyers;

- Biomass has lower calorific value;

- When compared to coal, biomass has a high amount of moisture;

- Biomasses have a lower activation energy than coal;

- The use of biomass makes carbon sequestration possible and can generate credits for the industry.

It is important to highlight that biomasses, even having similar characteristics, can vary according to the type of plant, form of planting, climate, soil, time of harvest, among other variables that interfere in their composition.

III. METHODOLOGY

In the first part of this research was shown a brief review of the literature to understand the facts related to the injection of pulverized materials and a replacement rate, as well as the possible uses of biomass in the production of hot metal. After, several data were collected, mainly the defined properties of biomass tested in the injection simulator of the Metallurgical Engineering department of the Federal University of Ouro Preto, so that a replacement rate can be considered. For the mixtures contained biomass and coal, a weighted average was calculated.

Finally, some materials were selected and the replacement rates were calculated using equations (2) and (3) showed in the first part. A simple arithmetic mean was obtained by the two equations to obtain a measure of central tendency.

The data regarding the properties, as well as the calculation of the replacement rate and some discussions will be shown below.

IV. RESULTS AND DISCUSSIONS

4.1 Estimate Replacement Rate

The replacement rate can be determined by the amount of coke or fuel that is no longer burdened at the top, as seen above. However, this calculation may not be so simple, so it is necessary to correct it for the operating conditions of each blast furnace.

Several authors have proposed calculations for the corrected replacement rate, each using the parameters of the blast furnace in which they studied. In this work, the replacement rate was calculated using the formulas of Brouwer et. al. (1992) (2) and Brouwer and Toxopeus (1991) (3), previously presented.

As the calculation presented was performed for KNHS blast furnaces, an average of the results obtained using the results of both equations.

The properties of coal, biomasses, as well as some mixture are shown in Table 1.

Table1. Raw Materials Properties

Raw Material	%C	%H	%Ash	%Volatiles	%Moisture
Coal	80,24	3,80	13,45	24,13	0,20
Moringa Husk	48,84	6,53	2,36	76,60	1,47
40%Moringa Husk+60%Coal	67,68	4,89	9,01	45,12	0,71
Charcoal	69,7	3,2	7,73	25,8	0,63
Eucalyptus Husk	50,1	5,42	2,43	68,73	5,77
Sugarcane Bagasse	46,4	4,68	4,33	75,03	7,03
Elephant Grass	40	5,36	13,5	69,95	0,1
Rice Rusk	43,4	4,33	9,55	73,18	0,1
Corn Cob	45,5	6,7	1,16	81,31	0,79

Corn Straw	44,8	6,8	1,58	81,68	0,31
Corn Stem and Leaf	45,6	6,5	3,43	78,3	2,2

It is possible to see in the table that the mixtures have average properties, between coal and biomass. By increasing the content of biomass in coal, the carbon content and moisture content increase, while the hydrogen content, volatile materials and ash decrease. Table 2 shows the values obtained by calculating the replacement rate using the two formulas presented and the simple average of the rates obtained.

Table 2. Replacement Rate Calculated.

Raw Material	**Replacement Rate (Equation 3)**	**Replacement Rate (Equation 2)**	**Replacement Rate Avarege**
Coal	0,96	0,96	0,96
Moringa Husk	0,25	0,27	0,26
40%MoringaHusk+60%Coal	0,68	0,68	0,68
Charcoal	0,63	0,67	0,65
Eucalyptus Husk	0,23	0,18	0,21
Sugarcane Bagasse	0,13	0,08	0,11
Elephant Grass	0,10	0,19	0,15
Rice Rusk	0,10	0,20	0,15
Corn Cob	0,17	0,21	0,19
Corn Straw	0,16	0,21	0,19
Corn Stem and Leaf	0,19	0,20	0,19

The replacement rate for biomasses is usually lower than coal, which, analyzing this point, makes its use unfeasible. When analyzing biomasses with lower moisture content an improvement is observed, however the great advantage is the use of these biomasses together with coal. The use of agriculture waste in the mixture with coal can generate an environmental gain, with the reduction of CO_2 emissions, and an economic gain, by exchanging the more expensive coal for biomass with lower added value. These factors can compensate for the decrease in the substitution rate when compared to pure coal.

It is possible to notice in the graph of Figure 4 that when the carbon content decrease, the replacement rate decreases. As in both formulas used the carbon content has greater value, a fall in the replacement rate is expected when adding biomass, as it has a lower carbon content, consequently the carbon content of the mixture will be lower. These raw materials, biomasses, can pass away from a pretreatment for take out the moisture and volatiles content, what can be increase the calorific value and consequently the replacement rate.

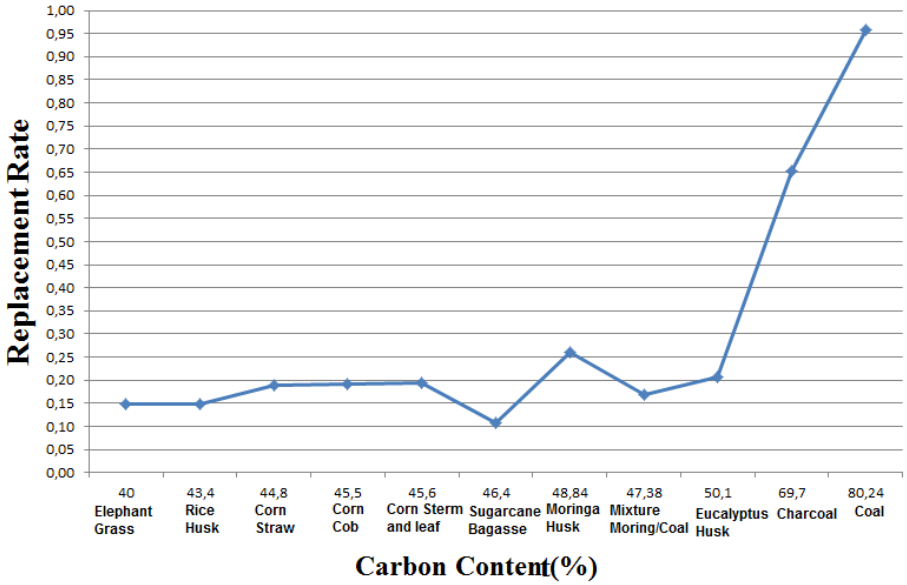

Fig.4: Replacement rate x carbon content.

According to Fernandes (2007), the replacement rate does not depend on the injection rate for the same operational condition, but changes always occur when the injection rate is increased. This is because when the injection rate is increased; the combustion efficiency is reduced, thus reducing the metal reduction efficiency in the preparation zone.

Emphasizing, these formulas were proposed for the blast furnaces studied by the authors and may not correspond to the replacement rate for other blast furnaces with different operating procedures. In addition, various material properties can influence the replacement rate, that is, a set of factors and / or properties can act simultaneously affecting the replacement rate. One very important point is related to CO content of the biomass volatiles. As it is known this CO can increase the replacement ratio. This factor was not considered in our calculations, due to the fact that the equations above do not consider this variable.

The calculation allowed us to have an idea of the influence of the using biomasses in the mixture with coal in the replacement rate, which is an important indicator for the productivity of the blast furnace.

V. CONCLUSION

It is possible to conclude that the replacement rate is an important variable, not only in the operation of the blast furnace, but in the choice of raw materials to be used in the process. It is well known that the replacement rate of biomasses is much lower than that of commonly used coal, but if the mixtures are analyzed, the substitution rates will be a little higher, which would make their use feasible. Finally, it is necessary to comment that in order to use the biomasses in the injection process it is necessary a pre-treatment of grinding and heating so that they increase the content fixed carbon what is important to the process. The use of biomass can bring environmental and economic gains since there is a decrease in the burning of fossil fuels and the use of a material with low added value.

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Resilience, daily spiritual experience and self-efficacy of university teachers

Resiliência, experiência espiritual diária e autoeficácia de professores universitários

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***Keywords*— Daily Spiritual Experience, Resilience, University Teachers.**

***Abstract*—** *The university context, nowadays, is faced with accelerated changes and transformations of great magnitude that interfere in the daily life of the teacher, in particular, in their self-efficacy. The general objective of this study was to analyse the relationship between resilience, daily spiritual experience and self-efficacy of university teachers. A quantitative methodology is presented, cross-sectional and correlational study approach conducted in 2019. Participants were 189 university teachers of health course area of a private university of Ceará, Brazil. The scales of resilience, daily spiritual experience and self-efficacy scale of the university teachers were applied. The results achieved showed a positive association between daily spiritual experience and resilience, as well as, between daily spiritual experience and teacher self-efficacy; also, between daily spiritual experience and teacher self-efficacy. Therefore, it is suggesting further studies to help clarify the results achieved and that encompassing individual and contextual variables that influence, promote or differentiate university teachers.*

I. INTRODUÇÃO

O contexto universitário do século XXI encontra-se influenciado pelo surgimento de importantes transformações de grande magnitude e diversidade nos saberes, com potencial para afetar de forma significativa o rendimento do trabalho docente e gerar mal-estar [1]. Porém, as consequências nefastas dessas mudanças são mais prementes quando o indivíduo mantém uma exposição contínua a eventos stressantes [1-5]. Neste âmbito, Brandão, Mahfoud e Gianordoli-Nascimento [6], Pasqualotto e Löhr [7], Olivares-Faúndez e Villalta [1], Otero-López, Villadefrancos, Castro e Santiago [8] asseveram que a natureza desgastante da docência universitária pode ser mediada pela capacidade do professor lidar com as ocorrências stressantes que vivencia no trabalho porque os fatores de risco não afetam todas as pessoas por igual [1]. Existem diferenças individuais que

atuam como fatores mediadores do mal-estar [1, 6, 8;], como por exemplo, a resiliência [1, 6, 8].

O vocábulo resiliência, do latim *resiliens*, significa "pular de volta", regressar a um estado anterior, saltar para trás, voltar e recuar [6, 9], remete para a noção de elasticidade e capacidade de recuperação. Recopilando sobre o constructo, Martins, Onça, Emílio e Siqueira [10] categorizaram a "resiliência" como a capacidade de adaptação, adaptação positiva, recuperação, resistência e superação. Logo, o indivíduo resiliente é aquele que detém um desenvolvimento bem-sucedido apesar das situações hostis vivenciadas [11].

A resiliência também é enfatizada como o produto de um processo dinâmico entre fatores protetores e de risco ou como um mecanismo de defesa [12, 13], repousando basicamente na capacidade de o indivíduo atuar como agente diante das condições adversas, persistindo nos seus esforços e retorno à normalidade, na capacidade de regulação da conduta, apoiando-se nos resultados, quando comparados a um padrão de referência e, sobretudo, na crença na sua competência para realizá-lo [14], permitindo às pessoas prosperarem perante as adversidades da vida quotidiana, nas quais se inclui o trabalho [15].

Outras variáveis reconhecidas como recursos que ajudam as pessoas a enfrentarem as adversidades diárias e os eventos traumáticos [16, 17], também consideradas componentes do conceito de qualidade de vida [18], são a espiritualidade e a religiosidade. Estas práticas e crenças espirituais e religiosas experienciadas em todo o mundo, pela influência motivacional que imprimem no sistema psicológico humano [19], têm vindo a ganhar atenção dos pesquisadores como variáveis associadas à saúde [20], nomeadamente à saúde no geral [20], à melhoria do estado de saúde física e mental [21] e a bons índices de saúde e bem-estar [22].

O estudo de Sharif, Moeini, Bromand e Binayi [21] mostra uma relação significativa e positiva entre as experiências espirituais diárias e a saúde em geral de idosos. No âmbito educacional, a manifestação da espiritualidade do professor e os seus benefícios para o aluno e sociedade é também salientada em estudos recentes [23-25] pelo sentido profissional que exibe e expressão à identidade da instituição onde labora [23]. Neste seguimento, interessa o entendimento das representações dos professores sobre o seu desempenho profissional, ou seja, sobre a sua autoeficácia docente.

O conceito de autoeficácia surge no quadro conceptual da Teoria Social Cognitiva [27-28] associado à percepção dos indivíduos sobre a sua capacidade de planear e executar as tarefas desejadas [29-32]. Isto denota que as crenças de autoeficácia aludem aos juízos de cada pessoa sobre a sua capacidade de executar uma determinada atividade. Em 1997, Bandura [27] procura demonstrar como os aspetos cognitivos, comportamentais, contextuais e afetivos das pessoas estão condicionados pela autoeficácia e, por essa razão, a sua teoria tem vindo a conquistar um lugar proeminente entre os constructos explicativos do êxito e do fracasso na atuação humana [33-34]. Para Bandura [27-29] a autoeficácia enquadra-se num dos mecanismos fundamentais do agenciamento humano. O sentido de "ser agente" simboliza intencionalidade na influência que o individuo exerce sobre o próprio funcionamento e sobre as circunstâncias da própria vida [29], pois, ao interferir no exercício do controlo, as crenças de autoeficácia influenciam o desempenho, a persistência e a motivação das pessoas para a realização de determinadas tarefas [14]. Os indivíduos provavelmente realizarão atividades em que acreditam ter mais capacidade de sucesso do que tarefas em que o sentido de competência é avaliado pelo indivíduo como reduzido. Assim, a autoeficácia faz diferença no modo como as pessoas sentem, pensam e agem e isso se reflete nas escolhas, nas condutas e no desempenho [35].

A literatura destaca a autoeficácia positiva como um fator associado ao êxito pessoal, à satisfação profissional e às experiências individuais bem sucedidas e à motivação laboral [30, 32, 36-38], com papel mediador na relação entre a sobrecarga de trabalho e as dimensões do *burnout* em professores.

Sentimentos de autoeficácia são salientados pela relação significativa entre o *burnout* e o rendimento académico docente [40], disponibilidade para o envolvimento em práticas colaborativas [41] e pelo impacto notável no desempenho académico de professores [42-43]. Os professores, confiantes nas suas crenças, com potencial para ensinar, pesquisar e gerir, são os elementos fundamentais para melhorar o processo efetivo das aprendizagens [44] e para colocar em ação as suas capacidades de aplicação de várias estratégias didáticas, nomeadamente, aquelas que são indicadas como representativas do ensino universitário, tais como a planificação do processo de ensino-aprendizagem, o envolvimento dos estudantes neste processo, a interação e a criação de um clima de aprendizagem positivo na sala de aula e a avaliação das aprendizagens dos alunos [45].

Bandura [27] também acrescenta uma dimensão coletiva à agência individual através de um sentimento de eficácia partilhada. As pessoas repartem conhecimentos, habilidades e recursos, apoiam-se mutuamente, formam alianças e trabalham juntas para solucionarem os seus problemas e melhorarem a qualidade de vida. Isto é, ao se auto percepcionarem mais capazes de desenvolverem as suas ações educativas com eficácia [46], os professores

influenciam o nível da persistência perante dificuldades e a criação de expetativas mais elevadas em relação aos alunos [47]. Por se tratar de um constructo que atua como preditor do sucesso académico do aluno [14], não respeita, apenas, à auto regulação e à motivação individual podendo se converter num fenómeno coletivo [48]. Assim sendo, este estudo tem como objetivo analisar relações entre resiliência, experiência espiritual quotidiana e autoeficácia de professores universitários partindo-se da seguinte hipótese: a autoeficácia do professor universitário pode ser explicada pelas diferentes dimensões da resiliência e da experiência espiritual quotidiana.

II. MÉTODO

2.1.- Amostra

Neste estudo quantitativo, transversal e correlacional participaram 189 professores universitários dos cursos de graduação da área da saúde, que laboram numa universidade privada do nordeste brasileiro. A amostra representativa contou com 36% de professores universitários de um universo de 530 [49], sendo 56 homens (29,50%) e 133 mulheres (70,40%). A média de idade é de 44,75 (*DP* = 9,94) e situa-se entre os 27 e os 77 anos.

2.2.- Instrumento

A resiliência dos professores universitários foi avaliada usando uma escala multidimensional, constituída por 25 itens, mensurados numa escala de *Likert* compreendida entre 1 (discordo totalmente) e 7 (concordo totalmente), projetada por Wagnild e Young [50], adaptada para português por Taranu [51]. Avalia o nível de resiliência individual nas dimensões "valorização de si próprio", "competência pessoal" e "aceitação da vida" como caraterísticas positivas da personalidade que contribuem para a adaptação do individuo perante eventos adversos do quotidiano. Os índices de confiabilidade da escala foram α = 0,696 na "valorização de si próprio", α = 0,822 na "competência pessoal" e α = 0,828 na aceitação da vida. A proporção de variabilidade nas respostas que resulta de diferenças nos inquiridos varia entre o fraco e o bom, sendo por isso, a sua fiabilidade admissível [52].

Para avaliar a experiência espiritual quotidiana recorreu-se à escala de auto relato desenvolvida por Underwood e Teresi [20] e adaptada para o português por Taranu [51]. Esta escala, mede as experiências espirituais que as pessoas vivenciam na sua vida quotidiana. Dos 16 itens que a compõem, 15 são medidos numa escala de *Likert* com 6 pontos (1 = muitas vezes por dia; 2 = todos os dias; 3 = na maior parte dos dias; 4 = alguns dias; 5 = de vez em quando; 6 = nunca ou quase nunca) e o último item, 16, trata de medir a espiritualidade global em forma oposta aos primeiros 15 itens, numa escala de *Likert* de 4 pontos (1 = nada, 2 = algo próximo, 3 = muito próximo, 4 = tão próximo quanto possível), medindo as dimensões "admiração, amor e desejo de proximidade com Deus", "gratidão e conexão" e "compaixão". A escala apresenta consistência interna admissível na dimensão "admiração, amor e proximidade com Deus" (α = 0,663), fraca na "gratidão e conexão" (α = 0,530) e muito boa na dimensão "compaixão" (α = 0,905). Embora a fiabilidade dos dados obtidos na dimensão "gratidão e conexão" seja fraca, decidiu-se mantê-la no estudo (α > 0,5) [52].

A autoeficácia dos professores universitários foi medida através da versão portuguesa da escala de *Likert* construída por Prieto [53]. A escala contém 44 itens de tipo quantitativo, cujas respostas vão de um a seis e divide-se em dois domínios: o primeiro avalia as crenças nas capacidades de cada docente, indo as respostas de "pouco capaz" (1) até "muito capaz" (6); o segundo mede as crenças de autoeficácia, sendo que cada uma das respostas varia entre "nunca" (1) e "sempre" (6). A proporção de variabilidade nas respostas que resulta de diferenças nos inquiridos varia entre razoável e bom, sendo α = 0,836 na dimensão "estratégicas didáticas para planificar as aulas", α = 0,789, "estratégias didáticas para implicar ativamente os alunos", α = 0,823 "estratégias didáticas para favorecer a interação na aula" e α = 0,824 "estratégias didáticas para avaliar a aprendizagem", sendo a sua fiabilidade admissível [52].

2.3.- Procedimentos

O estudo realizou-se após aprovação prévia do Comité de Ética (2.988.258) e assinatura do termo de consentimento livre e esclarecido dos participantes e assegurada a confidencialidade dos dados obtidos. Os questionários foram respondidos de forma anónima, voluntária e cumpridos os procedimentos éticos na investigação com seres humanos.

Os dados recolhidos foram processados no programa informático *SPSS – Statistical Package for Social Science*, versão 20.0. A análise exploratória de dados (teste de *Kolmogorov-Smirnov* e *Shapiro-Wilk*) revelou estarem cumpridos os pressupostos subjacentes à utilização de testes paramétricos [52]. Para averiguar se as variáveis em estudo estão relacionadas recorreu-se ao coeficiente de correlação de Pearson (*r*) pois, permite avaliar a direção e a magnitude dessa mesma associação [54]. No tratamento estatístico dos dados assumiu-se um a*lpha* = 0,05 como valor crítico de significância dos resultados dos testes.

III. RESULTADOS

Foram realizadas correlações entre a resiliência, a experiência espiritual quotidiana e a autoeficácia dos professores universitários. Os resultados da análise bivariada são apresentados separadamente em três grupos, designadamente, associação entre a resiliência e a experiência espiritual quotidiana, associação entre a resiliência e a autoeficácia docente e associação entre a experiência espiritual quotidiana e a autoeficácia docente.

A tabela 1 apresenta o coeficiente de correlação de Pearson entre as dimensões da resiliência e da experiência espiritual quotidiana. Na valorização de si próprio, verifica-se altas correlações positivas com a admiração amor e desejo de proximidade com Deus (r = 0,291, p = 0,000), com a gratidão e conexão (r = 0,311, p = 0,000) e com a compaixão (r = 0,280, p = 0,000). A competência pessoal indica elevadas correlações positivas com a admiração, amor e desejo de proximidade com Deus (r = 0,205, p = 0,005), com a gratidão e conexão (r = 0,243, p = 0,001) e com a compaixão (r = 0,205; p = 0,005). A aceitação da vida indica, apenas, fraca correlação com a gratidão e conexão (r = 0,149, p = 0,040).

Tabela.1: Associação entre a resiliência e a experiência espiritual quotidiana

Resiliência	Experiência espiritual quotidiana		
	Admiração, amor e desejo de proximidade com Deus	Gratidão e conexão	Compaixão
Valorização de si próprio	0.291**	0.311**	0.280**
	0.000	0.000	0.000
Competência pessoal	0.205**	0.243**	0.205**
	0.005	0.001	0.005
Aceitação da vida	0.076	0.149*	0.134
	0.298	0.040	0.066

**Correlações significativas ao nível de 0,01 (2-*tailed*).

*Correlações significativas ao nível de 0,05 (2-*tailed*).

Fonte: Elaborado pelos autores.

A tabela 2 indica que a resiliência se apresenta alta e positivamente correlacionada com a autoeficácia docente. Pode-se observar que a valorização de si próprio, a competência pessoal e a aceitação da vida se apresentam alta e positivamente associadas às estratégias didáticas para planificar as aulas (r = 0,490, p = 0,000; r = 0,393, p = 0,000; r = 0,336, p = 0,000), implicar ativamente os alunos (r = 0,472, p = 0,000; r = 0,428, p = 0,000; r = 0,170, p = 0,020), favorecer a interação nas aulas (r = 0,520, p = 0,000; r = 0,523, p = 0,000; r = 0,286, p = 0,000) e avaliar a aprendizagem (r = 0,431, p = 0,000; r = 0,461, p = 0,000; r = 0,234, p = 0,001).

Tabela.2: Associação entre a resiliência e a autoeficácia docente

Resiliência	Estratégias didáticas para...			
	Planificar as aulas	Implicar ativamente os alunos	Favorecer a interação na aula	Avaliar a aprendizagem
Valorização de si próprio	0.490**	0.472**	0.520**	0.431**
	0.000	0.000	0.000	0.000
Competência pessoal	0.393**	0.428**	0.523**	0.461**
	0.000	0.000	0.000	0.000
Aceitação da vida	0.336**	0.170*	0.286**	0.234**
	0.000	0.020	0.000	0.001

**Correlações significativas ao nível de 0,01 (2-*tailed*).

*Correlações significativas ao nível de 0,05 (2-*tailed*).

Fonte: Elaborado pelos autores.

A tabela 3 mostra as correlações entre a experiência espiritual quotidiana e a autoeficácia dos professores universitários. As dimensões admiração, amor e desejo de proximidade com Deus mantêm-se alta e positivamente correlacionadas com as estratégias para planificar as aulas (r = 0,216, p = 0,003) implicar ativamente os alunos (r = 0,166, p = 0,022), favorecer a interação na aula (r = 0,219, p = 0,002) e avaliar a aprendizagem (r = 0,289; p = 0,000). A dimensão gratidão e conexão apresenta associação positiva com - planificar as aulas (r = 0,232, p = 0,001), implicar ativamente os alunos na aula (r = 0,176, p = 0,015), favorecer a interação na aula (r = 0,238, p = 0,001) e avaliar a aprendizagem (r = 0,275, p = 0,000). O fator compaixão assinala associação baixa e positiva com as estratégias para favorecer a interação na aula (r = 0,145, p = 0,047) e para avaliar a aprendizagem (r = 0,158, p = 0,031) mas não indicia associação estatística com as estratégias didáticas para planificar as aulas (r = 0,137, p = 0,063) nem para implicar ativamente os alunos (r = 0,081, p = 0,266).

Tabela.3: Associação entre a experiência espiritual quotidiana e a autoeficácia docente

Experiência espiritual quotidiana	Estratégias didáticas para:			
	Planificar as aulas	Implicar ativamente os alunos	Favorecer a interação na aula	Avaliar a aprendizagem
Admiração, amor e proximidade com Deus	0.216**	0.166*	0.219**	0.289**
	0.003	0.022	0.002	0.000
Gratidão e conexão	0.232 **	0.176*	0.238**	0.275**
	0.001	0.015	0.001	0.000
Compaixão	0.137	0.081	0.145*	0.158*
	0.063	0.266	0.047	0.031

**Correlações significativas ao nível de 0,01 (2-*tailed*).

*Correlações significativas ao nível de 0,05 (2-*tailed*).

Fonte: Elaborado pelos autores.

IV. DISCUSSÃO

O trabalho docente universitário desempenha um papel crucial no funcionamento social não só pelo papel

formativo e motivador direcionado aos alunos, mas também pelas expectativas sociais adstritas ao primordial contributo do exercício pedagógico no desenvolvimento e bem comum das comunidades. Os professores universitários são os protagonistas fundamentais na formação de futuros profissionais, sendo indispensável neste contexto a ótima saúde física e psicológica destes trabalhadores para o progresso das suas imprescindíveis ações [1, 55]. Estudos internacionais posicionam o ensino superior no enfrentamento de concorrência e desafios do ambiente macro da globalização [56], apontam a prevalência de problemas de saúde ocupacional [57], mas também advogam que os professores universitários são os elementos indispensáveis na melhoria do processo de ensino-aprendizagem através do seu potencial pedagógico, investigativo e de gestão [44]. Foi nesse contexto, como previsto, que se procurou analisar a relação entre a resiliência e a experiência espiritual quotidiana e a autoeficácia docente na acepção de professores universitários da área da saúde que laboram numa universidade privada do nordeste brasileiro.

Quanto às caraterísticas da amostra, maioritariamente feminina, é representativa do universo dos docentes que lecionam no departamento de Saúde Coletiva, numa universidade privada do Ceará, no Nordeste Brasileiro. Globalmente, à medida que se foi apreciando as relações entre as variáveis, verificou-se que as dimensões da resiliência caminham a par da autoeficácia e da experiência espiritual quotidiana. Isto é, existem correlações positivas e significativas entre a resiliência e a experiência espiritual quotidiana, entre a experiência espiritual quotidiana e a autoeficácia e entre a autoeficácia e a resiliência [54]. Assim, maior resiliência está associada a maior experiência espiritual quotidiana, maior experiência espiritual quotidiana está associada a maior autoeficácia e maior resiliência está associada a maior autoeficácia.

Do estudo da associação entre a resiliência e a experiência espiritual quotidiana interessa observar que as dimensões "valorização de si próprio" e "competência pessoal" correlacionaram-se positivamente com todas as dimensões da experiência espiritual quotidiana "admiração, amor e desejo de proximidade com Deus", "gratidão e conexão" e "compaixão". Por sua vez, a dimensão "aceitação da vida" indiciou fraca correlação com a dimensão da experiência espiritual quotidiana – "gratidão e conexão". Estes resultados fornecem informações de interesse para a compreensão do psiquismo humano. Professores que relataram maior valorização de si próprio e maior competência pessoal, também se descreveram com maior ligação à vida espiritual quotidiana. Apesar da espiritualidade, bem como da religiosidade, serem legitimadas como práticas e crenças vivenciadas em todo o mundo, associadas à saúde [20], reconhecidas como recursos que auxiliam os indivíduos no enfrentamento dos eventos traumáticos do quotidiano [17] os resultados também sugerem influência positiva nestes profissionais. Neste âmbito, o estudo de Capelo, Pocinho e Rodrigues [18], desenvolvido em Portugal, evidenciou correlações significativas e positivas entre a dimensão amor e proximidade com Deus e a resiliência.

Expressivas são as dimensões da resiliência (valorização de si próprio, competência pessoal, aceitação da vida), que se correlacionam positivamente com a autoeficácia docente. Capazes de acreditar em si mesmos, os professores universitários que se auto percepcionam mais resilientes também consideram que são mais autoeficazes na concretização de estratégias didáticas para "planificar as aulas", "implicar ativamente os alunos", "favorecer a interação nas aulas" e "avaliar a aprendizagem", levando a inferir que o indivíduo resiliente consegue prosperar mesmo perante os reveses do contexto laboral [15]. Também, Fontaines e Urdanteta [59] analisaram a atitude resiliente do docente em ambientes universitários e detectaram manifestos níveis elevados na capacidade dos professores lidarem e superarem os problemas do contexto laboral.

Do estudo da associação entre a experiência espiritual quotidiana e a autoeficácia docente verificou-se que a "admiração, amor e desejo de proximidade com Deus" e a "gratidão e conexão" foram as dimensões da experiência espiritual quotidiana que se correlacionaram positivamente com todas as dimensões da autoeficácia (estratégias para planificar as aulas, implicar ativamente os alunos, favorecer a interação na aula e avaliar a aprendizagem), enquanto a "compaixão" apenas se correlaciona positivamente com as estratégias didáticas para favorecer a interação na aula e para avaliar a aprendizagem. Os resultados indiciam que os professores universitários que auto percepcionam níveis de experiência espiritual quotidiana mais elevada também se auto avaliam como mais autoeficazes em diferentes dimensões da docência. Nesta acepção, estudos advogam que o professor, ao se conectar com a essência da sua espiritualidade, influencia o seu desempenho profissional, o seu crescimento pessoal a nível humano-interacional, afetivo, ético, técnico e estético, também associa significado à sua existência, dá sentido profissional e expressão à identidade da organização onde trabalha [26], hodiernamente, condições determinantes para a convivência pacífica [25].

V. CONCLUSÃO

Nos últimos tempos emergiram diversos estudos focalizados na resiliência, na espiritualidade e na autoeficácia, porém, existe uma clara lacuna de pesquisa que incida sobre professores universitários e/ou relacione estas três variáveis. Os achados deste estudo corroboram a literatura, mas requerem novas pesquisas sobre os professores universitários, pois vários fatores podem contribuir para a explicação dos resultados alcançados como a cultura, o contexto, ser uma instituição privada, o sistema adotado pelo país, a legislação, entre outros. Também importa realçar que a natureza correlacional deste estudo não permite testar relações de causalidade levando a que as considerações explanadas precisem ser tomadas apenas como possibilidades. Contudo, as consistentes e positivas correlações observadas entre a resiliência e a autoeficácia docente exortam novas pesquisas que ajudem a descortinar como se dá o processo de adaptação, recuperação, resistência e superação das adversidades quotidianas. Da mesma forma, convém levar em consideração as associações significativas e positivas entre a experiência espiritual quotidiana e a resiliência e entre a experiência espiritual quotidiana e a autoeficácia reveladas por este grupo profissional. De modo similar seria importante conhecer quais são os fatores individuais e contextuais que influenciam, favorecem ou diferenciam os professores universitários. Em suma, novas pesquisas são indispensáveis, incluindo outros fatores, outras variáveis, outros contextos e até outras perspectivas, visando ampliar a compreensão sobre os professores universitários.

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The Virtual Environment Room as a Didactic Resource for the Teaching of Pathologies Associated with *Helicobacter pylori* from the Perspective of Gastroenterology Teachers

Sala Ambiente Virtual como Recurso Didático para Ensino de Patologias Associadas ao *Helicobacter pylori* a Partir da Perspectiva dos Docentes de Gastroenterologia

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***Palavras-Chave*— Lúdico, Sala ambiente virtual, Tecnologias digitais, Helicobacter pylori, Sistema digestório.**

***Abstract*—** *This study is an integral part of the master's thesis entitled Virtual Environment Room as a didactic resource for teaching pathologies associated with Helicobacter pylori. The study of pathologies associated with H. pylori in medical courses is based on the traditional method, predominantly composed of theoretical lectures and some practical classes in the laboratory. This form of approach makes the discipline little motivating for students and does not adequately stimulate the development of autonomy and critical, investigative and creative reasoning of students, constituting a challenge for the effective learning of the contents in question. This article aimed to present the results of the research with medical professors with specialization/residence in gastroenterology who are part of the Medicine course in the State of Rio de Janeiro. Eleven (11) gastroenterological professors participated in this stage, who voluntarily assumed the role of judges of the tool used. With the analysis of the material found, it was found that the teachers already use technological resources, although they do not use recreational resources, however, there is no professional training in the use of technologies, however, given the youthful framework of the teachers, this barrier is easily overcome by the experimentation process that is promoted by the interactive tool that was positively evaluated by them.*

***Resumo*—** *Esse estudo é parte integrante da dissertação de mestrado intitulada sala ambiente virtual como recurso didático para ensino de patologias associadas ao Helicobacter pylori. O estudo sobre as patologias associadas ao H. pylori nos cursos de medicina, se baseia no método tradicional, composto predominantemente por aulas teóricas*

expositivas e algumas aulas práticas em laboratório. Essa forma de abordagem torna a disciplina pouco motivadora para os alunos e não estimula adequadamente o desenvolvimento da autonomia e do raciocínio crítico, investigativo e criativo dos estudantes, constituindo-se um desafio para a efetiva aprendizagem dos conteúdos em questão. Esse artigo teve por objetivo apresentar os resultados da pesquisa com os Médicos docentes com especialização/residência em gastroenterologia que integram o curso de Medicina no Estado do Rio de Janeiro. Participaram dessa etapa 11 (onze) professores gastroenterologistas que voluntariamente assumiram papel de juízes da ferramenta empregada. Com a análise do material encontrado verificou-se que os professores já utilizam recursos tecnológicos, apesar de não empregarem recursos lúdicos, no entanto, não há capacitação do profissional para uso das tecnologias, porém, diante do quadro jovial dos docentes essa barreira é facilmente vencida pelo processo de experimentação que é promovido pela ferramenta interativa que foi avaliada positivamente por eles.

I. INTRODUÇÃO

Sala ambiente virtual de aprendizagem vem sendo elaborada para dar suporte aos docentes no gerenciamento de conteúdo. Estudos têm demonstrado que médicos e estudantes de medicina frequentemente apresentam dúvidas quanto às situações clínicas vivenciadas e que a aquisição de informações no cenário do atendimento clínico nem sempre é fácil, fato que pode dificultar o manejo adequado daquela situação [1].

Essas dúvidas trazem uma real necessidade de constante atualização que é inerente ao ensino médico e a qualificação profissional do médico [2], que pode ser viabilizada e facilitada empregando recursos tecnológicos e de mídia, as chamadas tecnologia digital de informação e comunicação (TDICs). Hoje, em pleno século 21, mediante aos estudos derivados do processo de ensino-aprendizagem e com as constantes evoluções tecnológicas (inteligência artificial, robótica, análise de dados etc.) observamos que o maior acesso à informação por parte de alunos e professores, o surgimento de novas práticas pedagógicas, as quais podem incorporar cada vez mais as tecnologias existentes, tendem a criar ambientes educacionais diferentes daqueles encontrados há tempos. Tantas mudanças também necessitam de um corpo docente preparado e, diante deste fato, propomos neste estudo investigar como os conhecimentos de professores para a atuação com TDIC estão integrados aos conhecimentos do conteúdo específico e aos conhecimentos pedagógico [3].

A grande inovação trazida pelo uso das TDICs ocorre pela isenção de metodologias ativas de aprendizagem, ou seja, valorização do indivíduo no próprio processo de ensino-aprendizagem, no qual ele passa a ter maior envolvimento, atuando de maneira efetiva na construção do próprio conhecimento. Neste sentido, ainda se observa o estímulo à liberdade individual e trabalho em equipe [4], o que sugere uma aprendizagem considerável, não somente em um contexto que remete à memorização de conteúdos transmitidos pelo educador, mas que permite a consolidação dos saberes de maneira mais efetiva [5].

E é nesse contexto e visando contribuir para a pesquisa médica que esse estudo se insere. É importante reiterar que a aprendizagem significativa se caracteriza pela interação entre conhecimentos prévios e conhecimentos novos, e que essa interação é não-literal e não-arbitrária. Nesse processo, os novos conhecimentos adquirem significado para o sujeito e os conhecimentos prévios adquirem novos significados ou maior estabilidade cognitiva [6].

A maioria dos projetos de cursos de medicina que figuram no Brasil orienta-se pelos pilhares da Educação contemporânea. Esses pilares têm uma ligação transdisciplinar que se identifica com nossa constituição como seres humanos: somos uma totalidade aberta e nossa Educação só se consolida se for integral. Essa visão de uma Educação integral ao refletir sobre os saberes necessários à Educação do futuro, expondo problemas fundamentais do ser humano, da sociedade e da cultura de nosso tempo. Não se educa senão o homem integral. Resultados de ensino e aprendizagem devem refletir, portanto, a formação complexa, a formação humana e o desenvolvimento integral do estudante [4].

O ensino e aprendizagem se alimenta de informações que nem sempre estão acessíveis espontaneamente. Para obtê-las, precisamos de um processo investigativo realizado em ciclos contínuos que compreendem planejarem realizar o processo de ensino e aprendizagem, planejar e desenvolver intervenções acadêmicas com base nos resultados das avaliações, planejar e realizar avaliações subsequentes dinamizando o ciclo ação,

reflexão, ação. O planejamento compreende a demarcação do "objeto a ser avaliado", ou seja, o que, em termos de conteúdo/habilidade, é alvo específico do ensino e aprendizagem [7].

A clareza sobre o material de trabalho, o meio as relações são os elementos que possibilitam pensar e refletir sobre quais são os atos, práticas e formas mais pertinentes para cada ato de avaliar. O material de trabalho é a principal referência do ensino e aprendizagem para demarcar o objeto que vai ser avaliado, ou seja, a descrição clara das competências que serão o "alvo" específico de um ensino e aprendizagem. É essa demarcação que orienta a escolha de atividades, instrumentos itens, porém nem sempre essa descrição é fácil, pois há ensino e aprendizagem menos abrangente que o ensino, assim como o ensino é menos abrangente do que o conhecimento existente [4].

Decidir, no universo do conhecimento produzido, o que deve ou não integrar o currículo talvez seja uma das maiores responsabilidades do planejamento acadêmico. Decidir sobre o que avaliar também. A escolha de instrumentos adequados, sua elaboração e a programação do momento mais propício à sua aplicação estão intimamente ligadas à natureza do que vai ser avaliado. Aplicados os instrumentos, obtêm-se os dados que informam sobre a aprendizagem partir do momento em que são analisados avaliativa mente e as conclusões dessa análise configuram-se como resultados de desempenho individual dos alunos e como produtos do trabalho acadêmico [8].

É preciso detectar onde ocorrem as deficiências para concretizar a formação de um profissional cidadão, ético, responsável, mais humano, que terá condições de contribuir para o fortalecimento da profissão, como atividade reconhecida, respeitada e comprometida com a sociedade e com as políticas defendidas pelo Sistema Único de Saúde (SUS) [9].

Diante do exposto fica claro o compromisso e a responsabilidade da educação superior com a formação de profissionais competentes, críticos reflexivos e de cidadãos que possam atuar, não apenas em sua área de formação, mas também, no processo de transformação da sociedade. As Diretrizes Curriculares definem ainda, que a formação do médico tem por objetivo dotar o profissional dos conhecimentos requeridos para o exercício das seguintes competências e habilidades gerais: atenção à saúde, tomada de decisões, comunicação, liderança, administração e gerenciamento e educação permanente.

A competência profissional é definida como a capacidade de articular e mobilizar conhecimentos, habilidades e atitudes, colocando-os em ação para resolver problemas e enfrentar situações de imprevisibilidade em dada situação e contexto cultural. Toda esta situação impõe um grande desafio aos estudiosos da temática. Nesse contexto, as metodologias ativas de aprendizado parecem apoiar e possibilitar atender às necessidades de conhecimento e aquisição de habilidades para atingir os objetivos de aprendizado frente às mais diversas situações de formação profissional, bem como para o aprendizado cognitivo, a retenção de conhecimento e transferência do saber.

Diante do exposto, esse artigo tem por objetivo apresentar os resultados da pesquisa com os médicos docentes com especialização/residência em gastroenterologia que integram o curso de Medicina no Estado do Rio de Janeiro sobre uma sala ambiente virtual de patologias associadas ao *Helicobacter pylori* para alunos do curso de graduação em medicina.

II. MATERIAIS E MÉTODOS

O artigo constitui-se de uma pesquisa exploratória de levantamento onde são apontadas as potencialidades da Sala Ambiente Virtual de Aprendizagem como um espaço de interação entre o docente e o conteúdo. Foi efetuado um workshop da Sala Ambiente Virtual sobre *H. pylori* que foi planejado e adaptado com base nas etapas da aprendizagem significativa proposta por Marco Antonio Moreira. O workshop foi dividido em três etapas, sendo elas, averiguação inicial, aplicação do produto educacional e avaliação final. Na averiguação inicial foi apresentado o questionário pré-teste, para averiguar os conhecimentos prévios e compreender como o aluno absorve questões sobre o *H. pylori*. Posteriormente, em aplicação do produto educacional em uma sala ambiente virtual de patologias associadas ao *H. pylori*, por meio de interatividade e vivência com o fenômeno, foi dada orientação e interpretação, além de apresentar estruturação das questões. Por fim, ocorreu a avaliação final com a presença do questionário pós-teste, através do formulário de apreciação e avaliação da assimilação de conteúdo.

Participaram dessa pesquisa 11 (onze) docentes em gastroenterologia que assinaram eletronicamente o termo de consentimento livre e esclarecido (TCLE), durante os meses de julho e agosto de 2021, após o aceite da plataforma Brasil de pesquisa, conforme Parecer Consubstanciado do Comitê de Ética, sob o número do protocolo: CAAE 45583021.9.0000.5237.

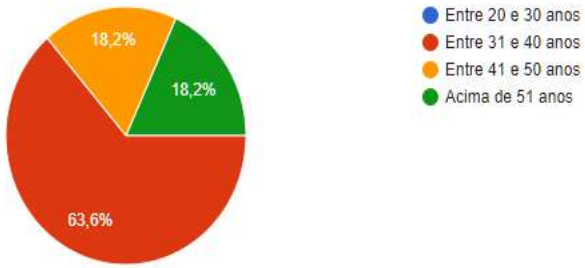
Os participantes tiveram que responder 6 (seis) questões para análise do perfil profissional do docente, em seguida um questionário sobre a validação do produto sala ambiente virtual foi apresentado, no Google Forms®. Esse questionário dividiu-se em 10 (dez) aspectos a serem

analisados: respeito a diretrizes curriculares nacionais do curso de medicina de 2014; acesso; aplicabilidade; contextualização; apresentação do tema; impacto potencial no ensino; impacto potencial social; abrangência territorial; inovação e estrutura. Em cada aspecto citado os docentes tinham que responder considerando a escala proposta, onde 1 = insuficiente; 2 = razoável; 3 = bom; 4 = muito bom e 5 = excelente.

III. RESULTADOS E DISCUSSÕES

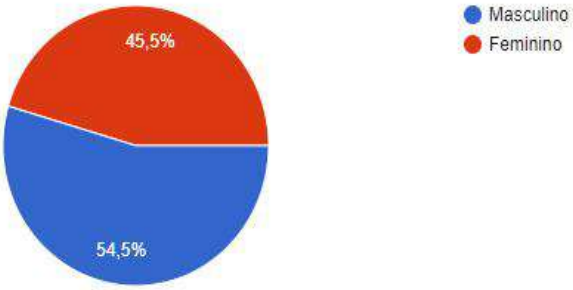
Iniciando pela análise do perfil dos docentes participantes, verifica-se (ver gráfico 1) que 63,6% têm entre 31 e 40 anos; 36,4% estão com idades acima de 41 anos. Aqui cabe estabelecer um parâmetro entre as gerações e o uso de tecnologias.

Gráfico 1. Idade dos Juízes



Fonte: Dos autores (2021)

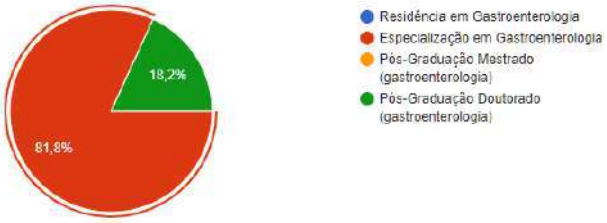
Gráfico 2. Sexo



Fonte: Dos autores (2021)

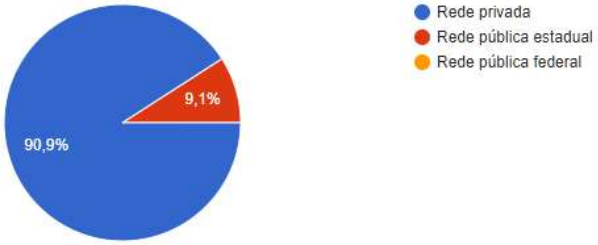
Em relação ao sexo, a amostra é semelhante com resultados de outras pesquisas [10, 11], envolvendo docentes em medicina, ou seja, com uma pequena diferença destacam-se a participação de profissionais do sexo masculino com 54,5% (ver gráfico 2). Destes 81,8% possuem especialização em gastroenterologia e 18,2% doutorado na área e 90,9% (ver gráfico 3) lecionam na rede privada de ensino superior médico (ver gráfico 4).

Gráfico 3. Escolaridade



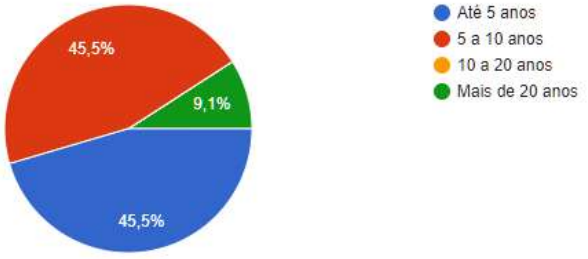
Fonte: Dos autores (2021)

Gráfico 4. Rede de ensino



Estudos específicos em relação à docência nos cursos superiores em medicina são escassos, no entanto, os poucos encontrados demonstram que o curso e a formação do docente têm passado por grandes transformações, sendo o ponto de partida os aspectos legais, determinados pelo Ministério da Educação, sobre a qualificação do profissional para lecionar no ensino superior [12]. Essas transformações no curso de medicina repercutem na pouca experiência em sala de aula encontrada em nossa amostra, apenas 9,1% possuem mais e dez anos de experiência, sendo que 91% têm até 10 anos de vivência em sala de aula (ver gráfico 5).

Gráfico 5. Experiência como docente



Fonte: Dos autores (2021)

A pouca experiência somada a juventude desses docentes é um aspecto favorável para a implantação de novas metodologias de ensino que utilizem recursos lúdicos [13]. Isso é verificado quando 63,6% dos participantes da pesquisa assumiram que apesar de não utilizarem recursos lúdicos, eles gostariam de aprender mais sobre esta forma de ensino (ver gráfico 6).

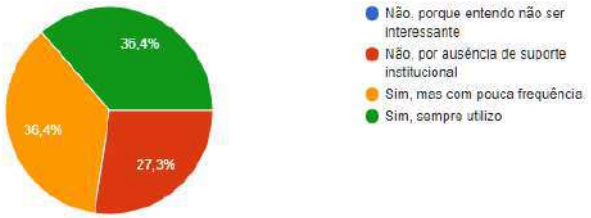
Gráfico 6. Emprego de ferramentas lúdicas

Fonte: Dos autores (2021)

A importância de utilizar o lúdico na educação de jovens e adultos é verificada em diversos estudos [14] ao estudar sobre a ludicidade no ensino de medicina verificaram que as atividades lúdicas atuam como diferencial na formação médica humanizada e crítica e concretizam a importância das metodologias ativas ao envolver os/as alunos/as e gerar questionamentos relacionados aos conceitos e aprendizados adquiridos com a experiência, proporcionando um ambiente de criatividade reflexiva que transcende o modelo tradicional de ensino. Essa afirmativa é colaborada por [15], que ao analisarem a prática do jogo no ensino de parasitologia, nos cursos de medicina veterinária, constaram que o jogo é recomendado para o Ensino Superior e pode ser aplicada em diversas outras disciplinas e áreas do conhecimento.

Outro aspecto analisado foi o emprego das tecnologias de informação e comunicação (TIC) na prática pedagógica (ver gráfico 7), um total de 36,4% afirmou que sempre utilizam; o mesmo percentual informou fazer uso com pouca frequência e 27,3% alegaram não fazerem uso por falta de apoio institucional. Destes que afirmaram fazer uso, 63,6% apontaram o computador como principal ferramenta, o mesmo percentual utiliza também a internet; 36,4% outras ferramentas e 27,3% o uso de smartphones.

Gráfico 7. Emprego de TIC



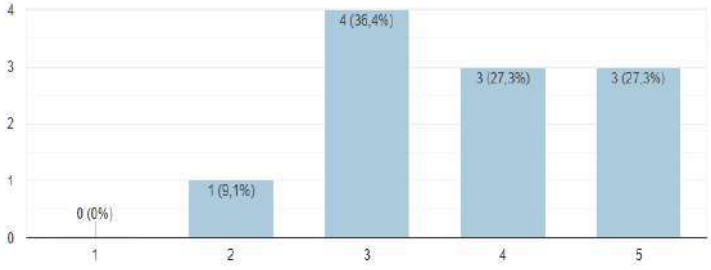
Fonte: Dos autores (2021)

É preciso que o professor receba treinamento para quebrar a barreira que existe entre ele e as tecnologias, visto que os educadores devem ter um papel dentro da sociedade que vai muito além do fazer de conta. É papel do educador possibilitar a inserção na comunidade estudantil de serviços que ajudem no seu desenvolvimento, além de, pesquisas a fim de contribuir, de alguma forma, para o crescimento intelectual dos alunos [16].

O que não se pode deixar de afirmar é que o professor deve estar em constante processo de formação. Na medida em que o docente se avalia enquanto um ser em processo constante de aprendizagem, é mais fácil que ele se manifeste criticamente com relação à realidade vivida, pois o professor que ensina, é o mesmo que aprende e participa efetivamente da construção de sua realidade e da realidade de seus alunos.

Passando para a análise das respostas do formulário de validação do produto sala ambiente virtual. Quanto a diretrizes curriculares nacionais (DCN) do curso de medicina de 2014 verificou-se que 36,4% consideraram bom; 27,3% muito bom; 27,3% excelente e apenas 9,2% consideraram razoável (ver gráfico 8).

Gráfico 8. Respeito as diretrizes curriculares nacionais



Fonte: Dos autores (2021)

A título de informação as DCN publicadas em 2014 enfatizam a preocupação em formar médicos generalistas efetivos na abordagem ao paciente da atenção básica e da urgência/emergência e que sejam resolutivos na promoção e redução dos riscos em saúde [17]. Centradas em três

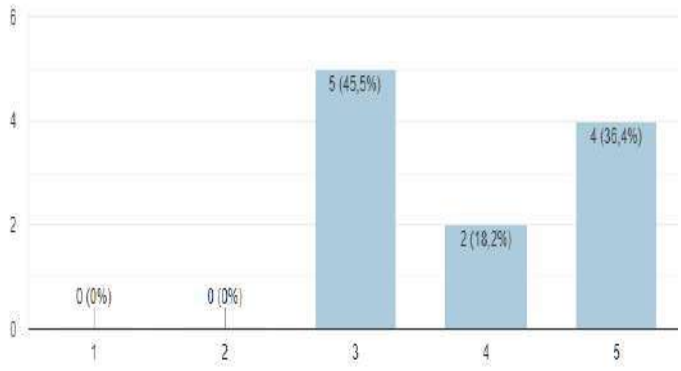
grandes áreas – Atenção Integral à Saúde, Educação em Saúde e Gestão em Saúde –, as DCN propõem por meio da articulação teórico-prática do projeto pedagógico do curso, objetivando a integração com conhecimentos de outras áreas, além do alinhamento às normas de instâncias governamentais, serviços oferecidos pelo SUS e por instituições prestadoras de serviços, oferecendo, assim, uma formação interprofissional e flexível que respeite as necessidades reais da população [17]. Tal processo de modificação na educação superou desafios ao romper com estruturas amplamente exploradas nos modelos de ensino presencial [18].

Nesse sentido, verifica-se que a mudança de comportamento e da cultura acadêmica é um grande entrave. Os cursos de graduação em medicina estão crescendo anualmente, para acompanhar esse crescimento surge a necessidade de estudos que analisem suas particularidades, uma delas, talvez a principal, a ensino e aprendizagem da aprendizagem desses cursos.

Porém ao realizar uma vasta pesquisa verificou-se que são escassos os estudos que abordam essa temática [19]. Verifica-se que o processo de ensino e aprendizagem é um tema bastante delicado já que possui implicações pedagógicas que ultrapassam os aspectos metodológicos e/ou técnicos e atinge aspectos, éticos, sociais e psicológicos de suma importância. Sem a objetividade do significado do conceito de ensino e aprendizagem, docentes e acadêmicos vivenciam práticas avaliativas que podem tanto servir de estímulos, promovendo avanço e crescimento, quanto podem desestimular, frustrar e até mesmo impedir o avanço e o crescimento do aluno [2].

Adiante, quanto ao acesso verifica-se (ver gráfico 9) que 45,5% consideram bom; 36,4% excelente e 18,2% muito bom. Em relação a esse resultado observa-se que os docentes que consideraram muito bom e excelente já fazem uso de recursos tecnológicos e são mais jovens.

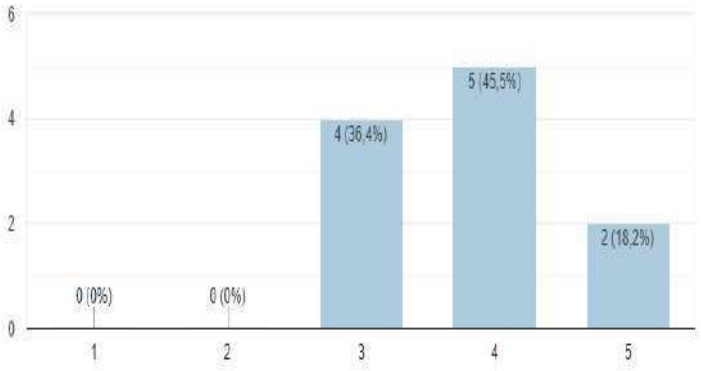
Gráfico 9. Acesso



Fonte: Dos autores (2021)

Abordando a aplicabilidade da sala ambiente virtual nota-se (ver gráfico 10) que 45,5% consideraram muito bom; 36,4% bom e 18,2% excelente demonstrando assim a viabilidade do emprego da sala ambiente virtual, tanto no acesso, como demonstrado anteriormente, como na aplicabilidade.

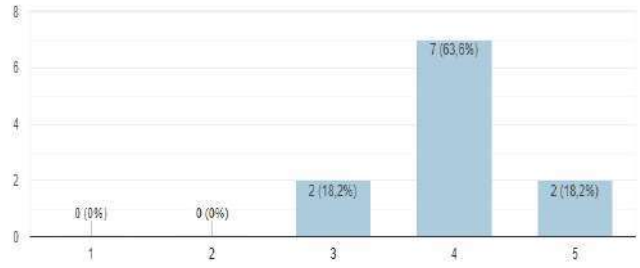
Gráfico 10. Aplicabilidade



Fonte: Dos autores (2021)

A contextualização da ferramenta também foi avaliada de forma positiva (ver gráfico 11), em 63,6% da amostra que a consideraram muito bom; seguidos por 18,2% que consideraram bom e 18,2% muito bom. A importância do caráter interativo das aulas se manifesta ao permitir o desenvolvimento da necessidade interna do aluno de reestruturar os conhecimentos ou de corrigir os seus desequilíbrios (contradições) acerca da realidade nas inter-relações colaborativas que estabelece com o grupo [20].

Gráfico 11. Contextualização



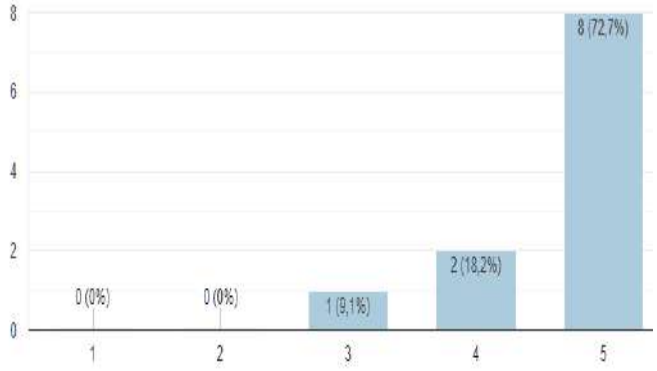
Fonte: Dos autores (2021)

A representação do tema foi considerada excelente por 72,7% da amostra (ver gráfico 12), ou seja, um total de 8 (oito) docentes apreciaram como foram tratados os assuntos da sala ambiente virtual, isso demonstra como os docentes também apreciam recursos lúdicos e tecnológicos. Isso é confirmado quando 45,5% dos docentes consideram excelente o impacto potencial no ensino e 45,5% consideram muito bom, mostrando assim a

aceitabilidade da ferramenta desenvolvida (ver gráfico 13) que também teve impacto social positivado por 45,5% dos docentes que a consideraram excelente; 27,3% muito boa e 27,3% boa (ver gráfico 14).

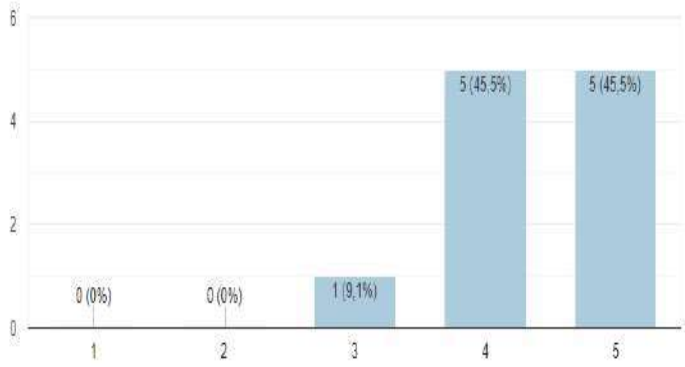
A elaboração de conteúdos virtuais interativos, e visualmente adequados ao estudo de algumas metodologias educacionais e as tecnologias condizentes aos seus objetivos, possibilitou o fornecimento de apoio significativo para uma aprendizagem personalizada dos participantes da utilização dos ambientes fornecidos pelo objeto de aprendizagem, promovendo um espaço colaborativo para a reflexão docente [21].

Gráfico 12. Representação



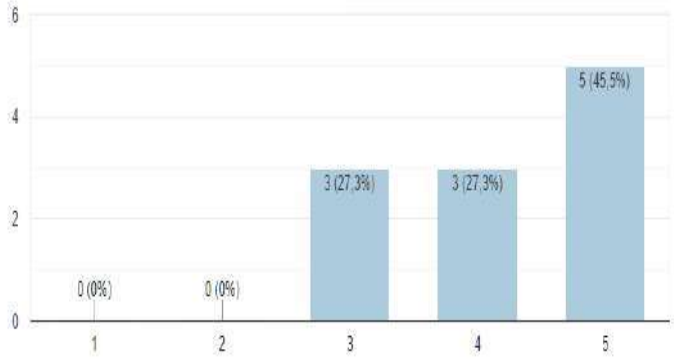
Fonte: Dos autores (2021)

Gráfico 13. Impacto potencial no ensino



Fonte: Dos autores (2021)

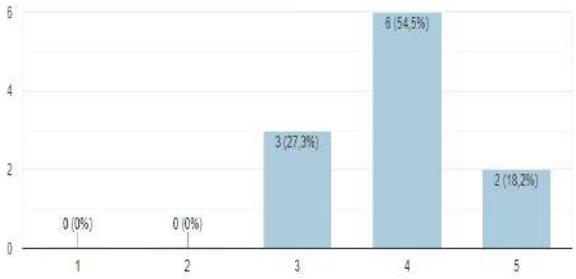
Gráfico 14. Impacto potencial social



Fonte: Dos autores (2021)

A abrangência territorial que buscava verificar se a sala ambiente virtual poderia ser utilizada em todo território nacional, levando em consideração o vocabulário utilizado também obteve resultados favoráveis (ver gráfico 15) com um total de 54,5% considerando muito boa; 27,3% boa e 18,2% excelente.

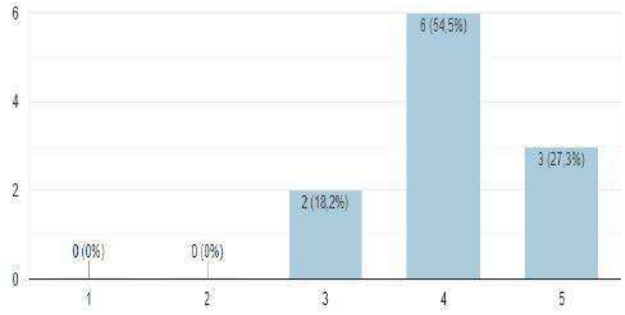
Gráfico 15. Abrangência territorial



Fonte: Dos autores (2021)

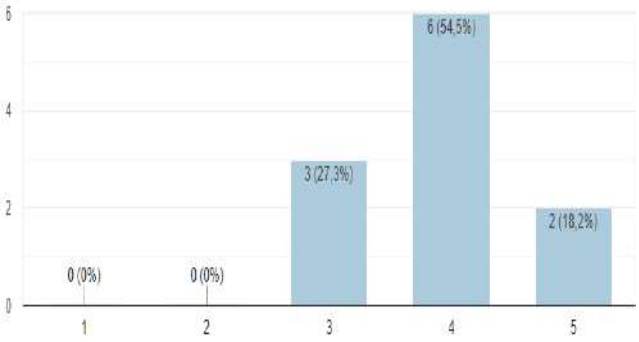
Quanto ao aspecto inovador (ver gráfico 16) todos os docentes acharam a ferramenta de algum modo inovadora, cerca de 54,6% a consideraram muito boa; 27,3% excelente e 18,2% boa. O caráter inovador da sala ambiente virtual pode ser apreciado em conjunto com a sua complexidade, já que toda inovação é acompanhada de alguma complexidade que pode ser de entendimento ou de emprego da ferramenta [22]. Em relação a complexidade 54,5% consideraram muito boa; 18,2% excelente e 27,3% excelente (ver gráfico 17).

Gráfico 16. Inovação



Fonte: Dos autores (2021)

Gráfico 17. Complexidade



Fonte: Dos autores (2021)

Por fim, todos os docentes afirmaram que fariam uso da sala ambiente virtual, assim como, por unanimidade todos informaram que indicariam para colegas, o que demonstra a satisfação com a ferramenta e o interesse dos docentes por recursos tecnológicos. Neste contexto, torna-se oportuno mencionar que um dos grandes desafios para os educadores nesse século é, com certeza, conseguir integrar os saberes e inserir as novas tecnologias no ambiente interativo da aprendizagem. O desafio gigantesco que aí se postula para todos os docentes está na construção e na organização de um tempo móvel, permeável, personalizado, que possa garantir elasticidade suficiente para atender as necessidades de cada aprendiz em suas relações com os conhecimentos e com as tecnologias [23].

Fazendo analogias entre modelos pedagógicos e modos de operação de sistemas tecnológicos de comunicação, observa-se num processo ensino-aprendizagem legitimado na centralidade do professor, tanto quanto hierarquia, quanto detentor exclusivo do saber, numa estreita relação com a estrutura e operação de um canal de comunicação, do ponto de vista da organização sistêmica.

IV. CONCLUSÃO

An importância do caráter interativo das aulas de medicina se manifesta ao permitir o desenvolvimento da necessidade interna do aluno de reestruturar os conhecimentos ou de corrigir os seus desequilíbrios (contradições) acerca da realidade nas inter-relações colaborativas que estabelece com o grupo. Isso porque, dentro do ponto de vista construtivista, é a partir da interação social que o aluno junto com o professor e seus pares, consegue transformar seu desenvolvimento potencial em desenvolvimento real. Essa transformação ocorre somente se houver algum significado, motivação, sentido ou interesse do discente para a sua experiência enquanto sujeito do processo de aprendizagem, ou seja, se estiver em sua zona de desenvolvimento proximal.

Os resultados encontrados mostram que as professoras reconhecem a importância de se utilizar os recursos tecnológicos e das ferramentas lúdicas. Verificou-se que os professores já utilizam recursos tecnológicos, apesar de não empregarem recursos lúdicos, no entanto, não há capacitação do profissional para uso das tecnologias, porém, diante do quadro jovial dos docentes essa barreira é facilmente vencida pelo processo de experimentação que é promovido pela ferramenta interativa que foi avaliada positivamente por eles.

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The Supplier's Civil Responsibility for Wasting the Consumer's Vital Time in Light of the Productive Diversion Theory

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***Abstract*—** *This article takes a historical narrative approach to the theory of the consumer's productive deviation, and the duty to repair the existential off-balance sheet damage, resulting from the waste of the consumer's vital time, due to vices and defects in the consumer relationship, emphasizing its applicability from its requirements and necessary assumptions. In the course of this study, we will address Resolution no. 39/248 of 1985 of the UN, which has as its scope the consumer protection, and its guiding principles, comparing with the homeland consumer standard, the Consumer Defense Code - CDC (Law No. Law No. 8.078, of September 11, nineteen ninety). Continuing, we will approach the infra-constitutional norms that enshrine time as a protected legal asset, guaranteeing the right to reparation due to its violation, based on a constitutional filtering, taking doctrine and jurisprudence as a parameter.*

I. INTRODUCTION

It is not new that man (broad sense) longs for the extension of his existence. Humanity's object of desire is not just to increase your life span, but to increase your life expectancy with quality.

Thus, human beings have increasingly invested their productive resources, which we will later address in greater depth, to meet their needs, not just the basic ones, but those that bring them a greater sense of satisfaction, pleasure, happiness, that is, that it causes well-being.

This need to get more and more sense of well-being induced man, until then primitive, to abandon his habit of producing only for his subsistence, and start to focus on producing more than he needed, not to accumulate wealth, but so you could exchange for another product of your need. This happened as man started to live in society.

From this exchange relation of surplus production, the first relations of trade and consumption emerge.

It so happens that as consumer relations evolved, the problems, in a broad sense, of these consumer relations were also evolving, however, society, no longer primitive, no longer had the competence to resolve its conflicts through its force itself, requiring a greater intervening power that would resolve the conflicts, with the idea of replacing the will of the parties involved with the will of the judge.

With these considerations in mind, the objective of this research is to establish the relationship between the vices and defects in the consumption relationship, the obligation of suppliers to solve the problems in the consumption relationship that were not caused by the consumer, and the duty to repair the vital time wasted by

the consumer, arising from the failure of suppliers to solve the problems of the consumer relationship.

The research has a basic purpose, with bibliographic-documentary collection procedure, and uses the inductive method that starts from the observation of doctrine and jurisprudence, for the specific scenario of examining the applicability of the theory of productive deviation of the consumer, based on its requirements and necessary assumptions, and the consequent obligation to repair the waste of the consumer's vital time, as a result of vices and defects in the consumption relationship.

It has an exploratory profile that brings together procedures for surveying, analyzing and consolidating primary and secondary data obtained through a review of literature, laws and jurisprudence.

II. BRIEF SUMMARY OF THE HISTORICITY OF TRADE AND CONSUMPTION RELATIONS

In the dawn of humanity, before man lived in society, trade did not exist, since its production was aimed at subsistence, without any focus on surplus production.

And the search for surplus production, and the realization of exchanges began with man's need to live in society, and occurred slowly and gradually.

In this tuning fork Fran Martins[5] teaches that:

At the beginning of civilization, social groups sought to suffice themselves, producing material they needed or using what they could easily obtain from nature for their survival – food, rudimentary weapons, utensils. The natural growth of populations, over time, soon showed the impossibility of this system, which is only viable in small human settlements. Then, there was the exchange of unnecessary, surplus or superfluous goods for certain groups, but necessary for others [...].

From that moment, and from the exchange relations, the first contemporary trade relations began to emerge, since the skills and abilities were not capable of supplying all of man's needs, they started to establish an exchange relation for their surplus products , so that a fisherman, for example, could exchange a portion of his surplus fish with a portion of a farmer's surplus maize production.

These “equivalent” quantities were freely agreed between the parties, according to their respective needs, but the value of each wealth or good produced was related to the amount of time and effort used in its production.

In this sense, Rainer Gonçalves[6] argues that:

From the beginnings of commercial activities, the amount of labor employed in the manufacture of a wealth or commodity was a fundamental presupposition for its price to be determined. Therefore, the difficulty of producing a wealth or its rarity would be essential factors that would indicate its high price. On the other hand, other easily obtainable or simply manufactured goods would have a much lower valuation.

This form of relationship was efficient for the historical moment in which they lived, and it lasted for hundreds of years. However, this form of commercial exchange tended to become increasingly complex, with the involvement of multiple agents. So the most recent civilizations felt the need to adapt. From this need the first coins arise.

In a second evolutionary moment of the more contemporary consumer relations, the commercial relationship occurred, as a rule, with the physical/in-person meeting between suppliers and consumers, and eventually by telephone, through telemarketing and telesales services.

Ademarcos Almeida Porto [7], when it comes to commercial evolution due to technological ascension, argues that:

Currently, with the frightening technological development and the facilities of the digital age – especially the internet – it is possible to sell something anywhere on the planet without having to travel. This does not mean that traditional commerce, face to face, has lost its prominent place in society; on the contrary, it remains in evidence and has as its main symbol the shopping centers (the modern counterparts of the markets and stores mentioned above) that are multiplying in large cities.

The current moment stands out, when the Covid-19 pandemic came, boosting even more the e-commerce market - e-commerce , especially as a result of the numerous decrees of the 3 spheres of the executive power, determining measures of social distancing, restricting the movement of people, determining that bars and restaurants, beverage distributors, conveniences, shopping centers, and the most diverse branches of the economy, refrain from providing face-to-face service, so that the business community had to adapt, adhering/expanding the relations of consumption, by electronic/virtual means.

With the advent and expansion of the worldwide computer network, and the ease of trade arising from technological expansion, consumer relations increased exponentially, as did the problems arising from these consumer relations.

In this sense Rizatto Nunes [8] prescribes that:

Unfortunately, in times of pandemic, new abuses are seen to have emerged and the usual ones have increased. In addition, hundreds of new e-commerce companies have sprung up and the number of internet transactions has

almost doubled. These are extraordinary numbers. Consumers, who have always been quite driven and driven to consume products and services through offers made via advertising, have become prisoners of this model, as they are isolated. In addition, the web/internet and social networks started to function as an extraordinary channel of offers.

III. ELEMENTS OF CONSUMER RELATIONS

In the words of José Geraldo Brito Filomeno[9] (2019, p.82) consumer is "... the character who in the consumer market purchases goods or contracts the provision of services, as the final recipient, assuming that he does so with a view to meeting a need own...

The Consumer Protection Code, on the other hand, deals with consumer concepts, in the caput of art. 2, as "... every individual or legal entity that acquires or uses a product or service as a final recipient", as well as a supplier, as per the head of art. 3rd, being this:

... every individual or legal entity, public or private, national or foreign, as well as non-personalized entities, that carry out production, assembly, creation, construction, transformation, import, export, distribution or commercialization of products or services.

Flavio Tartuce[10] explains that " The word supplier is in a broad sense, encompassing the supplier of products - in a strict sense - and the service provider ", further clarifying that "suppliers or providers may be legal entities governed by Public Law or Law Private. Among the first, the public services that are covered by the CDC deserve to be highlighted, including specific treatment in its art. 22".

From the concepts presented, we can deduce that a consumer relationship is the one established between a consumer and a supplier, linked by a product or service. These are objective requirements that must exist. It is, therefore, a sine qua non condition.

In this sense Leonardo de Medeiros [11] teaches:

[...] we observe that the elements that make up the consumption relationship are consumer and supplier, negotiating a product and/or service. It is important to emphasize that the consumption relationship always requires the presence of the consumer and the supplier; product and/or service. In other words, if any of the elements are missing, there will be no consumption relationship.

IV. CONSUMER PROTECTION AT THE INTERNATIONAL SCOPE

In item 2 of this study, we address as a result of the advent and expansion of the internet, and of electronic commerce, was the exponential growth of consumer relations.

It must be recognized that, as a result of this expansion, international consumer relations, which previously took place primarily between local suppliers and the tourist consumer, have also undergone an exponential increase, so that it is necessary to investigate whether there are international standards for consumer protection , and the protective focus of these eventual norms.

In the international field, we highlight Resolution n. 039/248 of April 16, 1985, which establishes international guidelines for consumer protection, permeated by objectives, and guiding principles.

The caput of art. 1 of Resolution n. 039/248, which has consumer protection as its scope, recognizes, in free translation, that "...consumers often face imbalances in economic terms, educational levels and bargaining power and bearing in mind that consumers must have the right of access to non-dangerous products... " (UN, 1985)

Of the objectives of the international standard, I highlight those provided for in subparagraphs c, def, in verbis :

(c) To encourage high levels of ethical conduct for those engaged in the production and distribution of goods and services to consumers;

(d) To assist countries in curbing abusive business practices by all enterprises at the national and international levels which adversely affect consumers;

(f) To further international co-operation in the field of consumer protection;

These objectives include the pursuit of high levels of ethical conduct from suppliers (c); the coercion of abusive commercial practices by suppliers, both in domestic and international consumer relations (d); and also international cooperation with regard to consumer protection (f).

As for the guiding principles of the international standard, it is imperative to list all the provisions present, which I now list:

(a) The protection of consumers from hazards to their health and safety;

(b) The promotion and protection of the economic interests of consumers;

(c) Access of consumers to adequate information to enable them to make informed choices according to individual wishes and needs;

(d) Consumer education;

(e) Availability of effective consumer redress;

(f) Freedom to form consumer and other relevant groups or organizations and the opportunity of such organizations to present their views in decision-making processes affecting them.

When addressing Resolution n. 039/248 UN, Paula Santos de Abreu[12] explains these principles, teaching that:

...the UN General Assembly edited resolution n. 39/248 of 10/04/1985 on consumer protection, affirming the principle of vulnerability at the international level. The guidelines constituted a comprehensive model describing eight areas of action for States to provide consumer protection. Among them: a) protection of consumers against risks to their health and safety, b) promotion and protection of the economic interests of consumers, c) access of consumers to adequate information, d) consumer education, e) possibility of compensation in in the event of damage, f) freedom to form groups and other consumer organizations and the opportunity for these to present their views in decision-making processes that affect them. These guidelines provided an important set of internationally recognized core objectives, designed especially for developing countries to help them structure and strengthen their consumer protection policies.

Still on the law of consumer relations, at the international level, we can highlight the Treaty on the Functioning of the European Union (TFEU) - Treaty on the Functioning of the European Union in literal translation, which lists 5 consumer rights, and treats them as fundamental rights, as Jana Valant teaches[13]

The Council adopted its first special program for consumer protection and information policy in 1975,9 where it defined five fundamental consumer rights: the right to protection of health and safety, the right to protection of economic interests, the right to claim for damages, the right to an education, and the right to legal representation (or the right otherwise to be heard). This program (together with its successors) has served as a basis for an ever corpus of directives and growing regulations in the area of consumer protection.

For the author, the 5 fundamental rights established by the Council of the European Union would have as scope the protection of safety and health (1); protection of economic interests (2); The right to claim compensation for damages arising from the consumer relationship (3); the right to education, in the sense of clear information to the consumer (4); and what the author called the right to be heard or representation (5).

These fundamental rights, described by the author, would be part of a set of consumer protection tools, the first tool being European Union legislation, the second would be tools to assess, monitor and improve consumer protection, subdivided into 3 sub-items, namely: a) Market monitoring tools; b) Awareness-raising tools; and c) Tools for stepping up enforcement and redress (Tools to intensify the application and obtain redress).

Still on the European Union, Cláudia Lima Marques [14] teaches that:

The European Union has always been concerned with ensuring a system of transactions in the internal market that would enable these "integrated international" negotiations and contracts to guarantee security and adequacy for consumers. The free circulation of products, services, capital and people allows these transactions to multiply and it is the objective of the consumer protection policy that these can happen in the best possible way.

Thus, even at the international level, the vulnerability of the consumer is recognized and protected, in order to minimize the existing disparity between suppliers and consumers.

V. CONSUMER PROTECTION WITHIN THE INTERNAL SCOPE

Consumer protection, in the current internal legal order, in addition to having a constitutional nature, is in the strict part of the constitution, which deals with fundamental rights and guarantees, listed in item XXXII, of art. 5 of the Federal Constitution, in verbis :

Art. 5. Everyone is equal before the law, without distinction of any kind, guaranteeing Brazilians and foreigners residing in the country the inviolability of the right to life, liberty, equality, security and property, in the following terms:

XXXII - the State shall promote, in accordance with the law, consumer protection; (Brazil, 1988)

Notwithstanding the aforementioned protection, the constitution strengthens consumer protection sparsely by the constitution, attributing to the Union, the States and the Federal District, concurrent competence to legislate, according to the intelligence of Art. 24, item VIII, regarding the " ... . liability for damage to the environment, to the consumer, to goods and rights of artistic, aesthetic, historical, tourist and landscape value".

It also establishes the constitutional norm, as one of the principles of the economic order, consumer protection. This is provided for in the caput of Article 170, in conjunction with its item V, but let's see:

Art. 170. The economic order, founded on valuing human work and free enterprise, is intended to ensure a

dignified existence for all, in accordance with the dictates of social justice, observing the following principles:

V - consumer protection;

The concern with consumer protection, already expressed in the core of the constitution, was enshrined when the constituent set a period of 120 (one hundred and twenty) days for the National Congress to prepare the Consumer Protection Code, pursuant to article 48 of the Act of the Transitional Constitutional Provisions.

According to Cláudia Lima Marques and Laís Bergstein [15] explain

Still at the constitutional level, the fact that art. 24, VIII, CRFB, attribute concurrent legislative competence to the Union, the States and the Federal District to legislate on liability for damages to the consumer. This is a useful forecast insofar as consumer relations have both local and diffuse effects – and the legislative collaboration of all these entities favors the expansion of consumer protection in the market.

The Consumer Defense Code came to implement art. 5th, XXXII of the Constitution by posing as objective as intelligence caput Art. 4th, " ... meeting the needs of consumers, respecting their dignity, health and safety, protecting their economic interests, improving their quality of life, as well as the transparency and harmony of consumer relations. .. ", expressly bringing in its core, the Principle of Consumer Vulnerability, expressed in item I, of art. 4th.

According to José Geraldo Brito Filomeno[16] we must understand consumer vulnerability as " ...the fragility of consumers, vis-à-vis suppliers, either with regard to the economic aspect and purchasing power, or with regard to the so-called information provided by the supplier or still technical ".

The disparity of weapons between consumers and suppliers in the consumer relationship is clear, when the legislator establishes legal instruments for the execution of the national policy on consumer relations, expressed in the items of art. 5th, otherwise let's see:

Art. 5 For the execution of the National Consumer Relations Policy, the public authorities will have the following instruments, among others:

I - maintenance of full and free legal assistance for needy consumers;

II - institution of Consumer Defense Justice Prosecutors, within the scope of the Public Ministry;

III - creation of police stations specialized in assisting consumers who are victims of criminal consumer offenses;

IV - creation of Special Small Claims Courts and Specialized Courts for the solution of consumer disputes;

V - granting incentives for the creation and development of Consumer Protection Associations.

VI. CONSUMER PROTECTION INSTRUMENTS

It should be noted that the first instrument that enables the execution of the national policy on consumer relations is Free Legal Assistance, and it could not be different. What would be the sense of creating a protective norm, to an agent known to be weak and vulnerable, if there was no instrument capable of guaranteeing the recipient of the norm, the search for the implementation of the protective norm?

Citizenship is the full exercise of rights. It can be conceptualized as the exercise of rights and duties inherent to the responsibilities of a citizen.

It is not for any reason that the Magna Carta promulgated in 1988 is nicknamed " Citizen Constitution ". In its preamble, the Original Constituent Power makes it clear that the current constitution is intended to " ...ensure the exercise of social and individual rights, freedom, security, well-being, development, equality and justice as supreme values of a fraternal, pluralistic and unprejudiced society... ". (Brazil, 1988)

Based on these ideals, the Fundamental Principles of the Federative Republic of Brazil were followed, including citizenship and human dignity, pursuant to Article 1, items II and III, " in verbis "

Art. 1 The Federative Republic of Brazil, formed by the indissoluble union of States and Municipalities and the Federal District, constitutes a Democratic State of Law and has as its foundations:

II - citizenship;

III - the dignity of the human person; (Brazil, 1988)

A citizen is anyone who is in full enjoyment of their civil, political and social rights, basic rights protected by the State, and intertwined with the principle of human dignity.

The exercise of citizenship is not limited to the right to vote and be voted. In order for the full exercise of citizenship to occur, citizens must, in addition to exercising their political rights, be aware of other rights and have the means to pursue them.

In Brazil, we have a widespread common sense that " justice is only for the rich ".

This common sense needs to be vigorously fought, as the Federal Constitution lists citizenship as a fundamental

principle and, in theory, presents means of guaranteeing this fundamental principle, such as free justice and free legal assistance, to those who prove their insufficiency of resources.

The other instruments for implementing the National Consumer Relations Policy will be through a positive provision of the State, for the creation of public bodies, in the broad sense, and for the promotion of the creation of associations, both in consumer protection.

These instruments are necessary for the consumer to be able to demand that the State exercise its jurisdictional Power-Duty, in order to solve its conflicts, and in the final analysis, they are conditions without which the consumer will not be able to fully exercise his citizenship.

VII. JURISDICTION, RIGHT OF ACTION, AND LEGAL ASSISTANCE AS A FORM OF EXERCISING CITIZENSHIP

Jurisdiction comes from the Latin Jurisdictio, juris = law, and dictio/dicere = to say. Therefore Jurisdiction, etymologically, means to say the right.

In primitive societies, the parties sought the solution of their conflicts, according to their will, and by their own means, without the mediation or intervention of a higher hierarchical power, both for the declaration or not of the existence of a right, and for the satisfaction of the resisted claim. This way of resolving a conflict is known as self-protection or self-defense. Thus, whoever had an interest in a particular good in life, would seek it through physical strength. In short, force was used by an "individual" to the detriment of another "individual", as a way of superimposing any resistance, with the purpose of satisfying an individual claim, using the " law of more " at certain times. strong" , or in the popular way known as " justice in their own hands" , legally known nowadays as an arbitrary exercise of their own reasons, an institute that, as a rule, is prohibited by the current Brazilian legal system, including typified in the penal code, under the terms of the Art. 345 of Decree Law 2848/40, “ in verbis ”;

Art. 345 - To take justice into their own hands, to satisfy a claim, albeit a legitimate one, except when the law allows it:

Penalty - detention, from fifteen days to a month, or fine, in addition to the penalty corresponding to violence. (Brazil, 1940)

With the emergence of the Contemporary Modern State, the State took upon itself the capacity to decide social conflicts, giving rise, at that moment, to the power-duty of jurisdiction.

The doctrine conceptualizes jurisdiction as one of the forms of composition of conflicts, with jurisdiction being the power-duty of the State, consisting in the substitution of the will of the parties.

Jurisdiction is, therefore, one of the functions of the State, personified by a legally invested agent - Judge, and seeking to resolve the conflict impartially, it replaces the will of the holders of the right, or interests, presented in the dispute.

Diogo Assunção[17] argues that:

[...] the jurisdiction has as its ultimate purpose social pacification and consists of a power-duty of the State, because, if on the one hand it corresponds to a manifestation of the sovereign power of the State, imposing its decisions in an imperative way, on the other hand it corresponds to a duty that the State assumes to settle any conflict that may be presented to it.

Power is said because the State, when provoked to resolve conflicts, has the power to decide according to the legal system, replacing the will of the parties. This decision must be complied with voluntarily and in good faith, and in case of non-compliance, the State may, by force, enforce its compliance.

In addition, duty is said, because the State, when provoked, cannot refrain from resolving the conflict, even if this is eventually not covered by the national legal system. This stems from the constitutional principle of the right to action, and the Inevitability of jurisdiction, provided for in article 5, XXXV of the Federal Constitution of 1988, providing that " the law shall not exclude from the Judiciary Power's assessment any injury or threat to rights" . (BRAZIL, 1988)

To Wadi Lammêgo[18] :

Through this principle, everyone has access to justice to claim preventive or reparatory jurisdictional protection for injury or threat of injury to an individual, collective, diffuse, and even homogeneous individual right. It is, therefore, a subjective public right, arising from the state assumption of administration of justice, granted to man to invoke the jurisdictional provision, in relation to the conflict of interests qualified by an irresistible claim.

After the assimilation of this jurisdictional function, the State was bound by the obligation to decide in any disputes that were presented to it, and cannot, therefore, exempt itself from the responsibility to decide.

BARROSO (2012, p. 95) argues that:

Once the state monopoly of jurisdiction was instituted, the power of the state gave rise to the duty to resolve disputes. And every duty is reflected in the emergence of a

subjective right in favor of those who can demand its observance. This right to demand from the State the solution of conflicts of interest can be defined as a right to exercise and obtain jurisdictional protection, which is precisely the action.

The action, therefore, is a subjective right of the aggrieved party, to demand from the State, the jurisdictional provision in the solution of that conflict. It is not characterized by the State's requirement to enforce its will, but rather by requiring the Judge State to apply the legal system in force in that particular case.

At a given time, the State took upon itself the role of solving conflicts, giving rise to the duty to protect the legally protected assets of life, and consequently gives rise to the subjective right of those who, in case of injury, or threat of injury, to these assets legal, provoke the state.

Now, what would be the applicability of these norms, which were formally born of full effectiveness, if the State did not also have a guarantee for those who were economically under-sufficient? What would be the use of a constitutional norm, guaranteeing me the right to provoke the State to resolve my conflict, if I was not also guaranteed a means to provoke it?

The above questions are answered in the wise words of Ticiano Alves e Silva[19] by saying that:

Not assisting those who do not have the resources to go to court, abandoning them, is the same as denying them legal protection. The laws would be of no use if, in the face of a violation, the poor were not allowed to obtain state jurisdictional protection and the reestablishment of the violated legal order. The fundamental right to equality would be attacked in the hypothesis.

Without the completeness of these conditions, access to justice would not be protected, as this, in the words of Alexandre Fernandes Dantas[20] , corresponds to the " [...] system by which people can claim their rights and/or resolve their disputes under the auspices of the State. "

Thus, free legal aid is, therefore, a requirement for validity and effectiveness, for exercising the right to action, and, consequently, for exercising citizenship itself.

VIII. TIME AS WELL AS LEGAL PROTECTED?

When it comes to time, so that there is a duty to repair, it is necessary to verify whether time would be a protected legal asset, so that the violation of this legal asset may result in the duty to repair.

Time is a limited asset in human life. This does not stop in the interest of the owner of the property, it does not accumulate, nor does it recover.

Although time has these characteristics, it cannot be inferred that, in the legal sphere, it is a protected legal asset. It is necessary to find sources of law, whether positive norms, principles, doctrines, or even the recognition of this protection in the jurisprudential sphere.

In the normative sphere of the principles, we can infer that time is considered a protected legal asset, of such importance, that the original constituent chose to treat it, albeit implicitly, in the list of fundamental rights. This is provided for in item LXXVIII, of article 5 of our Charter, known as the principle of reasonable duration of the process, which guarantees " all, in the judicial and administrative scope, the reasonable duration of the process and the means to guarantee the speed of processing. " (Brasil, 1988)

From the reading of Decree no. 6,523/2008 (known as SAC Law) we can observe that there is a concern with time, according to the intelligence of §4, of art. 4, by expressly stating that " Specific regulations will address the maximum time necessary for direct contact with the attendant, when this option is selected ." (Brazil, 2008)

In the labor sphere, we have several texts, Decree Law n. 5.452/1943, which protect time, such as chapter II, section II, from art.58 to 65, which deal with the working day (in hours), or even Section III, which deals with rest periods (in hours), and also Article 457, which fixes the remuneration at the time the employee is available to the employer and renders his services to him.

It is worth noting that there are already numerous judgments recognizing time as a protected legal asset, so that its violation deserves redress, but let's see:

DECISION: AGREE the Judges who are members of the Tenth Civil Chamber of the COURT OF JUSTICE OF THE STATE OF PARANÁ, by unanimous vote, to hear and grant the appeal, with Judge Luiz Lopes, with separate vote, as he arbitrates the pain and suffering to a greater extent. SUMMARY: CIVIL RESPONSIBILITY. CONSUMER RELATIONSHIP. CONDUCT REITERATED BY THE BANKING INSTITUTION. IT TAKES ONE HOUR AND TWENTY-FIVE MINUTES IN ONE DAY, IT TAKES TWENTY-EIGHT MINUTES TEN DAYS IN ANOTHER. DELAY IN CUSTOMER SERVICE. APPLICATION OF ART. 14 OF THE CDC. STRICT RESPONSIBILITY. NO PROOF OF EXCLUDING CAUSE. DUTY TO INDEMNIFY CONFIGURED. MORAL DAMAGE.QUANTUM INDEMNITY FIXED AT R$ 10,000.00 (TEN THOUSAND REAIS). INTEREST AND INFLATION. INITIAL TERM. DATE OF JUDGMENT. APPEAL KNOWN AND PROVIDED. (TJPR - 10th Civil Code - AC - 1239964-9 - Metropolitan Region of Londrina -

Central Forum of Londrina - Reporter: Arquelau Araujo Ribas - By majority - - J. 01.29.2015)(TJ-PR - APL: 12399649 PR 1239964-9 (Judgment), Rapporteur: Arquelau Araujo Ribas, Judgment Date: 01/29/2015, 10th Civil Chamber, Publication Date: DJ: 1523 03/11/2015)"

In the same vein, the collegiate bodies of the Court of Justice of the State of Rio de Janeiro have been accepting this theory.

CIVIL APPEAL. ELECTRICITY. RIGHT. OF THE CONSUMER. ACTION OF OBLIGATION TO MAKE CUMULATIVE WITH A REQUEST FOR COMPENSATION FOR PAINAL DAMAGES DUE TO THE DRAWING UP OF TOI. SENTENCE OF ORIGIN. DEFENDANT'S APPEAL SUPPORTING THE LEGALITY OF THE BILLINGS. FAILED TO PROVIDE CONFIGURED SERVICES. CONCESSIONAIRE THAT DID NOT UNDERTAKE ITS PROBATORY BURDEN.

APPLICATION OF PRECEDENT 256 OF THIS COURT. MORAL DAMAGE CONFIGURED. APPLICATION OF THE PRODUCTIVE DEVIATION THEORY. APPEAL DENIED. (TJRJ. CIVIL APPEAL No. 0006551-97.2020.8.19.0031. TWENTY CIVIL CHAMBER. Rapporteur Judge Renato Lima Charnaux Sertã. Judgment Date: 06/16/2021 - Publication Date: 06/17/2021)

And still:

CIVIL APPEAL. CONSUMER RIGHT. ACTION FOR CONTRACT TERMINATION C/C REQUEST FOR INDEMNITY FOR MATERIAL AND PAINAL DAMAGE. REAL ESTATE DEVELOPMENT. PURCHASE AND SALE OF LOT OF LAND IN CONDOMINIUM UNDER CONSTRUCTION. TERMINATION INTENDED ON CHANGE IN THE FINANCIAL CONDITION OF THE AUTHOR. DEFENDANT'S ALLEGATION OF REFUSAL. JUDGMENT OF PARTIAL ORIGIN. IRRIGNATION OF THE DEFENDANT. Consumer relationship. The existence of an irrevocability and irreversibility clause does not preclude unilateral termination by prospective buyers. In fact, Law no. 13,786/2018 disciplined the termination of the contract by the purchaser of a real estate unit in real estate development and in urban land subdivision. Although it is not applicable to the specific case, since the contract in question was signed on a date prior to the validity of the aforementioned rule, it cannot be forgotten that the legislator did not make any consideration regarding the impossibility of termination in such cases. According to the STJ's consolidated understanding (Precedent 534) "in the event of resolution of a property purchase and sale agreement submitted to the Consumer Protection Code, the installments paid by the promising buyer must be immediately refunded - in full, in case of sole fault of the promising seller/builder, or partially, if it was the buyer who caused the cancellation". Refund of amounts correctly determined. With regard to legal amendments, the appellant has a partial reason. In fact, regarding the initial term of interest incidence, the STJ, at the time of the judgment of REsp No. 1,740,911/DF, submitted to the rite of repetitive appeals (Topic 1002), established the thesis that "In purchase and sale commitments of real estate units prior to Law No. 13,786/2018, in which the termination of the contract is claimed at the initiative of the promising buyer in a manner different from the agreed penalty clause, the default interest is levied from the final judgment of the decision.", which it is exactly the hypothesis of the case file. Reform of the sentence in this regard. In relation to the monetary correction of the installments paid, the judgment does not deserve any correction, since it determined its incidence from each disbursement, being in line with the jurisprudence of the STJ and this Court of Justice. Precedents. Moral damage. It is extracted from the body of evidence that the defendant tried several times to obtain the dissolution administratively. The defendant's refusal to accept the request for termination of the contract even though it is aware that, under the terms of the jurisprudential understanding consolidated in the Courts, it is the buyer's potestative right, constitutes a failure in the provision of the service to give rise to the duty of reparation. Consumer Productive Deviation Theory. Amount arbitrated by the lower court in R$5,000.00 (five thousand reais) that is reasonable and proportional to the peculiarities of the specific case. Fees for loss of suit. Fixing equitably. Impossibility. The guidance of the STJ was established in the sense that it is mandatory to apply the limits established in art. 85, §2, of the CPC. Precedents. Judgment that reforms in part. Maintenance of the minimum loss of suit of the plaintiff. Hypothesis that includes appeal fees. Art.85, §11, of the CPC. PARTIAL PROVISION OF THE APPEAL. (TJRJ. CIVIL APPEAL No. 0008614-66.2018.8.19.0031. TWENTY CIVIL CHAMBER. Rapporteur Judge Andre Emilio Ribeiro Von Melentovytch. Judgment Date: 06/15/2021 - Publication Date: 06/17/2021)

Thus, we can infer that time is an individual legal asset that, therefore, deserves state protection, and any damages may give rise to the duty to repair.

IX. CIVIL LIABILITY

Before (attempting) to conceptualize civil liability, it is imperative to present some doctrinal concepts, of which I highlight:

To Caio Mário da Silva Pereira[21] , civil liability

[...] consists in the realization of the abstract reparability of the damage in relation to a taxpayer of the legal relationship that is formed. Reparation and taxable person make up the binomial of civil liability, which is then enunciated as the principle that subordinates reparation to its incidence on the person causing the damage.

While for Gustavo Tepedino[22] , civil liability

[...] it gradually ceases to be linked to the punishment of the offending agent, and becomes related to the elementary principle that the unjust damage, thus understood as the injury to a legal interest deserving of protection, must be repaired, enshrining the function principle that came to be attributed to the institute: the patrimonial reparation of the damage suffered.

Flávio Tartuce[23] shares Álvaro Vilhaça Azevedo's definition, so that civil liability "[...] is present when "the debtor fails to comply with a precept established in a contract, or fails to observe the regulatory system, which regulates life . Civil liability is nothing more than the duty to indemnify the damage " ()

Also about civil liability, as taught by Eduardo Abílio Diniz[24] , this is

[...] the legal duty arising, also called derivative/successful or, still, secondary, which arises or derives/succeeds (therefrom or derived/successful) from non-compliance with an obligation, which, in turn, is a duty original or primary legal responsibility (hence civil liability is also a secondary legal duty)

Thus, regardless of the divergences of the aforementioned doctrines, basically civil liability consists of the duty of the agent causing the damage, to repair any damage to the legal interest protected by the alleged victim, in order to fully indemnify, reimburse, or compensate for the damage borne by the victim, namely, of restoring the victim to the status quo ante bellum[25] , or to repair the damage.

In consumer relations, as a result of the consumer's vulnerability, compared to the supplier, as a rule, the supplier's civil liability is objective, that is, it does not depend on the proof of intent or guilt, but only on the agent's conduct, the causal link, and the harmful result.

It is said as a rule, since this rule admits exceptions, they are those excluding civil liability, namely, a) Act of God and force majeure; b) state of danger; c) self-defense; d) regular exercise of rights; e) strict compliance with legal duty; and f) the victim's sole fault.

9.1. The agent's conduct

Paraphrasing Professor Eduardo Abílio[26] , human conduct is the subjective element of civil liability, since it is associated with the active subject of the harmful result.

With the exception of the incidence of causes excluding civil liability, namely, a) Act of God or force majeure; b) state of danger; c) regular exercise of the right; d) strict compliance with legal duty; and e) the victim's exclusive fault, human conduct, which results in damage, may imply the duty to repair.

9.2. The Causality Nexus

The causal link, prima facie, is to establish the relationship and cause and effect between human conduct, lato sensu , and harmful result borne by the victim.

It would, therefore, be the link between the potentially or effectively harmful result infringed on the victim, and the conduct presented by the supposed recipient of the duty to repair.

In this sense Gustavo Tepedino[27] explains that " [...] the causal link fulfills a double function: on the one hand, it allows determining to whom the harmful result should be attributed; on the other hand, it is essential in verifying the extent of the damage to be indemnified, as it serves as a measure of indemnity ".

9.3. of the damage

The damage, according to Professor Eduardo Abílio[28] " [...] it is the violation of the respective victim's property, whether this material property, also called patrimonial, or immaterial, also called off-balance sheet, or non-patrimonial ". According to the Civil Code[29] of 2002, "the one who, through an unlawful act (arts. 186 and 187), causes damage to others, is obliged to repair it ", this is provided for in the caput of art. 927 of said codex.

This standard must be combined with art. 186 and 187 respectively, namely:

Art. 186. Anyone who, by voluntary action or omission, negligence or recklessness, violates law and causes damage to others, even if exclusively moral, commits an unlawful act.

Art. 187. The holder of a right that, when exercising it, manifestly exceeds the limits imposed by its economic or social purpose, by good faith or good customs, also commits an unlawful act. (Brazil, 2002)

Only the combination of these three infraconstitutional provisions, associated with the intelligence of items V and X of Article 5 of the Federal Constitution, allow us to infer that those who, by action or omission, or abuse of rights, injure a protected legal asset, will be obliged to repair it, being the possibility of filing a civil redress action, a

subjective right of the victim, who may or may not exercise it within the legal term.

It should be noted that the duty to repair any damage is associated with the conduct of one or more agents, whether commissive or omissive, and with a potentially or effectively harmful event, as well as the existence of a causal link between the conduct of (s) agent(s), and the harmful result.

X. PRODUCTIVE RESOURCES OF THE CONSUMER

According to Dr. Marcos Dessaune[30] the consumer has some features, highlighting the following features:

...vulnerable natural resources, which are air, water and other goods in common use...; abstract cognitive resource, which is your consciousness; vulnerable vital resources, which are your psychic and physical balance; limited productive resources, which are your time and skills (set of knowledge or knowledge, skills or know-how and attitudes or know-how) necessary for the performance of any activity ; scarce material resources, which are their economically useful material goods; and conditioned volitional resource, which is their freedom – understood here as "the possibility of choice".

The author clarifies that this individual time available to each consumer, which he lists in the list of limited productive resources - in the sense of being finite, of not being cumulative - is the same as vital, or even existential, time that the author lectures from as follows:

... under the ontological focus, it is the implicit support of human existence, that is, it lasts for a certain time and develops within it. In other words, the total lifetime of each person is an individual finite good; it is personal capital that, through free and voluntary choices, can be converted into other material and immaterial goods, which can only be disposed of according to one's own conscience. In economic terms, it is a limited productive resource – [...] which cannot be accumulated or recovered throughout people's lives... (DESSAUNE, 2017, p.365)

Other productive consumer resources, as described by the author above, are competences, the author explaining that we must understand by competences, the knowledge acquired by the consumer in the course of his life, the skills developed and improved, and the attitudes, which as a rule accumulates on the initiative and dedication of each individual.

In order to form the set of competences, it is necessary that the individual has the time available to dedicate himself to this objective, the will to dedicate himself, but especially, that he has the freedom to dedicate himself.

The freedom in question is not restricted to the freedom to come and go, but its main scope is the freedom of choice, of how to enjoy your vital time, whether to dedicate yourself to improving skills, whether for leisure, dedication to family, friends, work, and even rest or pure leisure.

XI. DEVIATION OF CONSUMER PRODUCTIVE RESOURCES

What would be the diversion of the consumer's productive resources?

Paraphrasing Dr. Marcos Dessaune[31] , productive deviation occurs when the consumer, as a result of the supplier's unfair conduct, is forced to waste his productive resources, especially his vital or existential time, to solve problems in the consumption relationship, which the consumer did not create , and that would legally be the responsibility of the supplier. In this case there is a violation, a temporary limitation on the freedom of choice of what to do with vital time.

In this tuning fork Helen Neri[32] well explains that:

The time that must be supervised is linked to the person's personal time, which means, in their free time, that which could be devoted to any other activity, that is, it is time that will be spent according to the personal choice of each one. When someone has to spend their time with something that was not their choice, to solve a problem that was not generated by them, this is called unfair waste of time because of someone else's fault.

The author concludes by arguing that the result of unfair conduct by suppliers not only violates the principle of objective good faith, but there is a "...violation of the consumer's freedom, who could be using their free time to work, rest, enjoy your family. However, it directs you to solving problems at the supplier's negligence. The violation of freedom, in this context, generates moral damage".

Corroborating the arguments presented, Cláudia Lima Marques and Laís Bergstein[33] maintain that:

By implementing time-consuming and inefficient systems, failing to invest adequately in the production chain, the supplier transfers to the consumer the burden resulting from its inertia, or, better said, the risks inherent to its own activity. And such reckless conduct can generate damage, including damage for lost time, also called "temporal damage", which must be repaired.

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XII. REQUIREMENTS OR ASSUMPTIONS NECESSARY FOR THE APPLICATION OF THE THEORY

Although there are scholars and judges who admit the existence and applicability of the consumer's productive diversion theory, it is necessary to define how to apply the aforementioned theory.

For this, the creator of the theory lists some requirements or assumptions necessary for the duty to repair based on the theory of consumer productive deviation to remain configured, highlighting which would be mandatory requirements, and which would be optional.

12.1. Mandatory Requirements

12.1.1. Potential or effectively harmful consumption problem to the consumer[34] : This requirement is mandatory because without a consumption problem, there is no need to talk about a duty to repair, so that the starting point for the application of the consumer's productive deviation will be from the appearance of a defect or defect in the consumption relationship, from which would arise the duty to solve the problem, or repair the damage. On this treadmill the author clarifies that:

The consumer's productive deviation originates when the supplier creates a potential or actually harmful consumption problem and does not solve it spontaneously, quickly and effectively, leaving the operational and material time cost of doing so to the consumer.

12.1.2. The supplier's abusive practice of avoiding responsibility for the consumption problem: This requirement consists of the supplier's conduct in creating artifices and justifications, avoiding solving the potential or actually harmful consumption problem.

12.1.3. The harmful fact or event of the consumer's productive diversion[35] : Characterized by the effective waste of the consumer's vital time, both by the "... expenditure of the consumer's vital time, by the postponement or suppression of their planned or desired existential activities, by the deviation of their competences from these activities and, often , by the assumption of duties and costs of the supplier... "

12.1.4. The causal relationship between the supplier's abusive practice and the resulting harmful event : In short, it is the causal link between the supplier's conduct and the damage borne by the consumer.

12.1.5. The off-balance sheet damage of an existential nature suffered by the consumer[36] : this is " represented by the definitive loss of a portion of the consumer's total lifetime, by the harmful alteration of their daily life or their life project and by the installation in their life of a period of existential inactivity... " . It is observed that this necessary assumption is directly linked to the violation or temporary limitation of the consumer's freedom to decide the best way to apply his vital time, forcing him to waste his time in order to solve the consumption problem.

12.2. Optional Requirements

12.2.1. The emerging damage and/or loss of profit suffered by the consumer : This causes, in addition to the off-balance sheet damage of an existential nature, an effective property damage, which must be repaired.

12.2.2. Collective damage : Which according to Dr. Marcos[37] is "represented by the unlawful damage to the homogeneous individual right of a determined or determinable collective of consumers, linked by a common fact that causes them harm".

XIII. LEGAL PRECEDENTS

here are currently thousands of judicial precedents, whether State Courts or Federal Courts, at the most diverse levels of the judiciary, including the Superior Court of Justice – STJ, recognizing and applying the theory of consumer productive deviation.

Within the scope of the Court of Justice of the State of Rondônia, we highlight 3 precedents, of which two are from the 2nd Civil Chamber, and one from the Appeal Panel, namely:

SUMMARY Civil appeal. Telephony. Failure to provide the service. Improper billing. Unlawful act. Services not contracted. Productive diversion. Moral damage. Sustained. Indemnity. Value. Fixation criteria. Minority. Evidenced that there was an undue collection of amounts above that contracted by the consumer, requiring several electronic contacts with the telephone and, even so, the charges did not cease, the failure to provide the service is characterized and compensation for the pain and suffering arising therefrom is characterized . The arbitration of indemnity arising from moral damages must be done on a case-by-case basis, with common sense, moderation and reasonableness, paying attention to proportionality in relation to the degree of fault, extent and repercussion of the damages, economic capacity,

individual characteristics and the concept of the parties.[38]

And still:

SUMMARY Civil appeal. Adhesive feature. Defective product. Moral damage. Material damage. Sucumbency fees. The shutdown of the plaintiff's television for more than thirty days, due to the defect whose solution to the problem directly with the company did not appear to be effective, goes beyond the mere displeasure and causes moral damage subject to indemnification, especially because the judicial route was necessary for the search for your right. The arbitration of indemnity arising from moral damages must be done on a case-by-case basis, with common sense, moderation and reasonableness, paying attention to proportionality in relation to the degree of fault, extent and repercussion of the damages, economic capacity, individual characteristics and the concept of the parties.[39]

The latter, pursuant to the rapporteur's vote:

In this case, the so-called productive diversion thesis is involved, which is defended by Marcos Dessaune, who, in an article on 3/26/2014, on the CONJUR website, established that:

Productive diversion is characterized when the consumer, faced with a situation of poor service, needs to waste his time and divert his skills — from a necessary or preferred activity — to try to solve a problem created by the supplier, at a cost of unwanted opportunity, of an irretrievable nature.

This is exactly the case in the case.

It should be noted that the appellant's negligence in resolving the case made the use of the acquired television unfeasible, which undeniably violates the morality of the appellant, who, as a consumer, did not have his rights respected nor his claims considered, leaving him private unfairly from the use of the good acquired by him.

Unnamed Resource. Right of regret. Delay in returning values. Non-compliance with the sole paragraph of art. 49 of the CDC. Waste of useful time. Productive consumer diversion. Moral damage. Configured. Indemnity amount. Proportionality and reasonableness. 1. Failure to immediately return amounts after exercising the right of repentance, pursuant to art. 49, sole paragraph of the CDC, in addition to wear and tear, it causes feelings of impotence and frustration in the consumer, which gives rise to the duty to indemnify. 2. Respecting the proportionality and reasonableness of the indemnity for the damage suffered by the consumer and the value not meaning any form of illicit enrichment, the amount fixed at the origin must be maintained. (NOMINATED CIVIL APPEAL, Case No. 7005816-85.2019.822.0001, Court of Justice of the State of Rondônia, Appeal Panel - Porto Velho, Rapporteur of the Judgment: Judge José Augusto Alves Martins, Judgment date: 09/18/2020)

Second lectures brilliantly the Judge of Law José Augusto Alves Martins[40] :

The defendant's conduct is reprehensible, allowing the consumer to suffer when trying in vain to solve his problem. The Superior Court of Justice (STJ) has even adopted the Consumer Productive Deviation Theory, which has been adopted by other courts. I share an interesting explanatory judgment on the topic:

SUMMARY – APPEAL APPEAL – COMPENSATION FOR PAINAL DAMAGE – CONSUMER PRODUCTIVE DEVIATION – MORAL DAMAGE IN RE IPSA – REASONABLE AND PROPORTIONAL FIXED QUANTUM. Application of the thesis of "productive consumer deviation", according to which the conviction must consider the deviation of the individual's competences when attempting to solve a problem caused by the service provider, with repeated frustrations, due to its inefficiency and negligence. Moral damage in re ipsa. Reasonable and proportional fixed amount. Feature known and not provided. (TJ-MS - APL: 08039525620158120021 MS 0803952-56.2015.8.12.0021, Rapporteur: Judge Vilson Bertelli, Judgment Date: 12/07/2016, 2nd Civil Chamber, Publication Date: 12/08/2016)

I understand that the case in question occurred exactly what the defenders of this new theory say, so, then, the indemnity for moral damages should be applied in the modality in re ipsa .

In the STJ, the first precedent applying the theory was the REsp 1,737,412 - SE of the report of Minister Nancy Andrighi[41] .

SPECIAL RESOURCE. CONSUMER. TIME OF ATTENDANCE IN PRESENT AT BANKING AGENCIES. DUTY OF QUALITY, SAFETY, DURABILITY AND PERFORMANCE. ART. 4th, II, D, OF THE CDC. SOCIAL FUNCTION OF PRODUCTIVE ACTIVITY. MAXIMUM USE OF PRODUCTIVE RESOURCES. CONSUMER PRODUCTIVE DEVIATION THEORY. COLLECTIVE PAINAL DAMAGE. UNFAIR AND INTOLERABLE OFFENSE. ESSENTIAL VALUES OF THE SOCIETY. FUNCTIONS. PUNITIVE, REPRESSIVE AND REDISTRIBUTIVE. 1. This is a consumer collective, whereby the appellant requested that the appeal be sentenced to comply with the rules of face-to-face service at its bank branches related to the maximum waiting time in lines, the provision of toilets and the provision of seats

to people with mobility difficulties, in addition to compensation for collective pain and suffering caused by non-compliance with said obligations. 2. Special appeal filed on: 03/23/2016; concluded with the office on: 04/11/2017; judgment: CPC/73. 3. The appeal purpose is to determine whether non-compliance with municipal and federal rules that establish parameters for the adequate provision of face-to-face service at bank branches is capable of causing moral damages of a collective nature. 4. Collective moral damage is an autonomous kind of damage that is related to the psycho-physical integrity of the community, a strictly trans-individual asset and, therefore, does not identify with those traditional attributes of the human person (pain, suffering or psychic shock) , supported by individual moral damages. 5. Collective pain and suffering is not to be confused with the sum of natural off-balance-sheet injuries, therefore it is not subject to the principle of full reparation (art. 944, caput, of CC/02), fulfilling, moreover, specific functions. 6. In collective moral damage, the punitive function - exemplary sanctioning of the offender - is, allied to the preventive character - of inhibition of the repetition of the illegal practice - and the principle of prohibition of the agent's illicit enrichment, so that the eventual patrimonial gain obtained with the practice of the irregular act is reverted in favor of society. 7. The duty of quality, safety, durability and performance that is assigned to suppliers of products and services by art. 4, II, d, of the CDC, has an implicit collective content, a social function, related to the optimization and maximum use of productive resources available in society, including time. 8. The voluntary disregard of legal guarantees, with the clear intention of optimizing profit at the expense of the quality of the service, reveals an offense to the duties attached to the principle of objective good faith and constitutes an unfair and intolerable injury to the social function of the productive activity and to protection of the consumer's working time. 9. In the concrete case, the defendant financial institution chose not to adapt its service to the quality standards provided for in municipal and federal law, imposing on society the waste of useful time and causing an unfair and intolerable violation of the social interest of maximum use of productive resources , which is enough for the configuration of collective moral damage. 10. Special feature provided.

Recent judgments are applying the theory of consumer productive diversion, and its necessary assumptions, in non-consumerist legal relations, as is the case of TRF 1, applying the theory in favor of a beneficiary of sick pay, due to the delay in granting the social security benefit , and the need for the latter to return to the branch due to a registration error, equating the beneficiary's low sufficiency with the consumer's low sufficiency, otherwise let's see:

SUMMARY CIVIL APPEAL. INSS. DELAY IN THE CONCESSION OF SOCIAL SECURITY BENEFIT. SICKNESS ALLOWANCE. ADMINISTRATIVE MISTAKE. UNJUSTIFIED REGISTRATION ERROR. RETURN OF THE AUTHOR TO THE AGENCY. PRODUCTIVE DEVIATION THEORY. MORAL DAMAGES. OCCURRENCE. SENTENCE REFORMED. I. Civil liability of the Public Administration is provided for in art. 37, § 6 of the Federal Constitution, being objective in nature due to the adoption of the theory of administrative risk. Combining the constitutional precept with arts. 186, 187 and 927 of the Civil Code, it is understood that for the configuration of civil liability of the public entity and its consequent duty to indemnify, proof of the practice of administrative act by a state agent, damage and causal link between them, is waived the proof of intent or guilt. Precedents. II. As a rule, this E. Court has not recognized the right to compensation for moral damages due to the simple delay in granting social security benefits. Precedents. III. However, in the case of the case file, the plaintiff's administrative request for the granting of sick pay, although granted, was not processed for an administrative mistake, in an unjustified manner, and she had to refer again to the defendant's agency, in which the error was found. and the application is processed again, with the benefit application date later than the one on which it was actually performed. IV. Need for an official letter to be forwarded by the Federal Public Defender's Office so that there could be clarification to the plaintiff of the start date of her benefit, in which the INSS admitted the mistake, which was recognized only in the judicial sphere. V. The Consumer Productive Deviation Theory can also be applied in view of the time devoted to applying for and obtaining social security benefits. SAW. Compensation for pain and suffering fixed at R$ 10,000.00 (ten thousand reais). Precedents. VII. The plaintiff's appeal, partially upheld (item VI). [42]

In a most recent decision, on the occasion of the judgment of the Interlocutory Appeal in Appeal Review no. 1380-97.2018.5.17.141, the TST applied the theory of productive deviation in the employment relationship. In his vote, the judge clarified that:

In view of the similarities between consumption and labor relations, in particular the low-sufficiency characteristic of the consumer and the worker, I understand that the aforementioned theory is fully applicable in this Specialized Company, imposing on the employer to fail to comply with the legal duty incumbent upon him, taking the worker to the weariness of filing a lawsuit to obtain the good of life (undoubted by the way,

since the discharge of the CTPS is the employer's duty) to the payment of compensation for moral damages. Thus, the defendant's conviction for moral damages is irreparable. Once the suffering caused by the defendant's abusive attitude when evading basic worker rights is evident, the right to compensation remains undeniable, especially considering that social responsibility places the economy at the service of people's well-being.[43]

XIV. CONCLUSION

After going through a historical-normative sequence, we realized that in the beginnings of humanity's existence, there was no trade relationship, since production was geared towards subsistence, and with the passage of time, subsistence production was no longer sufficient for the satisfaction of basic needs.

With man starting to live in society, the first commercial relationships emerged, focused on the direct exchange of surplus products, which in short, gave rise to what is currently known as a consumer relationship.

We realized that with the emergence of consumer relationships, problems arising from these relationships also arose.

We also realized that the State, in taking over the exercise of jurisdiction, assumed the power to resolve the conflicts that were presented to them.

Among the guarantees offered by the State are the right to action, and the provision of free legal assistance, both in the technical-professional aspect, having specific bodies for the exercise of this right, as in the issue of exemption from the payment of procedural expenses, and even even from the loss of suit.

The concern of the Original Constituent, as well as the legislators with the defense of the interests of consumers, was demonstrated in the context of the Federal Constitution of 1988, as well as in the Consumer Protection Code, with the express recognition of the consumer's vulnerability in the consumer relationship , and the disparity of weapons between suppliers and consumers.

We observe that time has a social value of such relevance that it has become a legal asset protected by constitutional and infra-constitutional norms.

We present consumer resources, namely, vulnerable natural resources; abstract cognitive resource; vulnerable vital resources; limited productive resources; scarce material resources; and conditioned volitional resource, highlighting the limited productive resources, clarifying that these are "...your time and your skills (set of knowledge or knowledge, skills or know-how and attitudes or know-how) necessary for the performance of any activity... ".

We conceptualize the diversion of the consumer's productive resources, explaining that it occurs when the consumer, due to problems in the consumption relationship that did not cause it, wastes his vital time and skills to solve consumption problems, which are the responsibility of the suppliers.

The requirements or assumptions necessary for the application of the consumer's productive deviation theory were presented, as well as legal precedents recognizing the theory and applying it.

It is noteworthy that, although the theory has emerged with scope to protect the rights and interests of the consumer, several courts are recognizing and applying the theory in non-consumerist legal relations, as in the precedents presented in the TRF1, which applied the theory to condemn the Union to pay moral damages to the beneficiary of sick pay, who had to file more than once with the INSS agency due to a registration error.

In this tuning fork, we present a very recent precedent of the TST, which, on the occasion of the judgment of the Interlocutory Appeal in a Review Appeal, recognized and applied, by analogy, the theory of the diversion of productive resources, " in view of the similarities existing between the relations of consumption and of work, in particular the low-sufficiency characteristic of the consumer and the worker... ", even though the legal relationship between the parties is not one of consumption, but one of work and employment.

With the observations, it is clear that the consumer's vital time is a protected, scarce, finite, non-accumulative and irrecoverable legal asset, and the damage to this asset, verified the presence of the requirements or assumptions necessary for the application of the theory, assume that the off-balance sheet damage of an existential nature will be considered, that is, the resulting damage is in re ipsa , and must be indemnified, and not treated as a mere unpleasantness, or mere mishaps or misfortunes of everyday life.

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Congestion Control in Unicast and Multicast CoAP-based Communications

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***Abstract*—** *Lightweight devices and constrained resources used in the Internet of Things (IoT) applications have developed in exorbitant numbers, generating a large amount of data required for intelligent data processing. One of the foremost emerging messaging protocols used to address the requirements of these lightweight IoT nodes is Constrained Application Protocol (CoAP). Considering the unlimited number of messages and notifications generated by these devices, the problem of congestion occurs in CoAP communications. In this context, to fulfill successfully the need of transactions and succeed to handle reliably unicast and multicast communications, CoAP dispose of congestion control mechanisms to manage both unicast and multicast communications. The challenge addressed in this paper consists of designing appropriate congestion control mechanisms for CoAP that ensures a secure network operation while keeping the utilization of network resources efficiently. Therefore, in this paper, we shed the light on congestion control algorithms used to manage unicast and multicast communications CoAP based; we present a critical analysis of its performances and highlight some of its shortcomings and pitfalls. We combine and put forward two of our proposed adaptive algorithms of congestion control based on network conditions in both unicast and multicast communications.*

I. INTRODUCTION

The IoT has invaded all the sides of our life and plenty of new applications are emerging in different fields of our environment. Furthermore, more and more technologies related to the IoT are opened out to the benefit of improving the quality of life. Nevertheless, although the fast progress of IoT and related technologies, the need for suitable and appropriate solutions involving constrained devices is necessary to overcome the problem persisting like network congestion.

The Constrained Application Protocol CoAP has been designed by the Internet Engineering Task Force (IETF) to support IoT with lightweight messaging for devices operating in a constrained environment. It defines two interactions types between end-points based on client/server model: a) One-to-one interaction (request/reply) and b) Multi-cast interaction (Client wants to interrogates multiple servers). Like HTTP, Clients have the power to manage resources using requests: GET, PUT, POST and DELETE to perform Create, Retrieve, Update, and Delete operations.

CoAP has successfully fulfilled the need of the lightweight features required to handle communication between constrained devices in IoT environment. However, these devices are generating an enormous

amount of messages and notifications that cause the network congestion.

Network congestion in CoAP represents the great limitation that hinders the right functioning of this protocol and causes the loss of packets. It can also significantly damage the performance of a network, manifesting in increased packet latencies, while a network may even become useless if the congestion collapse occurs [1]. On the other hand, unlike HTTP, CoAP does not run over TCP, it runs over UDP.

Consequently, the challenge addressed in CoAP based communication consists of designing a suitable congestion control mechanism that ensures a safe network operation while keeping the use of network resources efficiently.

Communication between clients and servers is afforded through connectionless datagrams. Retries and reordering are implemented within the application stack. So, retransmissions management is a challenge in CoAP. CoAP also allows UDP broadcasts and multicasts for addressing [2]. In this paper, we discuss two communication types Unicast and Multicast CoAP based communications.

In unicast communications, CoAP allows communications between single nodes (client to server or server to client). So, it must compute an adequate Retransmission Time Out (RTO) for the next transmission for each node. In this context, the core CoAP specification defines a basic congestion control mechanism that consists of the utilization of a back off mechanism to compute the Retransmission Time Out (RTO) for subsequent transmission. It is based on the use of a fixed RTO value that is doubled in each retransmission. Nevertheless, albeit the core CoAP specification defines a basic congestion control mechanism to make it ready to handle congestion control by itself, researches have proved that CoAP is not capable of being adaptive to network conditions.

To address all those aforementioned problems, many congestion control algorithms were proposed. In this paper we present the most important ones, we compare them and we highlight our own adaptive solutions.

On the other hand, in many IoT application fields, additionally to unicast communication, nodes should be addressed in groups, so as to manage the requirements of multiple communications between different and several devices, CoAP supports group communication [3]. Multicast communication is a communication driven from a single node to multiples nodes (client to servers or server to clients). However, CoAP ensures multicast communication in one sense, from a server to multiple clients, but in the other sense -from a client to multiple servers- , it relies on unicast communications. This has led to the problem of network congestion [4]. To resolve this problem, researchers propose to insert a delay between consecutive requests.

In addition to a review of congestion control algorithms in multicast CoAP based communication, we discuss our own proposition of the delay to insert between two requests.

The remainder of this paper is organized as follow: A description of CoAP congestion control algorithms in unicast communication is presented as well as our proposed adaptive algorithm in the second section. Then, in the third section, related works to group communication in CoAP including multicast group communications are described. Afterwards, the proposed improved congestion control algorithm is detailed. Finally, a conclusion and some future directions are closing up our paper in the fourth section.

II. COAP CONGESTION CONTROL IN UNICAST COMMUNICATIONS

2.1. Basic CoAP congestion control algorithm

Although, CoAP has become increasingly proposed and proved its effectiveness in gathering data from smart sensors and controlling constrained devices, the problem of network congestion in CoAP represents the great limitation that causes the packets loss.

Indeed, the core CoAP specification defines a basic congestion control mechanism that consists of the use of a backoff mechanism to compute the Retransmission Time Out (RTO) for the next transmission. It is based on the use of a fixed RTO value, which is doubled in each retransmission. Nevertheless, even if the core CoAP specification defines a basic congestion control mechanism to make it able to handle congestion control by itself, researches have proved that CoAP is not capable of being adaptive to network conditions and this goes back to the fact that it doesn't take into consideration the RTT of a packet since the network conditions may change frequently because of the dynamic topology and the density of WSN nodes [5]. Therefore, the calculation of an appropriate RTO is essential to overcome the problem of congestion.

2.2. Classical TCP congestion control algorithm

Unlike the basic CoAP congestion control that uses a fixed RTO, the computation of RTO in the classical TCP congestion control is based on the history variation of RTT. The specification of this algorithm is proposed by RFC 6298 [6].

According to this specification, the calculation of the actual RTO to use in the next transmission is based on two variables; smoothed average of RTT (SRTT) and RTT variation (RTTVAR); where SRTT is used to preserve the history of RTT and RTTVAR keeps the history of RTT variation. Both of these parameters are constant and their impact factors respectively are 7/8 and 3/4.

Initially, the RTO value is set to 1 second. After the first transmission, the first RTT value is received. To compute the following RTO value, SRTT is set as RTT received and RTTVAR is set as RTTreceived/2, the following formulas are used [7]:

SRTT = RTT

RTTVAR = RTT/2

After subsequent RTT measurements are received, the following formulas are applied:

$$SRTT = (1 - \alpha) * SRTT + \alpha * RTT \quad (1)$$

$$RTTVAR = (1 - \beta) * RTTVAR + \beta * |SRTT - RTT| \quad (2)$$

$$RTO = SRTT + \max (G, K*RTTVAR) \quad (3)$$

The formula (3) is used to estimate the RTO value to be used in the following transmission. When the RTO timer expires, the RTO value is doubled [8].

According to RFC 2988, the value of the constant K in (3) is 4. Furthermore in (1) and (2) α and β are also constants and their values respectively are 1/8, 1/4.

Moreover, the G value defines the clock granularity in seconds and according to experiences, finer clock granularities inferior or equal to 100 ms perform somewhat better than other granularity values [8]. Thus, it is recommended to choose the G value not greater than 100 ms [6]. At the same time, G should be at least one order of magnitude smaller than the RTT [9].

2.3. CoCoA

Since the basic CoAP congestion control mechanism can hardly meet the requirements of many IoT applications, several approaches were proposed to improve the aforementioned CoAP shortcomings. The CoAP Simple Congestion Control/Advanced CoCoA [10] is the most important extension of CoAP that has been standardized by IETF. Indeed, basic CoAP does not care about the network characteristics; it behaves the same way in any type of network. Therefore, in order to optimize the CoAP congestion control abilities, CoCoA, based on TCP RTO estimation algorithm, uses RTT measurements to add state information about individual RTOs for different destination endpoints. CoCoA algorithm is based on two mechanisms: (i) a strong estimator; the packet is received on the initial transmission without any retransmissions and (ii) a weak estimator; RTT value is measured after at most two retransmissions. Both of these mechanisms implement the same algorithm but have different sets of state variables. The overall RTO estimated in the formula (6) is made from the estimator that made the most recent contribution using either formula (4) or formula (5) [9].

$$RTO_{recent} = 0.25 * RTO_{weak} + 0.75 * RTO_{recent} \quad (4)$$

$$RTO_{recent} = 0.5 * RTO_{strong} + 0.5 * RTO_{recent} \quad (5)$$

$$RTO_{overall} = 0.5 * RTO_{recent} + 0.5 * RTO_{overall} \quad (6)$$

The fact that CoCoA uses a constant backoff factor and RTO aging mechanism penalize its performances. The reason why authors in [11] propose a mechanism using a variable backoff factor depending on the estimated RTO called CoCoA+. The improvement in this mechanism helps to avoid quick retransmissions for low RTO values, and to avoid slow retransmissions for large RTO values. In addition, in the case when the RTO value has not been updated for a long time, CoCoA+ adds an incorporated RTO aging mechanism.

Furthermore, in [12], the authors design a 4-state estimator scheme for CoCoA depending on the number of times a packet has been retransmitted. The transaction starts in state 1, and each time a packet is retransmitted, its state increases by one. Each time a packet is successfully transmitted and acknowledged within its stipulated time, its state decreases by one. This allows setting the backoff parameters accordingly.

Nevertheless, in the presence of a high number of packet losses, subsequent updates of the weak RTO estimator can cause some unexpected or unpredictable problems [13]. Since CoAP limits the Max_Retransmit in four, a new RTT_{weak} might be obtained after the second, third, fourth, or fifth transmission. Thus, the specification of correspondence between each transmission and its CoAP acknowledgment might be not possible. This mechanism may have a great impact on the calculation of the overall RTO. In addition, when the RTT_{weak} is measured after multiple retransmissions, the new calculated RTO might increase in a considerable way compared to RTO_{init}.

So, in the aforementioned congestion control mechanisms, the issue of setting a right RTO value with burst traffic is still limited because setting a correct and an accurate RTT of retransmitted packet is hardly obtained [14]. In table 1, CoAP congestion control algorithms are listed with basic characteristics.

Table .1: CoAP Congestion control algorithm's characteristics

Algorithm	Backoff method	RTT estimation	RTO aging	Derived from
CoAP	BBF	None	No	None
CoCoA	VBF	Strong & weak	Yes	Linux RTO
CoCoA-S	VBF	Strong & weak	Yes	CoCoA
CoCoA-E	VBF	Strong & weak	Yes	CoCoA & Eifel
4-state-strong	VBF	Four estimations	Yes	CoCoA

III. COAP CONGESTION CONTROL IN MULTICAST COMMUNICATIONS

In the IoT, applications use group communication to make transactions between its different nodes, this goes back to the fact that nodes should be addressed either individually or in groups.

In many IoT applications, nodes addressed in group, i.e., a one to many communication patterns is essential to meet the needs of the application. Furthermore, in some applications, to increase the accuracy and the reliability of gathered data, it is important to collect information from more than one sensor. Moreover, the information gathered at the same time from many sensors may be very crucial to decide the appropriate way to intervene in situations that require real time intervention. So, all these scenarios and others require a communication with a group of sensors as recognized in the Charter of IETF CoRE Working Group [15].

IETF CoRE working group has first recognized the need to support a non-reliable multicast message. Thus, they have developed a specification for Group Communication for CoAP in RFC 7390 [16] to explain how we can use the CoAP protocol in a group communication context. Indeed, Group communication based on CoAP consists of sending a single non-confirmable message to multiple nodes grouped into a specific group using UDP/IP multicast for the requests, and unicast UDP/IP for the responses (if there was any). This means that all the nodes grouped in this group receive the same exact message [17].

It was proved that the use of multicast communication for sending requests is very efficient but it does not affect the number of responses sent by the destination nodes since these are sent as unicasts. In the same context, authors in [18] presented an alternative lightweight forwarding algorithm for efficient multicast support in Low-power and Lossy Networks (LLNs). This allows reducing a number of requests in the LLN since it sends one request to multiple destinations at the same time instead of a unicast for each destination.

The problem of congestion happens when the traffic load offered to a network approaches the network capacity [19]. This phenomenon is one of the main obstacles that still hinder the well functioning of many protocols and thus impacts directly the efficiency of the communication. On the other hand, requests in group communication using CoAP engender a multitude of responses from different nodes, potentially causing congestion. Therefore, both the group communication multicast-based requests and the group communication CoAP unicast-based responses to these multicast requests must be conservatively controlled.

Indeed, it defines a random delay called leisure that consists of a period of time delay inserted between multiple multicast requests. This leisure could be a default value either used by the server or computed according to formula (7).

$$Leisure = S*G/R \quad (7)$$

Where, G is an estimated group size, R is a target data transfer rate R and S is an estimated response size.

Nevertheless, in the case when a single client is communicating with multiple servers using unicasts, CoAP does not specify a congestion control mechanism. To overcome this situation, authors in [20] proposed a simple solution consisting of a delay inserted between consecutive requests; this led to a limitation in the rate at which requests are sent.

In the following paper, we propose an improved formula to calculate the estimated delay to introduce between requests in order to reduce the network congestion.

IV. RESULTS AND DISCUSSION

4.1. Adaptive unicast congestion control algorithm

In addition to the fact that the basic CoAP congestion control does not use the RTT of previous transactions to estimate the following RTO, it also does not take into consideration the utility of the packet loss ratio as well, to adapt its behavior to network conditions.

The packet loss is defined as the number of packets that failed to reach their destination across a computer network. Packet loss is caused either by link-layer interference or by network congestion and it is measured as a percentage of packets lost according to packets sent.

Indeed, in IoT networks, the packet loss is considered one of the big consequences of the network congestion problem. Based on this fact, in [20], we propose an

improved congestion control algorithm based on the packet loss ratio and the RTT value considered in the previous transmission.

Furthermore, in order to provide an adaptive dynamic retransmission timeout that can be suitable for network conditions in the IoT applications, we propose to update the RTO value in each retransmission according to the packet loss ratio. The correlation between actual and previous RTO values seems primordial to adapt the recent RTO value to network conditions. Basically, the RTT and the packet loss ratio which is in a frequent change. Therefore, there is no need to aging techniques because our RTO is in a frequent change according to the packet loss changes and it will never keep a fixed value for an extended period. Thus, the server notifies the client with the packet loss ratio based on sequence numbers of received messages i.e. when the server receives a message, it gets a set of sequence numbers and it recognizes the sequence numbers missed then it calculates a packet loss percentage according to packets sent. In our conception, two scenarios are proposed; (i) if the packet loss ratio is lower than 50%, the RTO value will be updated according to formula (7) in order to prevent unnecessarily long idle time, otherwise, (ii) if the packet loss ratio exceeds 50%, the RTO will be updated in order to correct the loss according to formula (8). In other words, when the packet loss has a low value (pl < 0.5), we conserve nearly the same RTO value as the previous value ($RTO_{recent} \approx RTO_{previous}$), this is in order to reduce idle time (waiting time). On the other hand, when the pl increases (pl > 0.5) the RTO conserve as well nearly the same value as the previous value, this is in order to correct the loss of packets. These formulas aim to adapt the RTO calculation to network conditions (RTT and packet loss) by conserving nearly the same value of the retransmission timeout.

Initially, like the basic CoAP specification [15], we initiate the RTO to a random value between Ack_TimeOut and Ack_TimeOut*Ack_Random_Factor. Once the RTO is initiated, a message is sent to the corresponding client. Then after the reception of the message, the receiver calculates the RTT and the packet loss values based on the received packets and the sequence numbers. Afterward, the formulas (8) and (8) are used in order to calculate the following RTO to use in the next retransmission.

$$RTO_{recent} = RTT * packet\_loss\_ratio + (1-packet\_loss\_ratio) * RTO_{previous} \quad (8)$$

$$RTO_{recent} = RTO_{previous} * packet\_loss\_ratio + (1-packet\_loss\_ratio) * RTT \quad (9)$$

The detailed algorithm of our proposition is drawn in Figure 1.

```
RTO_init=random(ACK_TIMEOUT,ACK_TIMEOUT*ACK_RANDOM_FACTOR)

RTO = RTO_init

For (i=1; i<packet.packet_nbr ; i++)
        send_coap_packet ( )
        packet.pl=calculate_packet_loss ( )
        packet.rtt=calculate_rtt ( )
        receive_coap_ack ( )

        if (pl<0.5)
                then
                RTO=RTO*(1-packet.pl) + packet.rtt*packet.pl
                else
                RTO=RTO*packet.pl + (1-packet.pl)*packet.rtt
        endif
endfor
```

Fig. 1: Pseudo code of the proposed algorithm

This proposition presents a dynamic and controlled retransmission timeout adapted to be appropriate and suitable for the IoT communications particularities. The two mechanisms presented by our proposition effectively limit the growth of RTO values since it is the previous RTO that makes the higher weight in each of formula (8) and (9).

4.2. Adaptive multicast congestion control algorithm

Experiences show that communications via unicasts between a single client and multiple servers automatically engender a congestion of the network. In order to reduce the problem of congestion, we proposed in [21] a simple adaptive solution based on the leisure defined in the RFC 7390 [3].

Indeed, the fact that the CoAP congestion control, designed for group communication between a single client and multiple servers, doesn't take into consideration the link delay to calculate the delay to insert between consecutive multicast requests, this leads to a congestion control mechanism insensitive to network conditions.

Therefore, in order to improve the delay and to adapt the behavior of our solution to network conditions, we propose a delay between unicast requests depending on the link delay and the estimated group size as shown in formula (10).

$$D = \text{average link delay} * G / G-1 \quad (10)$$

Furthermore, the link delay represents the behavior of the network; if it increases, it means that congestion is more likely to happen, so in order to manage this problem, the estimated delay between unicast requests has to increase. On the other hand, if the link delay decreases, it means that the network is more available and the delays between requests have to be short adapting its behavior to the condition of the network.

To conclude, thanks to its flexibility and its ability to adapt its behavior to different network conditions, this

proposition consistently presents high performances and short response times; it has the ability to increase the number of successful transactions and to decrease the packet loss ratio.

V. CONCLUSION

IoT has offered the ability to transfer data between objects over a network using sensors without any human intervention. In this paper, two important research areas in CoAP based communications were highlighted.

In the two cases of unicast and multicast CoAP-based communication, the number of transactions is very high due to the use of lightweight devices and constrained resources. Thus, in such a network, the problem of congestion is very frequent. Nevertheless, authors propose solutions for congestion control insensitive to network conditions, the thing that lowers its performances.

In this paper, we seek to contribute to the current debate in the literature about congestion issue in CoAP-based communications.

The scientific contribution consists of a conducted large-scale study describing some algorithms used to control congestion in CoAP based communications.

Two suitable solutions to ensure safe network operation, while using network resources efficiently, were presented; unicast CoAP-based communication adaptive to network condition (an estimation of RTO value to use for the next transaction based on the packet loss ratio and the RTT of the previous transmission). Moreover, in multicast group CoAP-based communication an adaptive formula for the calculation of the delay to introduce between consecutive multiple requests was discussed.

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Pregnancy-specific hypertensive disease

Doença hipertensiva específica da gravidez – DHEG

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***Abstract*—** *Pregnancy-specific hypertensive disease (DHEG) is characterized by the symptomatic triad of hypertension, proteinuria, and edema in pregnant women with normal blood pressure after 20 weeks of pregnancy. The aim of the research was to analyze the literature at 20-year intervals that talk about the disease. The methodology is a comprehensive review that focuses on the investigation, description and analysis of scientific results published in major nursing journals on the subject of nursing between 2000 and 2021. Results: Hypertension syndrome during pregnancy is an important complication of pregnancy it is a major cause of maternal and fetal morbidity and death, especially in developing countries. Diagnosis can be clinical, laboratory and imaging. Imaging exams are important as they help in tracking them. The confirmation of pre-eclampsia is based on laboratory data from hemolysis, increased rates of TGO, Pyruvic Glutamic Transaminase (TGP) and Lactado Dehydrogenase (LDH) and low platelet count. It is concluded that pregnant women with DHEG are fragile and require great attention from health professionals, as they have a high risk of complications and sometimes need to be transferred to the intensive care unit, taking into account the risks for mothers, fetuses and newborns.*

***Resumo*—** *A doença hipertensiva especifica da gravidez (DHEG) é caracterizada pela tríade sintomática de hipertensão, proteinúria e edema em mulheres grávidas com pressão arterial normal após 20 semanas de gravidez. O objetivo da pesquisa foi analisar literatura com intervalos de 20 anos que falam sobre a doença. A metodologia trata-se uma revisão abrangente que enfoca a investigação, descrição e análise dos resultados científicos publicados nas principais revistas de enfermagem sobre a temática de enfermagem entre 2000 a 2021. Resultados: A síndrome de hipertensão durante a gravidez é uma complicação importante da gravidez é uma das principais causas de morbidade e morte materna e fetal, especialmente nos países em desenvolvimento. O diagnóstico pode ser clínico, laboratorial e por imagem. Os exames de imagem são importantes, pois auxiliam no seu rastreamento. A confirmação da pré-eclâmpsia é baseada nos dados laboratoriais a partir da hemólise, elevação das taxas de TGO, Transaminase Glutâmica Pirúvica (TGP) e Lactado*

Desidrogenasse (LDH) e baixa contagem de plaquetas. Conclui-se que as gestantes com DHEG são frágeis e requerem grande atenção dos profissionais de saúde, pois apresentam alto risco de complicações e, às vezes, precisam ser transferidas para a unidade de terapia intensiva, levando em consideração os riscos para as mães, fetos e recém-nascidos.

I. INTRODUCTION

Pregnancy-specific simple hypertension (DHEG) is characterized by the symptomatic triad of hypertension, proteinuria, and edema in pregnant women with normal blood pressure after 20 weeks of pregnancy. In addition to termination of pregnancy, it is an incurable disease and can progress to more complex diseases such as eclampsia, HELLP syndrome (hemolysis, increased activity of liver enzymes, thrombocytopenia) or DIC (diffuse intravascular coagulation) (DUSSE et al., 2001).

Hypertension (AH) is considered a serious public health problem, as millions of people are affected by this disease. According to observations, about 5% to 10% of pregnant women in Brazil suffer from arterial hypertension, being more common in pregnant women - Eclampsia, chronic hypertension or women who do not leave. It was confirmed that about 65% of them died as a result of this, which is considered a common disease in high-risk pregnant women, and has a significant impact on the still considered high maternal and perinatal morbidity and mortality (BRASIL, 2014; REINERS et al., 2009). Hypertension is the most relevant medical complication during pregnancy and childbirth. The term "hypertension in pregnancy" is often used to describe patients with mild to severe hypertension accompanied by various organ dysfunctions. Although the clinical manifestations may be similar, they can be caused by different reasons (BEZERRA et al., 2005).

When determining the manifestations of hypertension during pregnancy, prepregnancy hypertension must be differentiated from its specific symptoms. First, high blood pressure is the basic pathophysiological feature of the disease, and second, it is the result of the mother's body's poor adaptability to pregnancy. Hypertension is just one of its manifestations. The effects of these two conditions on the mother and fetus and their control are completely different (PERACOLI and PARPINELLI, 2005).

Diagnosis can be clinical, laboratory and imaging. Imaging exams are important as they help in tracking them. The confirmation of pre-eclampsia is based on laboratory data from hemolysis, increased rates of TGO, Pyruvic Glutamic Transaminase (TGP) and Lactado Dehydrogenase (LDH) and low platelet count. This pathology brings serious complications such as acute renal failure, however, it can be reversed in the puerperium if there is no tissue necrosis. There is no specific nursing intervention to prevent PE, however, care is based on the evolution of the condition, involving, in addition to the medical and nursing staff, several other professionals (SANTOS, 2018).

Pregnancy toxemia, currently called pregnancy-specific hypertension (DHEG), is the most relevant medical complication of postpartum pregnancy. It is characterized by a triad of symptoms in pregnant women with normal blood pressure after the 20th week of pregnancy: hypertension, proteinuria and edema (ANGONESI & POLATO, 2007). DHEG can harm the health of mothers and children, especially when serious illnesses occur. Studies prove some of the factors that contribute to this process, focusing on: unstable socioeconomic conditions, maternal weight before and during pregnancy, early pregnancy, low education, inadequate prenatal care and risk behaviors such as alcohol consumption (MOTTA ET AL., 2005).

At this stage, the disease is asymptomatic and its diagnosis depends only on physical examination and laboratory data of the pregnant woman, but its evolution can lead to more severe forms such as eclampsia and HELLP syndrome (SOUZA et al., 2011; FEBRASGO, 2011). According to the Ministry of Health and the Brazilian Federation of Associations of Obstetricians and Gynecologists (FEBRASCO), pregnant women at higher risk of DHEG are non-parturients, twin pregnant women, obesity, previous hypertension, family history, gestational diabetes and kidney disease (BRASIL, 2010; FEBRASGO, 2011).

given the above, the general objective of the research was to analyze literature on HDEG with 20-year intervals that talk about the disease.

II. MATERIALS AND METHODS

This study is a comprehensive review that focuses on the investigation, description and analysis of scientific results published in the main nursing journals on the subject of nursing, DHEG and intensive care.

The selection of articles was carried out through the online electronic scientific library (Scielo), Academic Google and the virtual health library database, through the health sciences descriptor (Decs): Nursing, Hypertension

and Pregnancy . For selection, the following inclusion criteria were followed: language of publication (Portuguese, Spanish and English), deadline, 2000 and 2021.

The bibliographic search also uses official documents such as laws, reports, technical manuals and book chapters related to the subject available on the Ministry of Health website.

Bibliographic works without full texts and those that do not allow for an in-depth reflection of the area of nursing on the subject in question are excluded. Data analysis is performed through the description of research and information, analysis of results, compilation of results and evaluation of results on the proposed topics.

III. LITERATURE REVIEW

Arterial hypertension

Hypertension syndrome during pregnancy is an important complication of pregnancy and is a major cause of maternal and fetal morbidity and death, especially in developing countries (MOURA et al., 2011).

Systemic arterial hypertension (SAH) is a clinical condition characterized by continuous levels of systolic blood pressure (≥140mmHg) and diastolic blood pressure (≥90mmHg). When the patient is at rest in a sitting position, the right upper limb is treated twice regularly at intervals between 4 to 6 hours, at least 2 weeks (ANDRADE et al., 2015; TOWNSEND et al., 2016).

Divided into primary (essential) or secondary, depending on the origin, it is idiopathic primary, and the secondary is derived from other diseases, such as diabetes, obesity and dyslipidemia. Both require careful laboratory control, medication and, in some cases, even surgery (ANDRADE et al., 2015; SIQUEIRA et al., 2017). SAH is a disease with high morbidity and mortality, responsible for almost half of the Brazilian population and with an increasing mortality rate worldwide, being classified as a longitudinally progressive pandemic (ANDRADE et al., 2015; RIBEIRO et al., 2015).

The main epidemiological risk factors for SAH are excessive sodium intake, family history, race, diabetes, obesity, hypothyroidism, nervousness, drinking, irregular diet, sedentary lifestyle, psychological factors, dyslipidemia, smoking and smoking. Socioeconomic, social environment and culture (ANDRADE et al., 2015; RIBEIRO et al., 2015; DUTRA et al., 2016).

Among pregnant women, the prevalence of SAH is equally high, considering the existing and those who experienced this condition during pregnancy. SAH has a high incidence in Brazil and worldwide, is present in pregnant women of all ages, being the main cause of maternal death in obstetrics (KINTIRAKI et al., 2015; TOWNSEND et al., 2016; SILVA et al., 2017). Research carried out in Helsinki, Finland and Greece revealed that children of mothers who currently suffer from complications of hypertension during pregnancy may suffer from cognitive impairment, mental problems and metabolic syndrome in the future. The biggest trend (KINTIRAKI et al., 2015; TOWNSEND et al., 2016). Important public and women's health issues, affecting more often primiparous women, prolific women in the third trimester, obese pregnant women and women with a family history of arterial hypertension.

Pregnancy-specific hypertensive disease – HDEG

Pre-existing hypertension during pregnancy can be diagnosed before conception or at week 20. After this date and 42 days after delivery, it is considered pregnancy-specific hypertension (DHEG) (RIBEIRO et al., 2015; KINTIRAKI et al. , 2015; TOWNSEND et al., 2016). The data provided here clarify (MELO et al., 2016; SILVA et al., 2017) that the Ministry of Health defines high-risk pregnancy as the situation in which the life or health of the mother or fetus / newborn is at risk (BRASIL, 2012; MELO et al., 2016; SILVA et al., 2017).

The main complications of hypertension during pregnancy include miscarriage, premature birth, fetal growth restriction, placental detachment, fetal distress and major organ diseases after birth (ALZATE et al., 2015; OLIVEIRA & GRACILIANO, 2015; MELO et al., 2015; al., 2016).

However, the most serious situation is when the disease progresses to pre-eclampsia, eclampsia or hemolytic syndrome, elevated liver enzymes and low platelet count (HELLP), all syndromes of high risk to maternal life (COUTINHO et al., 2014; MORAIS et al., 2015). Therefore, it is important to study which epidemiological factors cause SAH in pregnant women.

Nursing care for pregnant women and postpartum women with pre-eclampsia and/or eclampsia

Pre-eclampsia is a condition that can occur after the 20th week of pregnancy, during childbirth and up to 48 hours after childbirth. It affects approximately 5 to 8% of all pregnancies and is a rapidly progressing disease characterized by increased blood pressure (BP) tension and the presence of proteinuria. Some signs may indicate this, such as: presence of edema, especially on the face, around the eyes and hands; increased weight gain; nausea and/or vomiting; epigastric pain radiating to the upper extremities; headaches and vision changes (blurred vision and/or blurred vision); hyperreflexia, shortness of breath

and anxiety. However, this disease tends to evolve silently, that is, there are no indicative signs (WHO, 2013).

According to Ferreira et al (2016) the pre-eclampsia rate affects about 10% of primiparous pregnant women. The identification of signs and symptoms is very important so that the health team can act in order to provide quality care. The degree of complications will not affect the lives of more pregnant women or even their children.

Eclampsia is characterized by seizures in women and pre-eclampsia during pregnancy does not include other differential diagnoses such as epilepsy, meningitis and sepsis (WHO, 2005).

It is understood that the care provided by the nursing team based on the completion of rigorous scientific methods is the gold standard of medical care (EDWARD & MILLS, 2013). This method can improve the treatment effect of patients, provide better quality of care, minimize the cost due to reduced morbidity and mortality and iatrogenicity, and improve the safety and reliability standards of medical institutions.

Care for women during pregnancy is very important to them, as this type of assistance becomes the ideal choice for nurses to practice their technical and scientific knowledge, as it can promote continuous care for pregnant women. The objective is to determine health needs, determine prioritizing, planning, implementing and evaluating appropriate care actions to improve the quality and effectiveness of care (AGUIAR, 2010).

The nursing team plays an important role in prenatal care, in order to correctly and early determine which patients are more likely to have an unfavorable evolution of the disease, and the woman is welcome from the beginning of the pregnancy. One of the most important treatment methods is to instruct these pregnant women to eat healthily, practice light physical exercise and conduct adequate prenatal counseling (SANTANA et al., 2010).

Prenatal care (PN) is the monitoring of pregnant women by qualified professionals able to receive the pregnant woman and provide comprehensive and quality care. From the first day of pregnancy until delivery, in order to provide a better quality of life for pregnant women and children. Therefore, professionals who treat pregnant women must understand the physical factors, various emotions, economy and family factors, because these factors will affect women's adherence to PN counseling, thus affecting the quality of follow-up (PEIXOTO, 2011).

During pregnancy, some complications can be life-threatening for the mother and/or baby, constituting an emergency that requires immediate intervention. The physiological and anatomical changes of pregnancy can interfere with the assessment of pregnant women, and it is necessary that health professionals understand this knowledge so that they can carry out the correct assessment and provide adequate care (QUEROZ, 2012).

Therefore, among the professionals who received training for prenatal care for adequate care, nursing stands out, with a focus on nursing, so that they can do things for the human being that they cannot do on their own, that is, provide help or assistance in situations where parts of it cannot be done. Self care, guide or teach, supervise or recommend other professionals. It should be emphasized that the treatment of these patients depends largely on care, that is, patients with pre-eclampsia need quality care that meets their needs (SANTOS, 2018).

IV. FINAL CONSIDERATIONS

It is concluded that pregnant women with DHEG are fragile and require great attention from health professionals, as they have a high risk of complications and sometimes need to be transferred to the intensive care unit, taking into account the risks for mothers, fetuses and newborns.

Medical care for these women includes multidisciplinary care, especially nursing, which plays an important role in the provision of nursing care, through an accurate diagnosis, interventions tailored to their needs can be implemented so that the professional nurse can provide a quality assistance.

However, there is a need for maternal care, which is an ideal model for nursing professionals to apply all their technical-scientific knowledge to determine health needs, determine priorities, plan, implement and implement. Evaluate the appropriate care actions, aiming to promote better quality and more humanized care.

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Risk analysis of Waste Collection Workers in COVID-19 Pandemic period - Case Study

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***Abstract*—** *The decomposition processes of organic matter also through pathogenic microorganisms resulting in the generation of toxic and leachate gases that, if not effectively managed, can result in serious environmental impacts, contaminating the air, the soil, as well as human health. Workers connected to the collection of urban waste carry out the handling often improperly due to the absence of Personal Protective Equipment, being exposed to various contaminations. This work aims to analyze, in a succinct way, the possible impacts caused on the health of street sweepers, mainly during the COVID-19 pandemic period. The study took placefrom the on-site observation of the collection workers in the city of Recife, Pernambuco, Brazil. The analysis of conformity and non-conformity in the use of PPE by street sweepers was based on NR-6/2018 during the monitoring of routes performed during the day and night. It was found that most of the garbage collectors who were working on the collection were not in compliance with the use of personal protective equipment (PPE) to prevent exposure to occupational risks in the collection activity.*

I. INTRODUCTION

The unrestrained production of waste is one of the major problems linked to solid waste, as well as its collection and destination. The fast pace of population growth combined with the Pandemic COVID-19 period, which is still out of control, constitutes a worrying factor for the health of the population as well as of workers in solid waste collection services. According to the Brazilian Association of Public Cleaning and Special Waste Companies (ABRELPE, 2020), Brazil generated about 79.09 million tons of waste. Compared with the countries of Latin America, Brazil is the champion of waste generation, representing 40% of the total generated in the region (541 thousand tons / day). According to the same association, in relation to the year 2020, it is estimated that, due to the necessary safety measures in the quarantine, there was an increase of 15 to 25% in the amount of solid household waste and an increase of 10 to 20 times in the generation of hospital waste in health care units.

Many household wastes are contaminated due to the disposal of handkerchiefs, paper towels, diapers, or paper, among others, associated with the lack of orientation of the population regarding the separation of the wastes contaminated by COVID-19, serve as a major exposure focus for the street sweepers.

It should be noted that in addition to the risk caused by COVID-19, collection workers are in direct contact with other types of pathogenic microorganisms, toxic gases and leachate. During the period of decomposition of residues, microbiological processes are predominant in the formation of gases. However, there are other mechanisms involved that act either in isolation, or in association with

microbiology, in the transformation of substances into gases. These mechanisms are those of volatilization and chemical reactions (MACIEL, 2003).

According to Lins & Lins (2020), when workers connected to direct contact with solid waste do not use adequate PPE, they can be directly affected by hydrogen sulfide gas, which is highly toxic and irritating, acting on the nervous system, eyes and eyes. respiratory tract, with acute, subacute, and chronic intoxication, depending on the concentration of the gas, the duration in contact with gas, frequency of exposure and susceptibility. It is a volatile gas, and the main route of penetration is respiratory. The authors still maintain that when reaching the upper respiratory tract, sneezing, dyspnea, and coughing are manifested. These symptoms can evolve towards acute broncho pneumopathies and may even be confused with symptoms of COVID-19. Upon reaching the eyes, conjunctivitis may manifest.

According to Pedrosa (p.12, 2010) "the activity of garbage collection is classified as one of the most risky and unhealthy existing, due to the frequent contact of the worker with agents harmful to health" because in addition to performing their activities on top of the collection trucks, they are exposed to other types of risks such as physical and accidents.

The general objective of this article is to address the possible environmental risks to which workers responsible for the collection of Urban Solid Waste (MSW) are exposed, taking as examples the street sweepers in the city of Recife, capital of the state of Pernambuco (PE), Brazil.

II. METHODOLOGY

To evaluate the work environment of the street sweepers, direct observation and recording techniques were used, that is, it is a descriptive research, as according to Cervo and Berviam (2002, p. 66) “aims to observe, record, analyze and correlate phenomena or facts, without interfering in the analyzed environment. It is the type most used in the social sciences”. It should be noted that the development of observation instruments was based on the work of Antunes (2009) and Germano (2010).

Through Table 1, it became possible to identify, in part, the potential risks of agents in the workplace: physical, chemical, biological, ergonomic and others, as well as the existing preventive / control measures. Lazarri (2009) mentioned that workers involved in the collection of solid waste are exposed, in their work process, to six different types of occupational risks, namely:

- Physical: noise, vibration, heat, cold, humidity.
- Chemicals: gases, fog, fog, dust, toxic chemicals.
- Mechanics: pedestrians, falls, crushing by the compactor, fractures.
- Ergonomic: overload of the musculoskeletal function and the spine, with consequent pathological impairment and adoption of uncomfortable forced postures.
- Biological: contact with pathogenic biological agents (bacteria, fungi, parasites, viruses), mainly through sharps.
- Social: lack of training and adequate working conditions.

Field visits were made, which according to Santos (2002, p. 28), is the natural place where facts, phenomena and processes take place. The research was developed with monitoring, not interacting directly, collecting, and analyzing data through observation over a period of 1 year, in different shifts.

Table 2 was directed at environmental risk and the existing measures for control. It was possible to compile the existing protection measures (means, procedures, practices, infrastructures, etc.) against impacts that could increase environmental risks. It is noteworthy that the individual measures (also admitted as possible), were removed because there is no sense in protecting only one individual against environmental impacts.

The assessment of environmental aspects was based on the product of two factors: severity (s) and frequency (f), with each factor varying from 1 to 5 values. Severity is any actual or potential condition that can result in damage or loss.

The severity and frequency criteria are presented in Table 3. The significance (S) of each aspect is given by the expression:

$$S=2*s+f \quad \text{Eq. (II)}$$

Table 1. Working conditions.

Physical Agents				
Weather	Noise	Vibrations	Moisture	Prevention/control measures
Mechanical Agents				
Hit-and-run	Falls	Crushes	Fractures	Prevention measures
Chemical Agents				
Gases	Fog	Toxic Substances	Dust	Prevention measures
Biological Agents				
Fungi	Bacteria	Protozoa	Pathogen	Prevention measures
Ergonomic Agents				
Postures	Overloads	Extended Journey	Stress	Prevention measures
Social Agents				
Lack of Training	Prejudice	Working Conditions	Prevention measures	

Source: Adapted from Germano (2010).

Table 2.Severity and Frequency criteria of the comparative method for the evaluation of environmental aspects.

	Severity	**Frequency**
1	Too Low	Meaningless – once a year or less
2	Reduced	Reduced – more than once a year up to once a month
3	Medium	Moderate – more than once a month up to once a week
4	High	High – more than once a week up to once a day
5	Very High	Extremely high – continuous or more than once a day

Source: Germano(2010).

Significance is classified into three levels according to Table 3:

Table 3. Significance levels of the comparative method for evaluating environmental aspects

Level A	Significant (significance between 11 and 15)
Level B	Sensitive (significance between 9 and 10)
Level C	Non-Significant (significance between 3 and 8)

Source: Adapted from Germano (2010).

Similarly, risk assessment (R) arises from the product of two factors: gravity (G) and probability (P) resulting from the multiplication of preventive measures (MP) by exposure (E), as can be seen in equations III and IV.

$$R = G * P \quad \text{Eq. (III)}$$

$$P = MP * E \quad \text{Eq. (IV)}$$

All factors, G, MP and E, range from 1 to 4 values according to Chart 4.

Table 4. Severity Criteria, Preventive Measures and Exposure of the comparative method for occupational risk assessment.

	Severity	Preventive measures	Exposure
1	No disability	Organizational measures (e.g., structural measures, signage, health surveillance) or systematically applied procedures	The exposure of people is less than 1 hour per day
2	Partial temporary disability	Training, training, or procedures not systematically applied	Exposure of persons is less than 4 and more than 1 hour per day
3	Permanent disability partial, absolute temporary disability, professional illness (fitness)	Protective equipment (collective and individual) or without procedures adopted	Exposure of persons is less than 6 and more than 4 hours per day
4	Death, professional illness (ineptitude) or permanent total disability	No preventive measures taken	The exposure of people is more than 6 hours a day

Fonte: Germano (2010).

Risk is classified into two levels according to Table 5.

Table 5. Risk Levels of the comparative method for risk assessment.

Acceptable Risk	Acceptable between 1 and12
Risk not acceptable	Not acceptable between 16 and64

Source: Adapted from Germano (2010).

There was no need to use the Declaration of Helsinki because it is an adapted Methodology, besides not containing the use of images or names of people. It's just an observation survey.

III. RESULTS AND DISCUSSION

3.1 The Use of the Direct ObservationTechnique:

During the period of 1 year, it was possible to observe numerous collection trucks and the work carried out by the Collection Workers in the city of Recife in the year 2020. All analyses refer to workers who are linked to the compactor truck.

Waste collection professionals work in two shifts, a group during the day (from 7 am to the end of the route) recording about 8 hours of work. As for the nighttime the professionals are replaced. Every employee of the collection performs a workload of up to 8 hours and can stop if you finish your pre-defined journey.

When performing their activities outdoors, the Collection Workers are exposed to physical risks and accidents. Many of these workers are exposed to the weather without any kind of protection, such as covers, for example. Noise is common when the compactor truck is triggered to compact waste (often) in addition to the noises produced in traffic, and may generate partial or permanent hearing losses, headaches, nervous tension, stress, and hypertension. Velloso et al. (1997) also observed that the collection activities when carried out in the hills and in streets of precarious asphalt, place "the Collection Workers subject to trepidation because they travel in the stirrup of the collecting vehicle and, vibration, can cause low back pain and body pain, in addition to stress". In addition, the authors also state that during the collection of waste, the

Collection Workers "go up and down slopes, traveling miles on foot." According to Neves (2003), this finding comes because complaints of muscle pain are common due to over-running in a script, in addition, it becomes more exhausting to climb and descend the truck several times, and, in scripts with collection points close to each other, the Collection Worker rarely climbs the truck, going through the script next to the truck. It is also note point that the Collection Workers are subjected to situations of trampling.

It was observed that the Collection Workers perform their tasks at a fast pace, carrying several garbage bags simultaneously, holding them by the hands, arms, chest and even in the head, raising the risks of accidents. In addition, the associated biological and chemical risk is also observed. The possibility of biological contamination considering the huge variety of viruses, bacteria and protozoa present in the residues is a reality.

The odor of rotten egg emanating from the residues in the compactor trucks is associated with the sulfide gas. As observed by Lins & Lins (2020) the sulfide gas is highly toxic and irritating, and acts on the nervous system, eyes and airways and can generate acute, subacute, or chronic intoxication, depending on the concentration of gas, duration, frequency of exposure and individual susceptibility.

In turn, ammonia also present in compactor trucks with residues tends to cause an irritation in the mucous membranes and this can be felt right away when we are close, for example, close to the leach treatment system. According to Lins & Lins (2020), ammonia when it reaches the upper airways, sneezing, dyspnea, and cough, where these symptoms can evolve in the sense of acute broncho pneumopathies. When it reaches the eyes, these tears and may manifest conjunctivitis.

Another common agent is dust, which may be responsible for discomfort and momentary loss of vision, as well as respiratory and pulmonary problems as observed by Ferreira & Anjos (2001).

In municipal solid waste can still be found a variety of chemical and biological residues such as batteries and batteries; oils and greases; pesticides/herbicides; solvents; paints; cleaning products; cosmetics; expired remedies; aerosols; diapers; scarves; toilet paper, where they can be classified as dangerous, bringing deleterious effects to human health and the environment. In periods of pandemic, such as covid-19, residues such as diapers, scarves and toilet paper may contaminate the other residues due to its persistence.

Recent studies (VAN DOREMALEN et al., 2020; KAMPF et al., 2020) have suggested that SARS-CoV-2 persists in aerosol for approximately three hours and on surfaces for up to nine days, which underlies the theory that transmission only by droplets or fomites would not justify such potential for rapid dissemination of the virus in populations. Van Doremalen et al. (2020) also verified the stability of SARS-CoV-1 and SARS-CoV-2 (Covid-19) in the environment and evaluated the possible reasons why the new coronavirus presents greater transmissibility between humans directly or indirectly.

Ramos (2012) stated that pathogenic microorganisms appear in municipal solid waste through the presence of paper scarves, dressings, disposable diapers, toilet paper, absorbents, and condoms, where diseases such as Ascaris lumbricoides; Entamoeba coli; Schistosoma Mansoni; the hepatitis B-causing virus caused by a virus belonging to the Family Hepadnaviridae; and the most current Coronavirus COVID 19(SARS-CoV-2).

In addition to these, microorganisms responsible for dermatitis should also be mentioned. Mycoses are common, appearing more often on the hands and feet, where gloves and shoes establish favorable conditions for the development of microorganisms. Relatively high rates of coronary heart disease and hypertension have been detected among urban cleaning workers (especially among household workers). In all operations, exposure to organic dust and microorganisms can cause diseases of the respiratory tract.

In view of the investigation carried out in the analyzed period, it was observed that most of the Collection Workers were equipped with gloves and uniforms. It is emphasized that the uniforms used were not in accordance with what was required by NR-6/2018 where they should have a safety sleeve to protect the arm and forearm against biting and piercing agents.

Throughout the monitoring of various paths of the compactor trucks no Collection Worker was equipped with masks (at least cloth), essential protection against the new coronavirus COVID-19. The biological risk is real considering the frequency and time of exposure of Collection Workers, in addition to the chemical risk due to exposure to sulfide and ammonia gases. NR-6/2018 indicates the use of the facial respirator against organic vapors (gifts of organic matter decomposition) and specific gloves made of lightweight synthetic fiber. The gloves used by the Collection Workers have been synthetic rubber.

3.2 Useof the Evaluation Instrument:

y completing Table 6 of the working conditions according to the methodology adopted and based on Tables 1 to 5, it was observed that the average significance related to physical agents reached an average of 13 to 14 points, being classified as significant.

Performing the physical risk analysis, based on equations III and IV, as well as tables 2 to 5, it was observed that the total value was 36, which according to the methodology adopted is considered an unacceptable risk. The risk study is associated with severity (G) and probability (P) resulting in the multiplication of preventive measures (MP) by exposure (E).

As for mechanical agents, following the same methodological criterion adopted for physical risk, it was observed that the mean significance was 10 points, being classified as sensitive. However, considering that Collection Workers do not use EPIs related to mechanical risks, it reaches the maximum level of 64 points, being considered an unacceptable risk.

Table 6. Working Conditions.

Weather	Noise	Vibrations	Moisture	Prevention/control
Physical Agents				measures
15	15	15	9	36

Mechanical Agents				
Hit-and-run	Falls	Crushes	Fractures	Prevention/control measures
10	10	10	10	64

Chemical Agents				
Gases	Fog	Toxic Substances	Dust	Prevention/control measures
15	5	10	10	48

Biological Agents				
Fungi	Bacteria	Protozoa	Pathogen	Prevention/control measures
15	15	15	10	64

Ergonomic Agents				
Postures	Overloads	Extended Journey	Stress	Prevention/control measures
15	10	10	8	48

Social Agents			
Lack of Training	Prejudice	Working Conditions	Prevention/control measures
10	10	15	16

Source: The authors (2021).

Analyzing the chemical agents, following the methodological criterion adopted for the other analyses, it was observed that the mean significance reached 10 points, being classified as sensitive. However, considering that Collection Workers do not use EPIs as the facial respirator against organic vapors, according to NR-6/2018, chemical risks reach the level of 48 points, being considered an unacceptable risk.

The biological agents obtained an average significance of 11 points, being classified as significant. During the follow-ups, it was observed that the Collection Workers were not using the appropriate EPIs according to NR-6/2018. Biological agents also reached a maximum level of 64 points, being considered an unacceptable risk.

For ergonomic agents, an average significance of 10 points was obtained and classified as sensitive. During direct observation, there was a total unconcern about the aspects related to posture by the Collection Workers. In addition, to carry out the services more quickly, it was common to observe the Collection Workers with overload of waste

bags. Ergonomic agents also reached a maximum level of 48 points, being considered an unacceptable risk.

Social agents were also analyzed, obtaining an average significance of 10points, being framed as sensitive. When performing the risk analysis, a score of 16 points was found, being at the limit between acceptable and unacceptable risk.

IV. FINAL CONSIDERATIONS

Using the technique of direct observation, when performing their activities outdoors, the Collection Workers are exposed to physical risks and accidents. Many of these workers are exposed to the weather, noise generated by compactor trucks and can cause a lot of damage to health.

In municipal solid waste, a variety of chemical and biological residues such as batteries are still found; oils and greases; pesticides/herbicides; solvents; paints; cleaning products; cosmetics; expired remedies; aerosols; diapers; scarves; toilet paper. In periods of pandemic, such as covid-19, residues such as diapers, scarves and toilet paper may contaminate the other residues due to its persistence.

In view of the investigation carried out in the analyzed period, it was observed that most of the Collection Workers were equipped only with gloves and uniforms. It is emphasized that the uniforms used were not in accordance with what was required by NR-6/2018 where they should have a safety sleeve to protect the arm and forearm against biting and piercing agents.

Throughout the monitoring of various paths of the compactor trucks no Collection Worker was equipped with masks (at least cloth), essential protection against the new coronavirus COVID-19. The biological risk is real considering the frequency and exposure time of the Collection Workers, in addition to the chemical risk related to exposure to sulfide and ammonia gases.

Analyzing all agents, following the methodological criterion adopted, it was observed that the mean significance reached 10 points, being framed as a sensitive significance. Analyzing the risks, it was observed that they are generally unacceptable.

The lack of training and uses of epis suitable for Collection Workers (during waste collection) demonstrates the omission on the part of contracting companies regarding the purchase and collection of the use of equipment by their employees, thus raising the level of environmental risks.

The lack of more robust information may cause distortions in the studies conducted, suggesting that it can be applied in small cities to better characterize the variables inserted.

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The exacerbated increase in self-medication in Brazil during the Covid-19 pandemic and the discourses that strengthen it: An integrative review

O Aumento exacerbado da automedicação no Brasil durante a pandemia da Covid-19 e os discursos que a fortalecem: Uma revisão integrativa

El exacerbadoaumento de la automedicaciónen Brasildurante la pandemia Covid-19 y los discursos que la fortalecen: Una revisiónintegradora

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Abstract— *The main purpose of this study was to discuss the self-medication of elderly patients with neuropsychological syndromes and the discourses that strengthen it, which is done through an integrative review. In alarming circumstances that the World Health Organization (WHO, 1998), recognizes self-medication and self-diagnosis as a serious public health problem due to its consequences. In view of these initial notes, the general objective of this study is to 1) carry out an investigative study of the discourses that supported and influenced the practice of self-*

***Keywords*— Self-medication. Pandemic. Denial speeches.**

***Palavras-chave*— Automedicação. Pandemia. Discursosnegacionistas.**

***Palabras clave*— Automedicación. Pandemia. Discursos de negación.**

medication in Brazil. Our other intentions are 2) to carry out an integrative review of the consequences of self-medication and 3) to carry out a methodological detailing of the studies that supported our research. Some of the results of our research were based on the fact because of the discourses that have strengthened this practice in Brazil since the 2018 post-presidential election. personal and institutional that influenced most people to self-medicate with the so-called Kit Covid, as a way to deny and delegitimize the sovereignty of science.

***Resumo*—** *A proposta central desse estudo foi discutir sobre a automedicação e os discursos que a fortalecem, o que é feito por meio de uma revisão integrativa. Em circunstâncias de alarme que a Organização Mundial da Saúde (OMS, 1998), reconhece a automedicação e o autodiagnóstico como um problema grave de saúde pública devido as suas consequências. Diante desses apontamentos iniciais, o objetivo geral deste consiste em 1) realizar um estudo investigativo dos discursos que fundamentaram e influenciaram a prática da automedicação no Brasil. Outras pretensões nossas são 2) realizar uma revisão integrativa das consequências da automedicação e 3) realizar um detalhamento metodológico dos estudos que subsidiaram nossa pesquisa. Alguns dos resultados da nossa pesquisa encontraram fundamentação no fato de que, a automedicação aumentou drasticamente em decorrência dos discursos que fortaleceram essa prática no Brasil desde o pós-eleições presidenciais de 2018. Houve, desse modo, vários pronunciamentos pessoais e institucionais que influenciaram grande parte das pessoas a se automedicarem com o chamado Kit Covid, como uma forma de negar e deslegitimar a soberania da ciência.*

***Resumen*—** *El objetivo principal de este estudiofue discutir laautomedicación y los discursos que lafortalecen, locual se hace a través de una revisión integradora. Enlas alarmantes circunstancias que laOrganización Mundial de laSalud (OMS, 1998), reconocelaautomedicación y el autodiagnóstico como un grave problema de salud pública por sus consecuencias. Dadas estas notas iniciales, el objetivo general de esto es 1) realizar unestudio investigativo de los discursos que apoyaron e influyeronenlapráctica de laautomedicaciónen Brasil. Nuestrasotras intenciones son 2) realizar una revisión integradora de lasconsecuencias de laautomedicación y 3) realizar undetalle metodológico de losestudios que apoyaronnuestrainvestigación. Algunos de los resultados de nuestrainvestigaciónfueron respaldados por elhecho de que laautomedicación se ha incrementado drásticamente como resultado de los discursos que han fortalecido esta prácticaen Brasil desde laseleccionespospresidenciales de 2018. llamado Kit Covid, como una forma de negar y deslegitimar lasoberanía de laciencia.*

I. INTRODUÇÃO

A Organização Mundial da Saúde (OMS, 2021) e a Comissão Europeia de farmácias comunitárias, no decorrer dos últimos anos, vieram apresentando ascensão progressiva para o uso de medicamentos sem a apresentação de prescrição médica (MELO et al., 2021). O fato que acentua tal processo é que durante o período pandêmico tal conduta multiplicou gradativamente.

Durante o período que seguimentos vivenciando, da pandemia da Covid-19, o uso de medicação sem prescrição no Brasil aumentou drasticamente e vem sendo discutido por autoridades da área. No centro desta discussão, podemos abordar o “tratamento precoce” para Covid-19 ou “Kit covid” como são chamados. Essas propostas consistem no uso combinado de fármacos (Azitromicina, Hidroxicloroquina ou Cloroquina,

Ivermectina, vitaminas e Zinco) que não apresentam efetividade terapêutica cientifica para este caso (ASSOCIÇÃO MÉDICOS PELA VIDA, 2021; GLOBO, 2021).

A automedicação pode ser vista como um elemento do autocuidado, mas quando inadequada, tais como o uso abusivo de medicamentos (polimedicação) e o uso de medicamentos *off label*, pode ter como consequências o uso irracional de medicamentos, efeitos indesejáveis, enfermidades iatrogênicas e mascaramento de doenças evolutivas [...] (ARRAIS et al, 1997). No entanto, atualmente, é visto com frequência no Brasil, o incentivo do uso medicamentoso como ferramenta de autocuidado devido ao atual cenário, como podemos notar via propagação através de redes sociais e na indústria midiática de maneira geral. Sob a ótica de Fernandéz et al., (2021), tal incentivo, deve ser acompanhado de estratégias que permitam a divulgação de informações sobre as medidas a serem tomadas para reduzir o risco de desenvolvimento de reações adversas a medicamentos, principalmente os fármacos de uso controlado.

Esse comportamento encontra-se presenta a nível mundial, tanto em países desenvolvidos socioeconomicamente, como não. O estudo de Medina e Dominguéz (2015) aponta que os Estados Unidos apresentam cerca de 37 mil mortes por ano em decorrência de superdosagem medicamentosa. No Reino Unido, o número de mortes por intoxicação por analgésicos gira por volta de 121 mortes por ano. Já na Argentina, apresenta um número elevado de internações por uso indevido de medicação. Conforme dados divulgados pela Agência Senado do Brasil,

> O Brasil é recordista em automedicação. A pesquisa *O Comportamento da Dor do Paulista*, realizada em 2014 pelo Instituto de Pesquisa Hibou, identificou que o brasileiro da Região Sudeste é o que mais se automedica de forma indiscriminada e sem medo das consequências. (AGÊNCIA SENADO, 2017)

Uma pesquisa realizada pelo Conselho Federal de Farmácia (CFF) e publicada pelo portal G1, do globo, no ano de 2019, apontava que na população estudada, 47 porcento da população se automedicava uma vez ao mês e 25 porcento todos os dias ou uma vez por semana.Tal iniciativa, além de colocar em risco a própria vida, apresentar efeitos colaterais ou até mesmo interações medicamentosas, incluindo o uso de chás caseiros, também dificulta o profissional médico na assertividade dos diagnósticos.

É nessas circunstâncias de alarme que a Organização Mundial da Saúde (OMS, 1998), reconhece a automedicação e o autodiagnóstico como um problema grave de saúde pública devido as suas consequências. A proporcionalidade alta do processo acelerado de envelhecimento, concomitante ao uso indevido de medicamentos sem respectivas prescrições, como já dito anteriormente, interfere diretamente na assertividade do diagnóstico e a implantação do plano terapêutico singular de maneira eficaz. Essa problemática, se intensifica a partir do momento que o paciente apresenta alguma alteração neuropsicológica previamente existente.

Diante desses apontamentos iniciais, o objetivo geral deste consiste em1) realizar umestudo investigativo dos discursos que fundamentaram e influenciaram a prática da automedicação no Brasil. Dito de outra forma, nossa proposta de investigação é analisar como os discursos em torno do kit covid influenciaram a população em geral a se automedicar. Outras pretensões nossas são 2) realizar uma revisão integrativa das consequências da automedicação. A seguir são explicitadas pequenas notas metodológicas sobre a população e amostra do nosso estudo.

Notas metodológicas

Para composição de nosso trabalho, foram encontrados 7 artigos na plataforma MEDLINE, nos idiomas inglês e português brasileiro, porém apenas 3 apresentavam-se disponíveis para a especificidade de nossa pesquisa. A seguir, dispomos de um quadro explanativo que agrega a amostra da pesquisa.

Quadro I: Amostra da pesquisa

Título	Autores	Periódico	Idioma	Ano
The importance of stress, self-efficacy, and self-medication for pharmacological neuroenhancement among employees and students	Larissa J. Maier; Severin Haug; Michael P. Schaub	*Elsevier Ireland Ltd*	Inglês	2015
Pharmacological cognitive enhancement among non-ADHD individuals—A	Larissa J. Maier, Jason A. Ferris,	*International Journal of Drug*	Inglês	2018

cross-sectional study in 15 countries	Adam R. Winstock	*Policy*		
Automedicação e uso indiscriminado de medicamentos durante a pandemia da COVID-19	MELO, José Romério rabelo et al.	*Cadernos de Saúde Pública*	Português Brasileiro	2021

Fonte: Criação dos próprios autores

Tornou-se pertinente partirmos de 2015 até 2021 para percebermos o crescimento gradativo que houve entre os casos de pacientes que se automedicavam em decorrência dos diversos discursos que se proliferaram em torno da automedicação a partir de meados de 2020, ápice do cenário pandêmico em terreno brasileiro.

II. DISCURSOS QUE FUNDAMENTARAM E INFLUENCIARAM A PRÁTICA DA AUTOMEDICAÇÃO

Ao longo do ano de 2020, foi possível verificar, nos principais portais eletrônicos mundiais, uma corrente proliferativa de discursos que primavam pela vida e alertavam quanto às consequências da pandemia provocada pelo coronavírus(SARS-CoV-2) e orientavam sobre a importância das vacinas (LE MONDE1, 2020; THE NEW YORK TIMES2, 2020; EL PAÍS3, 2020a; 2021). No entanto, também é nesse cenário, em terreno brasileiro, que se perfaz o negacionismo científico, por meio de discursos que combatem a ciência e procedimentos advindos dos campos da saúde, como a voz médica e farmacológica.

Diante do painel que se edificou no decorrer do ano de 2020 e que ainda ressoa até o segundo semestre de 2021, compreendemos que, dentre os principais discursos produzidos, estão aqueles advindos de sujeitos representantes da direita conservadora brasileira, prefigurados e personificados na voz do atual presidente da República, Jair Messias Bolsonaro. Nosso entendimento não advém de questões subjetivas, mas de pesquisas científicas, como o posicionamento da ONU, que reconheceu que, em seus discursos, "Bolsonaro defende tratamento sem eficácia contra Covid-1" (G1 GLOBO, 2021).

É nesse sentido que se propagou a prática da automedicação, a partir do momento em que diversas pessoas creditaram e legitimaram discursos que negam a eficácia da vacina. Vejamos alguns:

1. Bolsonaro, no dia 21 de setembro de 2021, ao discursar na abertura da 76ª Assembleia Geral da Organização das Nações Unidas (ONU), defendeu a adoção do chamado tratamento precoce contra a Covid-19, cuja ineficácia já foi cientificamente comprovada (G1 Globo, 2021).
2. Em depoimento à CPI da Covid-19, no dia 25 de maio de 2021, a secretária de Gestão do Trabalho e da Educação do Ministério da Saúde, Mayra Pinheiro[4], fez defesa ferrenha do uso da hidroxicloroquina, medicamente este que é "comprovadamente sem eficácia para tratamento da Covid-19 (Folha de S. Paulo, 2021)
3. Mayra Pinheiro, ainda Em depoimento à CPI da Covid-19, admitiu que **a Pasta Federal orientou médicos de todo o país para que adotassem o tratamento precoce** (Folha de S. Paulo, 2021, grifos nossos)

É graças a esses posicionamentos e posturas em defesa do negacionismo científico que se propagaram discursos necropolíticos, quedemonstram dois tipos de práticas imperantes: a) uma gama de medicamentos envolvidos nas reações adversas a medicamentos (RAMs) - prescritas por médicos durante a internação e b) a própria automedicação, haja vista a suposta ineficácia da vacina e do uso de máscaras.

Sobre isso, recorremos a dados divulgados pela Organização Mundial da Saúde (OMS, 1998), segundo a qual *a automedicação* consiste na seleção e o uso de medicamentos (incluindo chás e produtos tradicionais) por pessoas para o tratamento de doenças autodiagnosticadas ou sintomas. A automedicação, desse modo, fenômeno bastante discutido na cultura médico-farmacêutica, pode

[1] Disponível em: https://www.uol.com.br/vivabem/noticias/rfi/2020/06/24/infectologista-frances-diz-que-vacina-contra-a-covid-19-e-improvavel.htm Acesso em: 12.09.2021.
[2] Disponível em: https://www.nytimes.com/interactive/2020/health/sinovac-covid-19-vaccine.html Acesso em: 12.08.2021.
[3] Disponível em: https://brasil.elpais.com/brasil/2021-01-07/coronavac-atinge-78-de-eficacia-em-testes-no-brasil-segundo-o-governo-de-sao-paulo.html Acesso em 10.09.2021.

[4] Ainda de acordo com a Folha de S. Paulo (2021), Mayra, também conhecida como capitã cloroquina, apresentou versões divergentes em relação às apresentadas pelo ex-ministro da saúde Eduardo Pazuello.

ser compreendida como um elemento do autocuidado, no entanto, quando inadequada, tais como o uso abusivo de medicamentos pode ter como consequências o uso irracional de medicamentos efeitos indesejáveis (MALIK, 2020; QUISPE-CAÑARI et al., 2021), além do mascaramento de doenças evolutivas.

Pensar, então, na automedicação da população e nos discursos que fortalecem essa prática no Brasil é reconhecer que, desde o pós-eleições presidenciais de 2018, houve vários pronunciamentos pessoais e institucionais que influenciaram grande parte das pessoas a se automedicarem com o chamado Kit Covid, como uma forma de negar e deslegitimar a soberania da ciência. De acordo com Melo et al., (2021),

> Durante a pandemia de COVID-19, o padrão de consumo de medicamentos no Brasil chamou a atenção. Estava no centro dessa questão o denominado "tratamento precoce" ou "kit-covid": uma combinação de medicamentos sem evidências científicas conclusivas para o uso com essa finalidade, que inclui a hidroxicloroquina ou cloroquina, associada à azitromicina, à ivermectina e à nitazoxanida, além dos suplementos de zinco e das vitaminas C e D. A prescrição e o uso desses medicamentos *off label* para tratar ou prevenir a COVID-19 recebeu contornos de grande credibilidade, quando o "tratamento precoce" e o "kit-covid" foram divulgados e o seu uso incentivado amplamente nas mídias sociais (WhatsApp, Facebook e Instagram).

Os pesquisadores ainda mencionam que a divulgação midiática do kit covid para que as pessoas se automedicassem se deu por profissionais médicos (HOSPITAIS BRASIL, 2021; BATISTA, 2021), por autoridades públicas e também por meio de posicionamentos oficiais do Ministério da Saúde e Governo Federal (BRASIL, 2021), inclusive por meio do aplicativo Trate Cov (G1 GLOBO, 2021).

Com isso, reafirmamos que a automedicação aumentou drasticamente no contexto pandêmico que assolou o Brasil em 2020 e 2021, problema imputado aos consumidores desses medicamentos e no *specificum* de nosso estudo, portadores de síndromes neuropsicológicas. Apesar da existência de múltiplos condicionantes e muitos outros atores envolvidos promovendo a prática de uma automedicação estimulada pela mídia e autoridades (MELO et al., 2021), as consequências no Brasil têm sido erosivas, pois a população se vê em meio a medo e incertezas. Tais consequências são foco da nossa discussão na próxima seção.

III. CONSEQUÊNCIAS DA AUTOMEDICAÇÃO: UMA REVISÃO INTEGRATIVA

A automedicação, numa ótica generalista, é provocada por alguns aspectos que potencializam esta iniciativa. Estes aspectos, seguindo os parâmetros do estudo de Maier et. al (2015) aponta que em primeiro caso, o primeiro motivo que motiva as atitudes é o estresse frequente e de longo prazo. O segundo motivo que ressalta sobre a pesquisa do autor supracitado são os estressores ocasionados por trabalho e estudos e por último, pessoas já mentalmente afetadas por síndromes, uso de drogas e outros fatores.

Kamimura et. al (2012) apontou que o número de idosos portadores de demência ocasionada por doenças neurodegenerativas aumentará até o ano de 2030, principalmente, provocadas pelo Alzheimer.

Doenças que afetam a cognição constituem fatores potencializadorestanto para abandono do planto terapêutico singular quanto para o uso de medicações não prescritas. Kamimura et. al (2012), ressalta a escassez de estudos que abordam esta temática e esta realidade notamos no desenvolvimento da nossa pesquisa. Além de reiterar a relevância da temática, o autor traz também a proposta para o desenvolvimento de estratégias para adaptação adequada entre o paciente e o tratamento.

Segundo Maier et. al (2018), o uso das medicações é para o tratamento de problemas psicológicos e indução do sono, porém, quando é utilizado por caminhos que perpassam as prescrições médicas, não fica evidente o seu tempo de tratamento. O uso dessas substâncias de maneira indevida ou descontrolada, podem apresentar disparidade e dificultar os diagnósticos pelos profissionais da saúde.

Podemos citar alguns exemplos de substâncias, sendo elas:

> [...] beta-bloqueadores e substâncias psicoativas com geralmente efeitos sedativos, como álcool, cannabis e benzodiazepínicos também são usados para aprimoramento cognitivo direto ou indireto, para reduzir nervosismo e ansiedade do teste antes de exames ou apresentações também como aumentar o relaxamento depois da escola ou do trabalho para ter um melhor desempenho na próxima dia. (MAIER et. al, 2018)

Algumas dessas substâncias, também são utilizadas como estimulantes e aprimoramentos dos quadros cognitivos, no entanto há que manter vigilância e cuidado, pois o paciente pode apresentar alguns efeitos adversos, como por exemplo, flutuação do nível de

consciência. É nesta perspectiva que apontamos no nosso estudo a necessidade para o uso consciente de determinados fármacos com o acompanhamento do médico assistente.

IV. CONCLUSÕES

Ao longo desse estudo foi possível verificar alguns dos diversos discursos que fundamentaram e influenciaram a prática da automedicação no Brasil. Dito de outra forma, nossa proposta foi concretizada, na medida em quese analisou como os discursos em torno do kit covid influenciaram a população em geral a se automedicar. Foi possível, ainda, realizar uma revisão integrativa das consequências da automedicação.

Consideramos que a pesquisa atingiu o objetivo de identificar as consequências da automedicação através da literatura analisada. Averiguou-se que os posicionamentos e posturas em defesa do negacionismo científico que se propagaram discursos necropolíticosdemonstram dois tipos de práticas imperantes: a) uma gama de medicamentos envolvidos nas reações adversas a medicamentos (RAMs) - prescritas por médicos durante a internação e b) a própria automedicação, haja vista a suposta ineficácia da vacina e do uso de máscaras.

Assim, diante da escassez de estudos publicados nesta temática, ressaltamos a necessidade de explorar assuntos relacionados à automedicação no Brasil, visto o seu percentual no cenário brasileiro. Reiteramos, desse modo, a necessidade da criação de estratégias para reduzir as práticas citadas sabendo da complexidade das possíveis consequências da automedicação na saúde da população.

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Analytical Formulation of Breaker Equations

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Abstract— *In this study, equations to calculate breaker height, breaker length, and breaker depth were formulated. The analytical formulations were based on the velocity potential of the solution of the Laplace equation. The substitution of velocity potential to weighted kinematic free surface boundary condition yielded equation for wave amplitude function. The dispersion equation was obtained by substituting the velocity potential and wave amplitude function into the weighted momentum Euler equation. The relation between breaker height and breaker wavenumber is extracted from the wave amplitude function. The breaker wavenumber equation was obtained by substituting this relation into the dispersion equation. Furthermore, the breaker depth equation obtained was put to the wavenumber conservation equation with the variables of breaker height and breaker wavenumber. The breaker wave amplitude equation, the breaker wavenumber equation, and the breaker depth equation are simple equations that are very easy to use.*

I. INTRODUCTION

There are quite a lot of empirically formulated equations to calculate the water wave characteristics at the point breaking wave. These equations are called the breaker index. There arebreaker height index to calculate breaker height,breaker depth index to calculate breaker depth with an input of breaker height, andbreaker length index to calculate breaker length with the inputs of breaker height and breaker depth.

Some researchers who put forward equation for the breaker height index include Le Mehaut and Koh (1967), Komar and Gaughan (1972), Sunamura and Horikawa (1974), Singamsetti and Wind (1980), Ogawa and Sutto (1984), Larson and Kraus (1989a), Smith and Kraus (1990), Gourlay (1992), and Pittikon and Shibayama (2000).

Meanwhile, studies dealing with breaker depth index are conducted by Mc Cowan (1984), Galvin (1969), Collins and Weir (1969), Goda (1970), Weggel (1972), Sunamura (1980), Singamsetti and Wind (1980), Seyama and Kimura (1988), Larson and Kraus (1989b), Smith and Kraus (1990).

In terms of breaker length index, researchers proposing the studies include Miche (1944), Battjes and Jansen (1978), Ostendorf and Madsen (1979), Battjes and Stive (1985), Kamphuis (1991), Rattanapitikon and Shibayama (2000) and Rattanapitikon et al. (2003).

This study formulated equations for water wave characteristics at the point breaking wave based on hydrodynamic equations including the equations for breaker height, breaker length, and breaker depth. Using this method, a relationship among the three is elaborated.

In this research, the wave amplitude function was formulated using the weighted kinematic free surface boundary condition and the weighted Euler's momentum equation. Hence,there is a weighting coefficient in the equations of breaker wavenumber, breaker depth, and shoaling in the dispersion equation. The weighting coefficient is obtained by calibrating the critical wave steepness with the critical wave steepness criteria from Michell (1893), where the critical wave height used is the maximum wave height from Wiegell (1949; 1964). In addition to calibrating the critical wave steepness, the weighting coefficient is also obtained by calibrating the breaker height with the breaker height from the breaker

height index equation. The breaker depth obtained is also calibrated to the breaker depth from the breaker depth index.

The breaker length generated from the breaker length index equations has a very wide spread and is much different from the critical wave steepness either from Michell (1893) or Toffoli et al (2010). Therefore, breaker length calibration was not carried out in this study. Only comparisons between the breaker length model and the breaker length from the Miche's (1944) breaker formula were made.

II. VELOCITY POTENTIAL

The complete velocity potential obtained from the solution of the Laplace equation with the separation variable method (Dean, 1991) is:

$$\phi(x,z,t) = G(\cos kx + sin\, kx)coshk(h+z)\, sin\, \sigma\, t$$

.....(1)

k is the wavenumber, in general, k and G are wave constants,σ is the angular frequency, $x$is the horizontal axis at the still water levels, while z is the vertical axis, where $z = 0$at the still water levels.

In this equation, there are two components of velocity potential. They are the$\cos kx$ and $\sin kx$components. The constants G and $k$must have the same value on the two components of velocity potential. Therefore, the two constants are determined at a value of $kx$where the two sinusoidal functions are the same. The point is called the characteristic point. The characteristic point on the horizontal $x$axis is the point where the value of $\cos kx$ is equal to the value of $\sin kx$. Likewise, the wave amplitude which is also a wave constant is determined at the characteristic point.

At this characteristic point, analysis can be done using only one component of the velocity potential, which in this study is the $\cos kx$.

$$\Phi(x,z,t) = G\, cos\, kx\, coshk(h+z)\, sin\, \sigma\, t$$....(2)

The use of one component implies that the value of G in (2) is the sum of the components $\cos kx$ and $\sin kx$, or that G in (2) has double values.

The water particle velocity in the horizontal x direction is,

$$u(x,z,t) = -\frac{\partial \phi}{\partial x} = Gk\, sin\, kx\, coshk(h+z)\, sin\, \sigma\, t$$

...(3)

The water particle velocity in the vertical z direction is,

$$w(x,z,t) = -\frac{\partial \phi}{\partial z} = -Gk\, cos\, kx\, sinhk(h+z)\, sin\, \sigma\, t$$

...(4)

In the velocity potential equation, there are two conservation equations (Hutahaean, 2021), which are the energy-conservation equation and the wavenumber conservation equation.

a. Energy Conservation Equation

$$G\frac{\partial k}{\partial x} + 2k\frac{\partial G}{\partial x} = 0 \qquad .....(5)$$

b. Wavenumber Conservation Equation

$$\frac{\partial k\left(h+\frac{A}{2}\right)}{\partial x} = 0.....(6)$$

In which$A$is the wave amplitude.

III. WAVE AMPLITUDE FUNCTION

The wave amplitude function was formulated using the Weighted Kinematic Free Surface Boundary Condition (KFSBC) from Hutahaean (2021):

$$\gamma\frac{\partial \eta}{\partial t} = w_\eta - u_\eta\frac{\partial \eta}{\partial x}\ldots(7)$$

γ is the weighted coefficient that is positive and greater than 1, $\eta = \eta(x,t)$ is the water wave surface elevation equation, w_η is the particle velocity in the vertical direction on the water surface, while u_η is the water particle velocity in the horizontal-x direction. . Substitutions (3) and (4) on (7),

$$\gamma\frac{\partial \eta}{\partial t} = -Gk\, cos\, kx\, sinhk(h+\eta)\, sin\, \sigma\, t$$
$$-Gk\, sin\, kx\, coshk(h+\eta)\, sin\, \sigma\, t\frac{\partial \eta}{\partial x}$$

For$\cos kx \neq 0$,

$$\gamma\frac{\partial \eta}{\partial t} = -Gkcoshk(h+\eta)\left(tanhk(h+\eta) + \frac{sin\, kx}{cos\, kx}\frac{\partial \eta}{\partial x}\right)$$

$\cos kx\, sin\, \sigma\, t$

For a periodic function,

$$Gkcoshk(h+\eta)\left(tanhk(h+\eta) + \frac{sin\, kx}{cos\, kx}\frac{\partial \eta}{\partial x}\right) = constant$$

This equation is a wave constant, whose value is calculated at the characteristic point, the point where $\cos kx = \sin kx$,

$$\gamma\frac{\partial \eta}{\partial t} = -Gkcoshk(h+\eta)\left(tanhk(h+\eta) + \frac{\partial \eta}{\partial x}\right)\cos kx\, sin\, \sigma\, t$$

This equation is integrated to time-t,

$$\eta(x,t) = \frac{Gk}{\gamma\sigma} coshk(h+\eta)\left(tanhk(h+\eta) + \frac{\partial\eta}{\partial x}\right)\cos kx\cos\sigma t$$

The wave amplitude function defined is,

$$A = \frac{Gk}{\gamma\sigma} coshk(h+\eta)\left(tanhk(h+\eta) + \frac{\partial\eta}{\partial x}\right)$$

Given that G is doubled, the right-hand side must be divided by 2,

$$A = \frac{Gk}{2\gamma\sigma} coshk(h+\eta)\left(tanhk(h+\eta) + \frac{\partial\eta}{\partial x}\right)$$

The water level equation becomes,

$$\eta(x,t) = A\cos kx\cos\sigma t \quad .....(8)$$

The wave amplitude, which is also a wave constant, must be constant and have the same value as the $cos\,\sigma\,t$ and $sin\,\sigma\,t$functions. Thus, the value of the wave amplitude is determined at the characteristic points x and t where, $\cos kx = \sin kx$ and $\cos\sigma t = \sin\sigma t$.

At this characteristic point,

$\eta = \frac{A}{2}$and$\frac{\partial\eta}{\partial x} = -\frac{kA}{2}$

The equation for the wave amplitude function becomes,

$$A = \frac{Gk}{2\gamma\sigma} coshk\left(h+\frac{A}{2}\right)\left(tanhk\left(h+\frac{A}{2}\right) - \frac{kA}{2}\right)$$

Given that the wave amplitude A is constant, thus:

$$tanhk\left(h+\frac{A}{2}\right) = constant$$

and

$$coshk\left(h+\frac{A}{2}\right) = constant$$

Thus,

$$k\left(h+\frac{A}{2}\right) = constant$$

Defined as,

$$k\left(h+\tfrac{A}{2}\right) = \theta\pi ...(9)$$

$\theta$is a coefficient whose value will be determined by calibrating the breaker depth to the breaker depth from the breaker depth index. It is defined as:

$c_h = \tanh\theta\pi ...(10)$

$\beta = \cosh\theta\pi$ dan $\beta_1 = \sinh\theta\pi ....(11)$

Wave amplitude function becomes,

$$A == \frac{\beta Gk}{2\gamma\sigma}\left(c_h - \frac{kA}{2}\right).....(12)$$

This equation can be written as an equation for G:

$$G = \frac{2\gamma\sigma A}{\beta k\left(c_h - \frac{kA}{2}\right)} ......(13)$$

IV. DISPERSION EQUATION

The dispersion equation is formulated using the weighted Euler surface momentum equation (Hutahaean, 2021):

$$\gamma^2\frac{\partial u_\eta}{\partial t} + +\frac{1}{2}\frac{\partial}{\partial x}\left(\gamma u_\eta u_\eta + w_\eta w_\eta\right) = -g\frac{\partial\eta}{\partial x} ....(14)$$

Substituting u from (3) and w from (4), η of (8) with A from (12), and the obtained equation is worked out at the characteristic point.

$$\gamma^2\sigma + (\gamma\beta - \beta_1 c_h)\frac{1}{2}Gk^2 = \frac{gk}{2\gamma\sigma}\left(c_h - \frac{kA}{2}\right)$$

Then, G is substituted by (13) and the equation is multiplied by$\left(c_h - \frac{kA}{2}\right)$,

$$\gamma^2\sigma\left(c_h - \frac{kA}{2}\right) + (\gamma - c_h^2)\gamma\sigma kA = \frac{gk}{2\gamma\sigma}\left(c_h - \frac{kA}{2}\right)^2 ....(15)$$

This equation is a dispersion equation, with the wave amplitude A as the variable whose value is known.

To get the appropriate γ weighted coefficient, Michell's (1893) critical wave steepness criteria are used:

$\frac{H}{L} = 0.142$ ……(16)

The wave amplitude at (15), the maximum wave height at a wave period of Wiegel (1949; 1964) is used:

$H = \frac{gT^2}{15.6^2}$ …….(17)

Assuming a sinusoidal wave, then $A = \frac{H}{2}$. In (17), g is the gravitation (m/sec^2), T wave period (sec). The results of calculations with the value of the weighting coefficient $\gamma = 1.211$ and $\theta = 0.625$ are presented in Table (1), with a critical wave steepness referring to Michell's (1893) criteria.

Table.1: Wavelength and Critical Wave Steepness in Deep Water.

T (sec)	H_0 (m)	L_0 (m)	$\frac{H_0}{L_0}$
6	1.451	10.222	0.142
7	1.975	13.913	0.142
8	2.58	18.172	0.142
9	3.265	22.999	0.142
10	4.031	28.393	0.142
11	4.878	34.356	0.142
12	5.805	40.887	0.142
13	6.812	47.985	0.142
14	7.901	55.651	0.142
15	9.07	63.885	0.142

The wavelength in (15) is the wavelength at deep water h_0 which can be calculated by (9) as follows,

$h_0 = \frac{\theta\pi}{k_0} - \frac{A_0}{2}$.....(18)

Table.2: Deep water depth h_0 and $\frac{h_0}{L_0}$

T (sec)	H_0 (m)	h_0 (m)	$\frac{h_0}{L_0}$
6	1.451	2.831	0.277
7	1.975	3.854	0.277
8	2.58	5.034	0.277
9	3.265	6.371	0.277
10	4.031	7.865	0.277
11	4.878	9.517	0.277
12	5.805	11.326	0.277
13	6.812	13.292	0.277
14	7.901	15.416	0.277
15	9.07	17.697	0.277

A_0 was obtained from (17) while k_0 was obtained from (15). The value of deep water depth for each wave period is calculated by (18), where k_0 is calculated by (15) using the weighting coefficient $\gamma = 1.211$ and $\theta = 0.625$ as depicted in Table (2).

Deep water depth $h_0$in (18) and in Table 2, only shows the water depth limits where the wavenumber or wavelength at water depth greater than $h_0$is a constant value. The wavenumber is affected by water depth at a water depth of less than h_0.

The value of $\frac{h_0}{L_0} = 0.277$, half of the criteria of the Shore Protection Manual (1984) which uses $\frac{h_0}{L_0} = 0.5$.

V. BREAKER HEIGHT, $\frac{H_b}{L_b}$ EQUATION

$\frac{H_b}{L_b}$Equation was formulated using the wave amplitude function (12). The equation is differentiated on the x-horizontal axis for sloping bottom,

$$\frac{\partial A}{\partial x} = \frac{\beta}{2\gamma\sigma}\frac{\partial Gk}{\partial x}\left(c_h - \frac{kA}{2}\right) - \frac{\beta Gk}{4\gamma\sigma}\frac{\partial kA}{\partial x}$$

$\frac{\partial Gk}{\partial x}$was substitude by (5) and$\frac{\partial kA}{\partial x}$elaborated,

$$\frac{\partial A}{\partial x} = \frac{\beta}{2\gamma\sigma}\frac{G}{2}\frac{\partial k}{\partial x}\left(c_h - \frac{kA}{2}\right) - \frac{\beta Gk}{4\gamma\sigma}\left(k\frac{\partial A}{\partial x} + A\frac{\partial k}{\partial x}\right)$$

Breaking occurs in condition$\frac{\partial A}{\partial x} = 0$

$$0 = \frac{\beta}{4\gamma\sigma}G\frac{\partial k}{\partial x}\left(c_h - \frac{kA}{2}\right) - \frac{\beta Gk}{4\gamma\sigma}\left(A\frac{\partial k}{\partial x}\right)$$

The relation between wavenumber and wave amplitude at the breaker point is obtained,

$k_b A_b = \frac{2}{3}c_h$ .....(19)

Or,

$$\frac{H_b}{L_b} = \frac{2}{3\pi}c_h$$

If maximum$c_h$is used,where$c_h = 1$, therefore:

$$\frac{H_b}{L_b} = 0.212$$

It was discovered that$\frac{H_b}{L_b}$is a constant value that applies to all wave periods. (19) is substituted into (15) to get the breaker wave number equation,

$k_b = \frac{3}{g c_h}\gamma^2\sigma^2(2\gamma - c_h^2)$...(20)

In this equation, there is no variable of breaker height H_b or breaker amplitude A_b but the formulation used the relation $\frac{H_b}{L_b}$. Thus, it can be said that in (20), there is an effect of breaker wave amplitude, or there is an interaction between breaker wavenumber and breaker amplitude.

The breaker depth equation can be obtained by using the wavenumber conservation equation, which is,

$$k_b\left(h_b + \frac{A_b}{2}\right) = k_0\left(h_0 + \frac{A_0}{2}\right) = \theta\pi$$

So,

$$k_b\left(h_b + \frac{A_b}{2}\right) = \theta\pi$$

Or,

$h_b = \frac{\theta\pi}{k_b} - \frac{A_b}{2}$ ……(21)

From (19), (20), and (21), it can be said that in the breaking equation obtained there is an interaction among breaker characteristics.

VI. DETERMINATION OF THE VALUES OF γ AND θ

To get the weighting coefficientγ and deep water depth coefficientθ, the breaker height model is calibrated to the breaker height from the breaker height index (BHI) and the breaker depth model is calibrated to the breaker depth from the breaker depth index.

Breaker height comparison used was the mean value of the breaker height of five BHI (Gourlay, 1992; Komar&Gaughan,1972; Kraus, 1989; Smith & Kraus, 1990; Pitikon&Shibayama, 2000). Meanwhile, the breaker

depth is compared with the breaker depth from SPM (1984).

Komar and Gaughan (1972)

$$\frac{H_b}{H_0} = 0.56\left(\frac{H_0}{L_0}\right)^{-\frac{1}{5}} \quad \text{.....(22)}$$

Larson and Kraus (1989),

$$\frac{H_b}{H_0} = 0.53\left(\frac{H_0}{L_0}\right)^{-0.24} \quad \text{.....(23)}$$

Smith and Kraus (1990),

$$\frac{H_b}{H_0} = (0.34 + 2.74m)\left(\frac{H_0}{L_0}\right)^{-0.30+0.88m} \quad \text{.....(24)}$$

Gourlay (1992),

$$\frac{H_b}{H_0} = 0.478\left(\frac{H_0}{L_0}\right)^{-0.28} \quad \text{.....(25)}$$

Pitikon and Shibayama (2000) :

$$\frac{H_b}{H_0} = (10.02m^3 - 7.46m^2 + 1.32m + 0.55)\left(\frac{H_0}{L_0}\right)^{-\frac{1}{5}}$$

.....(26)

$H_0$is deep-water wave height, L_0 is deep water wavelength (calculated using linear wave theory, $k_0 = \frac{\sigma^2}{g}, L_0 = \frac{2\pi}{k_0}$, m is bottom slope and H_b is breaker height.

Equation for breaker depth index from SPM (1984) is:

$$\frac{h_b}{H_b} = \frac{1}{b-\left(\frac{aH_b}{gT^2}\right)} \text{or} h_b = \frac{H_b}{b-\left(\frac{aH_b}{gT^2}\right)} \quad \text{.....(27)}$$

$$a = 43.75(1 - e^{-19.0m}) b = \frac{1.56}{1 + e^{-19.5m}}$$

h_b is breaker depth.

For the deep-water wave height H_0 for the calculation input with BHI, the maximum breaker height (17) is used. In Tables (3) and (4), the results of calculations and comparisons between the results of the model and the results of BHI are presented, where the model used were$\gamma = 1.201$and $\theta = 0.623$.

Table.3: The Comparison ofBreaker Height H_bModel andH_b BHI.

T (sec)	H_0 (m)	H_b (m)	
		Model	BHI
6	1.451	1.721	1.721
7	1.975	2.343	2.343
8	2.58	3.06	3.06
9	3.265	3.872	3.873
10	4.031	4.781	4.781
11	4.878	5.785	5.785
12	5.805	6.884	6.885
13	6.812	8.079	8.08
14	7.901	9.37	9.371
15	9.07	10.757	10.757

In Table (4), the breaker depth index of $\frac{H_b}{h_b}$ model is compatible with $\frac{H_b}{h_b}$ of SPM, and also in accordance with Mc Cowan's equation (1894):

$$\frac{H_b}{h_b} = 0.78 \text{ .....(28)}$$

Table.4: The Comparison of breaker depth h_bModel andh_b SPM.

T (sec)	h_b (m)		$\frac{H_b}{h_b}$	
	Model	SPM	model	SPM
6	2.199	2.207	0.783	0.78
7	2.993	3.003	0.783	0.78
8	3.909	3.923	0.783	0.78
9	4.948	4.965	0.783	0.78
10	6.108	6.129	0.783	0.78
11	7.391	7.417	0.783	0.78
12	8.796	8.826	0.783	0.78
13	10.323	10.359	0.783	0.78
14	11.972	12.014	0.783	0.78
15	13.743	13.791	0.783	0.78

There is a relatively small difference in the value of γ. In deep water, the value of $\gamma = 1.211$ is obtained by calibrating to Michell's (1893) criteria. While the value of $\gamma = 1.201$is obtained the calibration of breaker height and breaker depth. However, this difference is also caused by the conditions of the Michell's criteria (1893) and the conditions of the breaker height index. If Michell's criteria are considered more accurate, $\gamma = 1.211$can be used, while if the breaker height index is more accurate, $\gamma = 1.201$ can be used. However, with this relatively small difference, the mean value of the two can be used, which slightly increasing the Michell's criteria and lowering the breaker height.

VII. THE COMPARISON OF BREAKER LENGTH

There are a number of breaker length indexes which have almost the same basic form. They are:

a. Miche (1944)

$$\frac{H_b}{L_b} = 0.142 \tanh\left(\frac{2\pi h_b}{L_b}\right) \quad \text{.....(29)}$$

b. Battjes and Jansen (19878)

$$\frac{H_b}{L_b} = 0.142 \tanh\left(\frac{0.8}{0.88}\frac{2\pi h_b}{L_b}\right) \text{.....(30)}$$

c. Battjes and Stive (1985)

$$\frac{H_b}{L_b} = 0.14 \tanh\left(\left(0.5 + 0.4 \tanh 33\frac{H_0}{L_0}\right)\frac{2\pi h_b}{0.88 L_b}\right)$$

.....(31)

d. Kamphuis (1991)

$$\frac{H_b}{L_b} = 0.127\ exp(4m) \tanh\left(\frac{2\pi h_b}{L_b}\right) \text{.....(32)}$$

e. Rattanapitikon and Shibayama (2000)

$$\frac{H_b}{L_b} = 0.14 \tanh\left((-11.21\ m^2 + 5.01\ m + 0.91\ )\frac{2\pi h_b}{L_b}\right)$$

.....(33)

In the Breaker Length Index equations, m is the bottom slope. In (31), H_0 is the deep-water wave height. While L_0 is the deep-water wave length of the linear wave theory dispersion equation of $k = \frac{\sigma^2}{g}$.

The breaker height H_b was calculated using the Breaker Height Index. The breaker depth is obtained using (28). With the input breaker height H_b and breaker depth h_b, the breaker length can be calculated by (29) – (33).

Table.5: Breaker Length Index value $\frac{H_b}{L_b}$ from (29)-(30)

T	$\frac{H_b}{L_b}$				
(sec)	(29)	(30)	(31)	(32)	(33)
6	0.083	0.038	0.087	0.03	0.036
7	0.083	0.038	0.087	0.03	0.036
8	0.083	0.038	0.087	0.03	0.036
9	0.083	0.038	0.087	0.03	0.036
10	0.083	0.038	0.087	0.03	0.036
11	0.083	0.038	0.087	0.03	0.036
12	0.083	0.038	0.087	0.03	0.036
13	0.083	0.038	0.087	0.03	0.036
14	0.083	0.038	0.087	0.03	0.036
15	0.083	0.038	0.087	0.03	0.036

The results of the calculation of $\frac{H_b}{L_b}$ with a number of breaker length index equations vary in value, with a very widespread. In addition, it is also much different from the critical wave steepness criteria both from Michell (1893) and Toffoli et al. (2010) where the criteria of Toffoli et al. (2010):

$$\frac{H_b}{L_b} = 0.170 \text{.....(34)}$$

Therefore, the value of the weighting coefficient γ and deep water coefficient θ in this study were adjusted to the breaker height index and breaker depth index only.

Comparison of breaker length model with $\gamma = 1.201$ and $\theta = 0.623$, with breaker length (29), is presented in Table (6). Where the breaker length of the model is much shorter with the breaker length index index$\frac{H_b}{L_b}$also much bigger.

Table.6: The Comparison ofBreaker Length Model andMiche'sBreaker Length

T	L_b (m)		$\frac{H_b}{L_b}$	
(sec)	model	Miche	model	Miche
6	8.44	20.802	0.204	0.083
7	11.488	28.314	0.204	0.083
8	15.005	36.982	0.204	0.083
9	18.991	46.805	0.204	0.083
10	23.446	57.785	0.204	0.083
11	28.369	69.919	0.204	0.083
12	33.762	83.21	0.204	0.083
13	39.623	97.656	0.204	0.083
14	45.954	113.258	0.204	0.083
15	52.753	130.015	0.204	0.083

The breaker length index of the model is also much greater than the critical wave steepness criteria of Michel (1893) and Toffoli et al. (2010). This is due to the wave energy compression when the waves move from deeper waters to shallower waters making the waves are stronger.

VIII. CONCLUSION

The equations for breaking characteristics in this study were formulated based on hydrodynamic equations, continuity equations, momentum equations, and conservation equations attached to the velocity potential, which were the energy conservation equation and the wavenumber conservation equation. Hence,first, it can be

concluded that the obtained equations satisfy the conservation laws of fluid dynamics.

The equations formulated are in line with the previous researchers in terms of breaker height and breaker depth. Considering that the breaker height is determined by the breaker depth and the breaker depth is determined by the breaker height and breaker length, it can be concluded that the breaker length formulated is appropriate or accurate. Thus, in general, it can be concluded that the breaking equations formulated can provide good information regarding the condition of the breaking wave characteristic.

There are still physical parameters that have not been included as a variable in the breaking equations obtained, which is the bottom slope. The next research is expected to develop a breaking equation involving bottom slope as the variable.

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Conceptual model of IoT architecture for poultry farming

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***Abstract*—** *The data connection between machines and people is one of the pillars of Industry 4.0 and the Internet of Things, boosting productivity in healthcare, manufacturing, logistics and smart cities. However, in the case of agribusiness, projections indicate a lower diffusion of these technologies, mainly due to the difficulty of their access by rural producers, especially in cases of smaller scale production. For rural producers who have access to this type of technology, there may be a difficulty in the usability of existing IoT applications, that is, users in the rural context may not feel familiar with the available graphical interfaces and end up not using the applications. This work aims to propose a data management architecture based on the IoT paradigm for small producers in the poultry sector, presenting a mapping of needs and priorities among stakeholders. As a result, an IoT architecture model in three layers was proposed, being the physical layer, the software layer and the data analytic layer. It is concluded that with the use of this tool, small producers will be able to make better decisions, identify poor performance and act quickly, economically, simply and ergonomically in meeting the requirements of international competitiveness, when compared to other producers in the same region.*

I. INTRODUCTION

Digital transformation is important for the performance of the agribusiness production chain as a whole, however, in Brazil, these evolution of industry 4.0 lead to a process of social selectivity [1]; the growing complexity of rural management, coupled with the difficulty that most small producers have in appropriating adequate technological knowledge, and the condition of implementing a digital architecture in their properties is causing some small rural producers to give up on maintaining themselves in their traditional production activities and migrate to the production of commodities aimed at the foreign market.

Brazil is the third largest poultry producer in the world (10.90% of world production in 2020), behind only China (16.94%) and the United States (17.15%), it is estimated that less than 1% of 180 thousand producers have some kind of automation and real-time control in their aviaries [1][2]. Paraná, the largest poultry producer in Brazil (33.4% of the national total), has about 921 aviaries (6% of the total slaughterhouses) with some type of automation [1].

Technologies used in smart agriculture include low-cost hardware devices, sensors and actuators that, when installed in specific locations, monitor and act in accordance with the objectives defined by the business rule, supporting their decision-making and providing greater efficiency in management [2]. However, there are still barriers in the implementation of IoT systems aimed at rural activities, whether due to the costs of implementation and maintenance or the lack of local infrastructure such as, for example, internet access, resistance on the part of producers and even difficulties in obtaining of credit lines

destined for these projects. Another obstacle, which touches the adhesion of technological solutions, is the lack of identification of the user with the existing applications [3][4][5]. What happens is a large number of applications with non-useful or non-intuitive resources, which lead to discouragement [5]. In this context, user experience elements became relevant for the development of applications, understanding their audience and their demands, not only meeting the business rules [6][7].

In this context, this research aims to propose a low cost and open source IoT data management architecture model for small producers in the broiler production chain, considering the user experience and usability aspects.

II. AGRIBUSINESS 4.0

The evolution of agriculture and livestock is closely linked to industrial revolutions. In a historical context prior to the first industrial revolution, all rural work needed the support offered by animals for the strength and traction of implements such as the plow. Around the 18th century, with the first industrial revolution in progress, it was possible to give more flexibility to some manual and craft tasks with the use of steam engines [8].

Only in the 19th century, with the second industrial revolution, it was possible to mechanize agricultural activity by replacing animal-drawn machines with combustion engines. It is noteworthy that fertilizer and crop protection biotechnologies and their spraying methods could also be boosted [9][10]. The 20th century witnessed the third industrial revolution, accompanied by information and communication technologies, with software capable of optimizing field management and allowing more accurate measurements of productivity, in addition to process automation [10][11], also known as agriculture of precision. Precision agriculture is the predecessor of digital agriculture (Agriculture 4.0) and is mainly characterized by the use of machines and technologies.

This new agriculture, until then, was characterized by making available a series of resources that involved biotechnology, corrective fertilization, pesticides, management techniques, GPS and increasingly modern and automated agricultural machines [8]. In summary, it is possible for the farmer to control the harvest through information and treat each area as unique, recognizing the differences in each region. The fourth industrial revolution [9] was also characterized by hyperconnectivity between those involved in the real-time agribusiness production chain, known as Agribusiness 4.0; this new scenario makes it possible to be present in the field without the need for an on-site worker, thanks to the intelligent automation of rural data collection and monitoring.

Pragmatically, “agriculture 4.0 is a set of innovations aimed at advanced technology, which aims to improve, optimize and monetize productivity in the field” [10]. The demand for optimization in the use of natural resources and inputs made farms migrate from agriculture 3.0 to agriculture 4.0, that is, it began to be monitored and massively automated. One of the first adaptations is the dissemination of sensors dispersed throughout the property and interconnected to the Internet, generating data in large volumes that need to be stored, processed, analyzed and made available for decision-making in rural areas [11].

III. POULTRY FARMING

Activities related to the process of production and marketing of agro-industrial products are named according to the perspective used. The term production chain or agro-industrial production chain defines activities based on a particular final product [12]. Among the various activities in poultry production, the highlight is the fattening of poultry for slaughter, especially broilers; therefore, this research includes the chicken production chain that falls under the poultry category, which also includes the production of fertilizers, eggs and other chickens [12][13]. The historical panorama of the broiler production chain begins in the mid-1950s, when poultry farming was basically a subsistence activity. Poultry farmers and agribusinesses started the integration process, which sought to improve the process from breeding to slaughter [12][14]. With this, agribusiness was able to schedule its annual production, obtain greater use of facilities and reduce costs [13][14].

Later, in the 70s, the agricultural sector underwent a process of modernization introduced in the technical bases of production and production processes. During this period, the poultry agroindustry stood out as a modern segment, which invested in the activity and established partnerships with foreign genetic improvement companies [12].

However, it was from the 1990s that the chicken meat production chain gained greater visibility in the Brazilian and world agribusiness scenario, thanks to the diversity of technological resources and effective management [14]. In the 2000s, the strong growth of Brazilian production was noticeable due to the improvement of processes and the sanitary quality of the herds and also to the significant improvement in the income of the Brazilian population, which brought a significant growth in domestic consumption [13][14] and led to the conquest of the foreign market.

IV. INTERNET OF THINGS

The concept of the Internet of Things is related to a physical entity of individual interest (thing) - an object such as a bicycle, an industrial machine, an air conditioner in a room, security cameras triggered by motion detection, lamps with control of lighting, etc. [15]. Depending on the nature of the "thing" (device), different technologies are used to connect them to the internet, such as identification devices (RFID, tags or barcodes), monitoring devices such as sensors (temperature and other sensors, cameras in vehicles, door locks or window openings) and actuators. According to [15][16][17], the IoT consists of a global network of billions of uniquely identifiable (and addressable) objects, embedded with sensors, actuators and controllers) and these are wirelessly connected to the Internet. The International Telecommunications Union determines the IoT as a dynamic global network infrastructure that can self-configure using interoperable standards and protocols where things (physical and virtual) have identities, attributes and personalities, use intelligent interfaces and can integrate seamlessly with the network [16][17]. IoT technologies are classified into three types: i) Detection and data collection technologies: they are responsible for detecting and collecting information about the physical environment (such as temperature, humidity or light sensors) or about objects (identity, status, energy level). ii) Data communication technologies: configure the way data transmission occurs in a given application. They can be classified into two main categories: wired or wireless. Wired technologies require an adequate physical infrastructure to run cables, which can be expensive and unfeasible in some cases. Wireless technologies require fewer physical hardware connections, making it easier to deploy in hard-to-reach locations or scarce electrical resources. Wireless communication means include wi-fi, Bluetooth and mobile data communication. iii) Data storage and analytics technologies: these encompass IoT applications, data analytics and management, and application platforms. In general, it can be said that IoT applications are running software that coordinates the interaction between people, systems and devices in the context of a certain purpose [15][16][17].

Over the years, several projects related to the Internet of Things (IoT) have specified their own architectural versions, based on the specific requirements that the projects were addressing [18][19][20]. Depending on the project scope or problem domain to be addressed, architectures were focusing on different aspects or on a subdomain of the IoT without a consolidated and always adaptable architecture [21]. According to [22], due to a great heterogeneity of application domains and, consequently, of requirements, the approaches to specify the architecture differed among the projects, resulting in more or less different architectures, composed of a series of components and protocols. Also, according to the author, this resulted in limited interoperability between systems, which also hampered discussions between domains. A survey by [23] indicated that the opinion of the IoT community is that IoT reference models are needed and the main goals of a common model are to enable interoperability between solutions, promote common understanding of IoT and facilitate integration with other systems. The most important components of an IoT reference model are terminology, interface, interaction model, standards, communication model and information security models.

V. USER EXPERIENCE

The concept of User eXperience (UX) can be commonly understood as subjective and context-dependent [24][25], UX is defined as "The perceptions and responses of a person that result from the use of a product, system or service". With the development of new technologies, users not only seek to perform a task, but also to have fun [26].

Usability from an interface design point of view is not enough to define the quality of a software and obtain user acceptance [25]. The product can be useful in technical matters, but unpleasant and not acceptable by most users [26]. It is in this context that UX and usability fit, covering details about the interactions between users and the product, from the perception of how the product works and whether their goals, needs and expectations are met in any context in which they use the product [27]. According to [25], UX is focused on meeting human needs beyond the instrumental, that is, beyond task-oriented aspects, to enrich product quality and create a holistic interaction [28][29]. Garrett's method for designing digital products that enhance the user experience requires elements that must be taken into account.

In the site objectives and user needs layer are business goals, creative goals, or other goals that originate internally for the site, along with the strategy of meeting the user's needs. The second layer: content requirements and functional specifications, requires the definition of the content elements needed by the website to meet the user's needs, as well as the detailed set of functionalities that the application must contain to meet the users' needs [28]. Information design is the presentation of information to facilitate understanding. Information architecture, on the other hand, refers to the structure of information on the screen to facilitate intuitive access to content. The information design refers to how the information will behave on the screen in order to facilitate the user's

understanding, in this element are the navigation design: interface elements to facilitate the user's movement through the information architecture [29]. The interface design aims to facilitate user interaction with system functionalities. Finally, visual design refers to the visual treatment of text, GUI elements and navigation components [27][28].

VI. METHODOLOGY

The research is exploratory and qualitative in nature, and the procedures to meet the research objective are described below: Data collection through interviews with stakeholders in the poultry production chain. The data analysis step used the "Needs Matrix" to rank stakeholder needs and priorities for an efficient IoT architecture. Finally, the conceptual model of the proposal is presented, meeting the requirements identified in the interviews and contemplating the technologies for the development of IoT applications.

VII. MAPPING PRIORITIES AND NEEDS

The information was collected through interviews with four poultry farmers, a poultry slaughtering agroindustry manager, a cooperative coordinator and a municipal server from the Agriculture and Environment department, totaling seven respondents. As for the issues of the relationship between producers and agribusiness, respondents mention that they receive advice from agricultural technicians, veterinarians and zoo technicians with information about birds, diseases, feed, animal welfare and other technical information on production [13].

Respondents mention that the partnership with agribusiness, also known as integration, takes place through the provision of services, agribusinesses provide chickens with up to three days of life to poultry farmers, who provide their labor and physical space (farm) for the carrying out the growth and fattening work. The complete cycle takes 45 to 50 days. For remuneration, the elements listed by respondents were: mortality rate, feed conversion rate, occurrence of diseases and inspection after slaughter, which calculates the average size and weight of chickens per batch [15]. Thus, the remuneration for the producer, in this partnership, depends on the good management of the aviary [13] [14].

These elements of remuneration are directly related to practical issues of production and management, being the greatest opportunity for the implementation of IoT devices, since the growth and fattening phases of the chickens are the most relevant for increasing the productivity and profitability of the producer [10][12][15][16].

To identify technological gaps, the researcher addressed the questions about which information technologies have access. Immediately, respondents responded that they have an application developed by the cooperative to request feed and other inputs for production; through the application it is possible to estimate the cost of raw material and check your purchase history; they also have access to the daily quote for chicken, corn and soy through the app and can consult the weather forecast [10][12].

Asked which IoT technologies exist for real-time management of handling processes, the poultry farmers mentioned that they are services offered by outsourced companies, but none of them contracted the services and the mentioned impediment was the high cost of implementation; one respondent mentions that he does not feel the need, as his production is small and his family is able to manage, but he stressed that he is interested in modernizing his farm, thinking of expanding production in the future [11][8]. Although none of the producers interviewed have a system in place, two of them mentioned the name of two companies that provide this type of service and claim to know neighboring producers who contracted this technology.

VIII. IoT CONCEPTUAL PROPOSAL

For the modeling, the layered model was adopted, since for the context of the broiler production chain the layered IoT architecture is appropriate because users already have their financial/accounting control systems, and the purpose of the architecture it is not to overwrite existing systems [16][17], but to include in the production routine another application to support in-situ production control. Furthermore, with the layered architecture, it is possible to update technologies or electronic components from the physical layer, keeping the interfaces (back-end and front-end), as the communication and service modules do not need to be changed. The architecture contains five layers: physical layer, communication layer, collection, treatment and storage layer, services layer, and visual layer. In addition to these five vertical layers, the proposal also includes three horizontal layers parallel to the vertical, namely: data quality, interoperability and security. The objectives and elements present in each layer are discussed below [18].

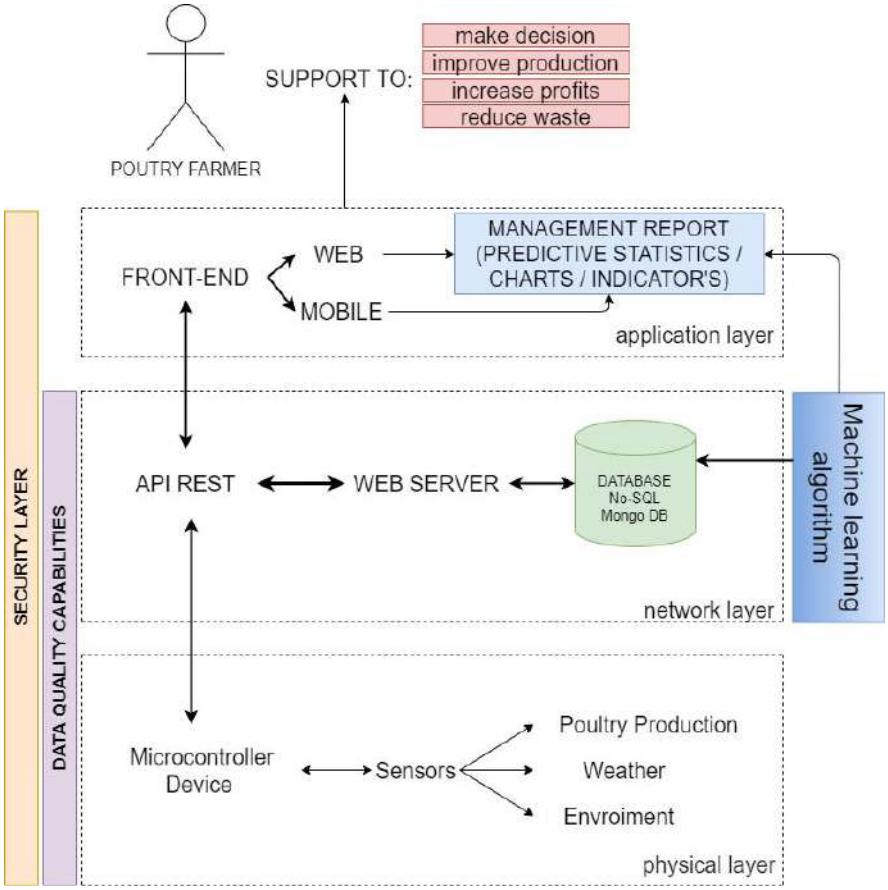

Fig. 1: IoT proposal Architecture

Physical Layer: The physical layer is the first (architectural basis), its objective is the physical presence of the Data Logger on the farm, it is the hardware that provides the data sources (sensors). Through the internet it is possible to establish communication between the physical layer with the others (ensuring the interoperability of the system); the importance of sensor calibration is related to the vertical layer of "Data Quality", that is, that the data is reliable and valid to be persisted, processed and visualized in the following layers; security, on the other hand, concerns the guarantee that the data sent by the microcontroller to the server is not maliciously injected by external sources. Hardware is uniquely identified; given the large number of "things" that can be interconnected, a unique identifier will allow you to track/monitor each item in the physical environment, ensuring accuracy in the management process, preventing a user's hardware from being identified as belonging to another user. Services layer: The services layer is the one that allows users to communicate between the server and the actuators, via WebSockets protocol, the connection between the Data Logger and the Server is established for actions without the need for requests from the client. Visual layer: can be considered the layer closest to the users who make use of the IoT architecture. This layer is responsible for making data and information available to system stakeholders through web and mobile platforms. It is also in the visual layer that the application requests information from data previously stored and processed in the application's routes, in order to provide graphics and indicators of what is happening in real time on the farm. Component responsible for facilitating data visualization and user decision-making: the data analysis module, on the web layer, also provides a control panel using the Shiny library of Software R, with statistical methods that aid in mapping production behavior and also generate forecast of the future behavior of poultry production.

IX. CONCLUSION

This research, which proposes an architecture based on IoT, is able to guide and support the management of small broiler producers, placing them in the context of Agribusiness 4.0, in order to improve their decision-making processes; identifying low performance and acting quickly, cheaply, simply and ergonomically, to meet the requirements of international competitiveness compared to large producers in the same region. Although there are

other architectures that use the IoT paradigm in the context of agribusiness, at the end of the development of this thesis, the objective is to contribute with the presentation of a scalable architecture that encompasses security, quality and data interoperability issues in an integrated manner. Furthermore, using the "Needs Matrix" tool, the methodological procedures used allow a thorough investigation of the needs and priorities of stakeholders in the chicken production chain to model the application that covers the user experience.

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Management of outsourcing and its relationship with hotels' performance: An empirical analysis of selected hotels in Erbil

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***Abstract*—** *The purpose of this study was to improve our understanding of accounting in the context of outsourcing management. Hotel outsourcing management issues have received some attention in professional-oriented periodicals (for example, Hotel and Motel Management, Lodging Hospitality), and some interest has been expressed by hospitality researchers (Hameed & Anwar, 2018). According to Anwar & Balcioglu, (2016), the importance of service industries is increasing, with the hotel and tourist sectors, in particular, being identified as interesting areas for future investigation. The purpose of this research is to examine the factors affecting hotel performance in Kurdistan and particularly in Erbil. A quantitative method used to analyse the present research. The sampling method used in this study was random sampling technique. The study was carried in Erbil. The researcher distributed 100 questionnaires, only 71 questionnaires were received and being completed properly. The results revealed that there is positive relationship between competition and hotel performance, there is positive relationship between size of hotel and hotel performance, there is positive relationship between level of quality and hotel performance, and finally the value B = .926 which is higher than 0.01, accordingly the result revealed that there is positive relationship between supply & demand factor and hotel performance. In terms of future study, given the wide range of operational tasks carried out in hotels, it would appear that the industry would provide an excellent setting in which to conduct future studies on differences in outsourcing contracts and different organizational structures utilized.*

I. INTRODUCTION

During the last decade, there has been an increased interest in the opportunities afforded by strategic alliances, and outsourcing in particular (Ismael et al. 2021);" "during the last decade, there has been an increased interest in the opportunities afforded by strategic alliances, and outsourcing in particular (Ali et al. 2021); (Gardi, 2021) Outsourcing has a number of significant implications for

management accounting, which are explored in further detail below. In the first place, the fact that cost relativity is a crucial issue in the outsourcing decision emphasizes the potentially significant role that management accounting may play in assisting decisions about whether or not to outsource (Qader et al. 2021). Hamad et al. (2021) points out that the decision to outsource has long-term consequences for the second time, indicating analytical issues that are comparable to those faced in capital budgeting, which is widely regarded as a critical management accounting decision-making sector (Fatah et al. 2021). To add to these pressures, management accounting is increasing its scope in terms of both financial and nonfinancial accountability as a result of the necessity for the establishment of management control systems for subcontracting (Ali & Hamad, 2021).With the execution of a two-phased empirical research strategy, both objectives have been accomplished (Ali & Anwar, 2021). During the first phase of the study, data from qualitative interviews was acquired and evaluated by a team of researchers. The administration of a questionnaire for a survey served as the foundation for the second step (Hamad, 2018). Accounting engagement in hotel outsourcing decision-making refers to the degree to which the accounting department participates and contributes to the decision-making process when deciding whether or not to outsource certain activities or complete functions to a third party (Anwar & Shukur,2015). It appears to be a structure that should be taken into account, especially in light of the increasing relevance of hotel outsourcing in the recent years (Hamza et al. 2021). Considering accounting's involvement in outsourcing appears to be a logical corollary to considering accounting sophistication in outsourcing decision-making, which can be seen as building on an established contingency research tradition of determining factors relating to facets of accounting sophistication in outsourcing decision-making (Sabir et al. 2021), which can be seen as building on an established contingency research tradition of determining factors relating to facets of accounting sophistication in outsourcing decision-making (Aziz et al. 2021). It was motivated by a number of characteristics that suggested that outsourcing was particularly significant in the hotel business that it was decided to concentrate the study on this area. In the first place (Sorguli et al. 2021), it appears that there is a large need for hotel managers who want to avoid being sidetracked from their core tasks (Ahmed et al. 2021) and (Anwar & Abdullah, 2021) define formalized formalized One distinguishing characteristic of the field of hotel management is the complexity that arises from the wide range of diverse activities carried out (for example, rooms, food and beverage, laundry, and so on) in a building where the provision of services coincides with the consumption of services by customers. Abdullah & Anwar, (2021) expresses concern about hotel managers attempting to "wear too many hats," and problems with failing hotel restaurants are usually attributed to the fact that the fundamental competencies required in hotels and restaurants are distinct (Anwar & Shukur, 2015). It is possible to cope with the problem of cultural diversity through the use of outsourcing. The high degree of labor intensity seen in the hotel business is a second factor contributing to the study's concentration on this sector (Anwar & Abd Zebari, 2015). Taking into account the high likelihood of performance variability, this characteristic implies a conflict between a significant financial incentive to outsource (in order to reduce labor management requirements) and the requirement to monitor subcontracted activity results as a result of the high likelihood of performance variability (Anwar & Surarchith, 2015). Third, the hotel industry is characterized by significant swings in sales volume and profitability. Anwar, (2017) found many features of hotel sales volatility, including economic cycle-induced volatility, seasonal sales volatility, weekly sales volatility, and intra-day sales volatility. Economic cycle-induced volatility is the most common kind of volatility (Anwar & Louis, 2017). When dealing with variable jobs, it is possible to reduce volatility by outsourcing them to specialized providers who, as a result of their size, are better equipped to deal with the ensuing volatility (Anwar, 2015). Hotel outsourcing management issues have received some attention in professional-oriented periodicals (for example, Hotel and Motel Management, Lodging Hospitality), and some interest has been expressed by hospitality researchers (Hameed & Anwar, 2018). According to Anwar & Balcioglu, (2016), the importance of service industries is increasing, with the hotel and tourist sectors, in particular, being identified as interesting areas for future investigation. In the next sections, you will find an outline for the remainder of the paper: a As a result of previous study, the next section creates a theoretical framework for the analysis by developing hypotheses regarding the factors that impact accounting's competence and participation in decision-making with relation to outsourced operations management (Anwar, 2016). Following that, the specific research approach that was employed is detailed in further depth (Anwar, 2017). A brief discussion of the study's findings is followed by a conclusion that considers the study's implications and limitations, as well as suggested areas for additional inquiry (Anwar & Ghafoor, 2017).

II. LITERARY CONTEXT OF STUDY AND PROPOSITION DEVELOPMENT

There have been evidence of an increasing research interest in management accounting for outsourcing, which is encouraging (Anwar & Qadir, 2017). Anwar & Climis, (2017) write in their evaluation of the achievements of the accounting literature on interfirm transactional interactions that "much remains to be researched and analyzed." They go on to say that "much remains to be explored and examined" (Anwar & Louis, 2017). The study presented above is notable for its major attention on the outsourcing decision-making process, as opposed to performance and control concerns, which distinguishes it from other similar studies (Anwar, 2015). The formulation of four sets of propositions pertaining to variables impacting accounting's participation and sophistication with regard to outsourcing decision-making is the subject of the next portion of the study (Ismael et al. 2021).

2.1. Competition

On a variety of parameters such as brand image, market sector, and pricing, hotels are subjected to extremely different degrees of competitive intensity (Ali et al. 2021). It is clear that hotel rivalry is endemic when it is recognized that every hotel has a different location, which has implications for the degree to which it has competing hotels in close physical proximity to one other (Gardi, 2021). According to Hamza et al. (2021), it is critical to create accounting systems that are suited for certain competitive settings. Several empirical studies, such as those cited by Qader et al. (2021), indicate a positive link between the intensity of competition and the adoption of formal controls (Hamad et al. 2021) and advanced accounting processes (Fatah et al. 2021). In addition, Ali & Hamad, (2021) discovered a positive link between the level of competition and the use of customer accounting software. All of these findings indicate to increased competition intensity as a means of encouraging more sophisticated accounting systems (Hamad, 2018).

2.2. Size

The size of a company was one of the earliest contingent variables investigated by accounting academics (Sabir et al. 2021). The research demonstrates a pretty strong consensus that the size of a company is positively related to accounting competence (Aziz et al. 2021). An argument in favor of this is that larger companies can spread the expense of more complex accounting systems across a broader client base that generates income (Sorguli et al. 2021). In addition, larger organizations tend to be more complicated and/or tougher to manage, necessitating the use of more sophisticated accounting systems to keep up with the demands of the business (Ahmed et al. 2021). In light of this logic and past study findings, it is predicted that the size of a company would be favorably connected to the engagement and complexity of the accounting department in the decision-making process about outsourcing (Anwar & Abdullah, 2021).

2.3. Quality level of hotel

According to the information gathered through interviews in the study, quality is a significant cultural component that permeates a hotel's management philosophy and approach to operations. The significance of the hotel star rating system serves to underline this point even more (Abdullah & Anwar, 2021). The use of a star rating system indicates that hotels have been independently branded in terms of their overall excellence (Anwar & Shukur, 2015). The expectation is that higher-quality hotels will have more complex management systems to support their higher-quality service delivery (Anwar & Abd Zebari, 2015). This is a given based on previous experience. It is possible that outsourcing operations in a labor-intensive business such as the hotel sector may result in a loss of control over the overall quality of service delivery (Anwar & Surarchith, 2015). It is possible that such a loss will have particularly negative consequences for a hotel's image and star rating (Anwar, 2017). High star rating hotels are expected to place greater emphasis on the maintenance of a high level of service quality Anwar & Louis, 2017). As a result, high star rating hotels will implement relatively sophisticated systems to assist in the decision-making process and to control the level of service provided by subcontractors (Anwar, 2015).

2.4. Professional qualification

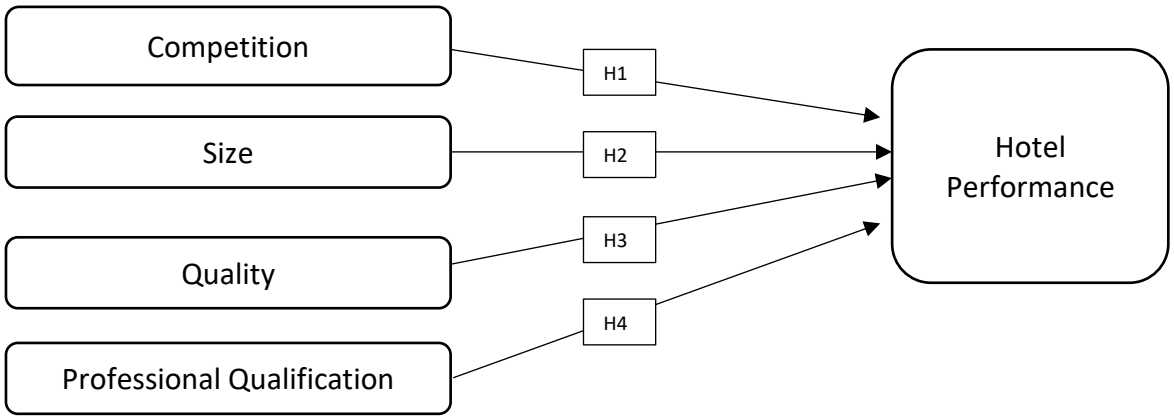
Many hotel financial controllers do not hold a professional accounting qualification, according to the results of the interviews that were performed (Hameed & Anwar, 2018). Burgesss's remark is corroborated by the evidence (Abdullah et al. 2017). This draws attention to a significant differentiating feature of accounting practice in the hospitality industry and emphasizes the relevance of this variable as a variable worthy of investigation in the current study. Hotels that place a higher value on the accounting function might be expected to have a better chance of having a financial controller who is professionally prepared (Anwar & Balcioglu, 2016). Because financial controllers may be anticipated to have a significant role in determining the sophistication of their accounting systems (Anwar, 2016), it is probable that the hiring of a professionally trained financial controller is positively associated to the sophistication of a hotel's accounting system (Anwar, 2017). Aside from that, it is believed that professional training would elevate the status of a financial controller inside a hotel, increasing the probability that he will be involved in important organizational decisions such as the choice to outsource (Anwar & Ghafoor, 2017). A study

conducted by Anwar & Qadir, (2017) examined the capital budgeting implications of hotels when the hotel owner is a separate legal entity from the hotel operator. If this unique element of hotel operating structures is taken into consideration, it appears that it might have potentially substantial implications for hotel management systems (Anwar & Climis, 2017). Because numerous respondents expressed the opinion that operators must give more thorough decision analysis while operating under a management contract with an owner, the inclusion of this component as a control variable was especially justified (Anwar & Louis, 2017). As Ismael et al. (2021) points out, performance has been assessed considerably more thoroughly as a dependant variable in accounting research than it has been appraised as an independent variable. This makes the observation made by Ali et al. (2021) all the more significant: "Effectiveness can be regarded an independent variable" (Gardi, 2021). In reaction to poor (or high) efficacy, for example, certain restrictions or a specific approach may be implemented." (Qader et al. 2021) In accordance with the logic of Hamad et al. (2021) and Fatah et al. (2021), the conclusion reached in this paper is that performance has the potential to impact the type of accounting systems used in conjunction with decision-making on outsourcing services (Ali & Hamad, 2021). Management in high-performing hotels may be more sensitive to the possibility of damage to the hotel's image as a consequence of ill-advised outsourcing of essential activities, which might explain the difference (Hamad, 2018). As a result, managers at high-performing hotels may be more likely than others to do lengthy and formalized assessments before deciding whether or not to outsource. Given this logic, the performance of the system has been designated as a control variable (Ali & Anwar, 2021). Hotels that adopt a longer-term, strategic approach to outsourcing may have more refined procedures in place to support their long-term goals in the area of outsourcing (Anwar & Shukur,2015). According to the findings of the interviews, many hotels outsourced on an ad hoc basis, typically in response to a specific event, whilst others executed their outsourcing decisions within the context of a long-term strategic plan (Hamza et al. 2021). This element has also been taken into consideration since a long-term strategic outsourcing goal may offer the environment for more extensive outsourcing studies to be undertaken in the future (Sabir et al. 2021). Aziz et al. (2021) offer an excellent overview of the significant amount of attention that has been paid to strategy as an antecedent variable impacting the design of management control systems in the past few decades. Sorguli et al. (2021), Ahmed et al. (2021), Anwar & Abdullah, (2021), and Abdullah & Anwar, (2021) are examples of empirical accounting research that has studied the role of strategy (Anwar & Shukur, 2015). The findings of research evaluating the link between strategy and management control system design, on the other hand, are rather ambiguous (Anwar & Abd Zebari, 2015). The widely acknowledged importance of strategy as an organizational variable, as well as the high level of interest that has been shown in it as a potential determinant of accounting system design, has motivated its inclusion in this study as a control variable as a result of its widespread recognition (Anwar & Surarchith, 2015). It is intuitively tempting to imply that hotels that outsource more frequently would have more established systems to assist outsourcing management, and this is supported by research. The greater the degree of outsourcing, the greater the requirement for an adequate accounting system to assist decision-making on outsourcing activities. When a hotel outsources a major portion of its operations, the risk of mistake associated with using an inadequate management system is greater and more costly to the organization. As a result of this justification, the control variable "degree of outsourcing" was included in the study (Ismael et al. 2021).

III. METHODOLOGY

The purpose of this research is to examine the factors affecting hotel performance in Kurdistan and particularly in Erbil. A quantitative method used to analyse the present research. The questionnaire consisted of two units, the first unit comprised of participants' demographic questions (respondent's age and respondents' gender. The second part of questionnaire consisted of 8 questions for competition, 9 questions for size of hotel, 10 questions for level of quality,8 questions for professional qualification, and 12 questions for hotel performance. The sampling method used in this study was random sampling technique. The study was carried in Erbil. The researcher distributed 100 questionnaires, only 71 questionnaires were received and being completed properly. The questionnaire was organized in multiple choice questions format. Five point Likret scale used, the participants were asked to range from strongly disagree to strongly agree.

Conceptual framework



Research Hypotheses:

H1: There is a significant and positive relationship between competition and hotel performance.

H2: There is a significant and positive relationship between size of hotel and hotel performance.

H3: There is a significant and positive relationship between level of quality and hotel performance.

H4: There is a significant and positive relationship between professional qualification and hotel performance

Table 1-Reliability tests

Variables	Cronbach's Alpha	Number of items
Competition	.832	8
Size of hotel	.812	9
Level of quality	.799	10
Professional qualification	.911	8
Hotel performance	.809	12

Table 1 shows the reliability analysis for four independent factors and a dependent factor. According to the reliability tests, the researchers found out Cronbach's Alpha for the competition =.832 for eight items, which are greater than .6 this means that competition's eight items were reliable for this study. The Cronbach's Alpha for the size of hotel =.812 for nine items, which are greater than .6 this means that size of hotel's nine items were reliable for this study. The Cronbach's Alpha for the level of quality =.799 for ten items, which are greater than.6 this means that level of quality's ten items were reliable for this study. The Cronbach's Alpha for the professional qualification =.911 for eight items, which are greater than .6 this means that professional qualification's eight items were reliable for this study and finally the Cronbach's Alpha for the hotel performance factor =.809 for twelve items, which are greater than .6 this means that hotel performance factor's twelve items were reliable for this study.

Table 2-Correlation analysis

Item	Pearson correlation	Competition	Size of hotel	Level of quality	Supply & demand
Hotel performance	Pearson correlation	.804**	.796**	.826**	.811**
		.000	.000	.000	.000
		71	71	71	71

** Correlation is significant at the 0.01 level (2-tailed)

Table 2 shows the correlation among four independent factors (competition, size of hotel, level of quality and supply & demand factor) and a dependent factor (hotel performance). The value of R between competition and hotel performance = .804** which indicates that they are significantly correlated. The value of R between size of hotel and hotel performance = .796** which indicates that they are significantly correlated. The value of R between level of quality and hotel performance = .826** which indicates that they are significantly correlated. The value of R between professional qualification and hotel performance = .811** which indicates that they are significantly correlated. The results revealed that overall all variables are significantly correlated with dependent factor.

Regression analysis

The researcher used single regression analysis to analyze the current study. In terms of the first research hypothesis a single regression used (as seen in table 3), with competition as an independent variable and hotel performance as the dependent variable.

Table 3-Coefficients H1

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.811	.211		3.511	.000
Competition	.878	.061	.821	17.612	.000

a. Dependent Variable: hotel performance

Table 3 shows the result of the first research hypothesis, the researcher found that the value B = .878 which is higher than 0.01, accordingly the result revealed that there is positive relationship between competition and hotel performance.

Table 4-Coefficients H2

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.838	.224		3.743	.000
Size of hotel	.862	.054	.826	15.904	.000

a. Dependent Variable: hotel performance

Table 4 shows the result of the second research hypothesis, the researcher found that the value B = .862 which is higher than 0.01, accordingly the result revealed that there is positive relationship between size of hotel and hotel performance.

Table 5-Coefficients H3

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.611	.230		3.142	.000
Level of quality	.632	.056	.589	14.684	.000

a. Dependent Variable: hotel performance

Table 5 shows the result of the third research hypothesis, the researcher found that the value B = .632 which is higher than 0.01, accordingly the result revealed that there is positive relationship between level of quality and hotel performance.

Table 6-Coefficients H4

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.367	.268		3.142	.000
Supply & demand	.926	.065	.896	14.262	.000

a. Dependent Variable: hotel performance

Table 6 shows the result of the fourth research hypothesis, the researcher found that the value B = .926 which is higher than 0.01, accordingly the result revealed that there is positive relationship between supply & demand factor and hotel performance.

IV. CONCLUSION

The purpose of this study was to improve our understanding of accounting in the context of outsourcing management. In terms of the first study goal, both interview and survey data suggest that there is significant cross-hotel variation in the extent to which the accounting function is involved in hotel outsourcing decision-making. Most likely, the high proclivity of hotels to hire financial controllers who do not possess a professional accounting certification serves to worsen the problem (55 percent in this study). The formalisation of outsourcing decision-making procedures is the most important of the six aspects of accounting participation that have been evaluated, while contractor performance monitoring is the least important. This latter observation implies that the operational department that is most directly associated with the function that is being outsourced bears the primary responsibility for evaluating contractor performance. This study might serve as the foundation for further investigation into whether accounting evaluation techniques should be modified when tasks that are being considered for outsourcing are fundamentally different in terms of qualities such as asset specificity or uncertainty. Items having a high degree of asset specificity or uncertainty, according to transaction cost economics (TCE), do not lend themselves to outsourcing due to the possibility of opportunistic behavior and incomplete contracting. TCE has been extensively used in empirical studies pertaining to the choice to outsource a business. Because of the potential problems that may occur if certain high-asset-specific or uncertain tasks are outsourced, it is possible that a more complicated accounting examination may be required in cases where certain activities are being evaluated for outsourcing. Among the study's most significant contributions is the recognition of the consequences associated with failure (i.e., costs incurred when arranging for an activity to be conducted in-house or finding a new supplier, should an outsourcing arrangement fail). There has been no consideration of the costs associated with a failed outsourcing contract in either the theoretical or empirical literatures that I have discovered. The lack of attention paid to failure costs may have led to the reported low ranking of failure costs in comparison to other cost aspects assessed in hotel outsourcing choices, as shown in this study. Another element that is likely to play a role in this low ranking is the uncertainty around the likelihood that these expenditures will be paid. However, the difficulties in estimating failure costs should not obscure the fact that these costs have the potential to be significant. Probabilities might be ascribed to the occurrence of uncertain future cash flows, in a manner similar to the processes that can be performed in the preparation of capital budgets and simulation analysis, in order to enable an estimating exercise for those cash flows. In terms of future study, given the wide range of operational tasks carried out in hotels, it would appear that the industry would provide an excellent setting in which to conduct future studies on differences in outsourcing contracts and different organizational structures utilized.

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The implementation of e-commerce in a medium-sized Brazilian textile company: A case study

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***Abstract*—** *The textile sector is currently the second-largest employer in Brazil, corresponding to 1.5 million direct employees. Due to the high international competition from countries with different production conditions, the Brazilian textile industry has been going through a period of economic difficulty aggravated by the COVID pandemic. Case study and action research were the methodologies applied for this study. We analyzed the impact of one specific enterprise that implemented B2C in the textile sector. We found that changing the indirect sales channel to direct sales using the marketplace proved to be an effective strategy in improving the margins and the sale obtained, thus offering better profitability conditions and an exciting alternative to gain a competitive advantage and improve sales growth.*

I. INTRODUCTION

The textile sector is of high importance in Brazil due to the intensive employment of labor which, in 2018, accounted for 1.5 million direct jobs and 8.0 million indirect ones. Of this number, 75% corresponds to female work. (Associação Brasileira da Indústria Têxtil e Confecção ABIT, 2020) This data source qualify the textile industry as the second largest employer in Brazil, only behind the food and beverage industry, resulting from the low mechanization and reduced use of technological resources throughout the production chain.

Given the context present, one of the strategies used by the textile sector is the reduction of the chain of intermediaries through the implementation of its own stores and e-commerce. According to (BAGATINI & LAIMER, 2019), online establishments grew 17% from 2013/18 annually, and this fact continues to occur during the COVID pandemics, with more intensity.

The present study intends to answer, from the methodology of the Action Research, to the following research question: “What is the effect of implementing online sales channels in a medium-sized company. This study address embroidery and is located in the textile conglomerate in the state of São Paulo, Brazil.

The general objective of this study was to analyze the impacts of direct-selling (B2C) and the changes in the relationship with customers, suppliers, and even in the company's internal management.

Creating value in a COVID context

Creating value is critical for companies to achieve sustainable growth, especially when they are going through an economic crisis and demonstrate slowness in overcoming it. The expansion of technology in the sales process could increase revenue and better relationships with the client. (Seki, O Impacto da Utilização de

Ferramentas Virtuais na Gestão de Pequenos Negócios, 2017)

Electronic commerce or e-commerce can be considered as an extension of traditional trade. It operates in a virtual environment of purchase, sales, exchange of products and services based on the support provided by computer equipment. (Teixeira, 2017) In addition, this form of commerce provides changes in business structures and improvement in processes, reducing costs and creating new opportunities. (ALBERTIN, 1999)

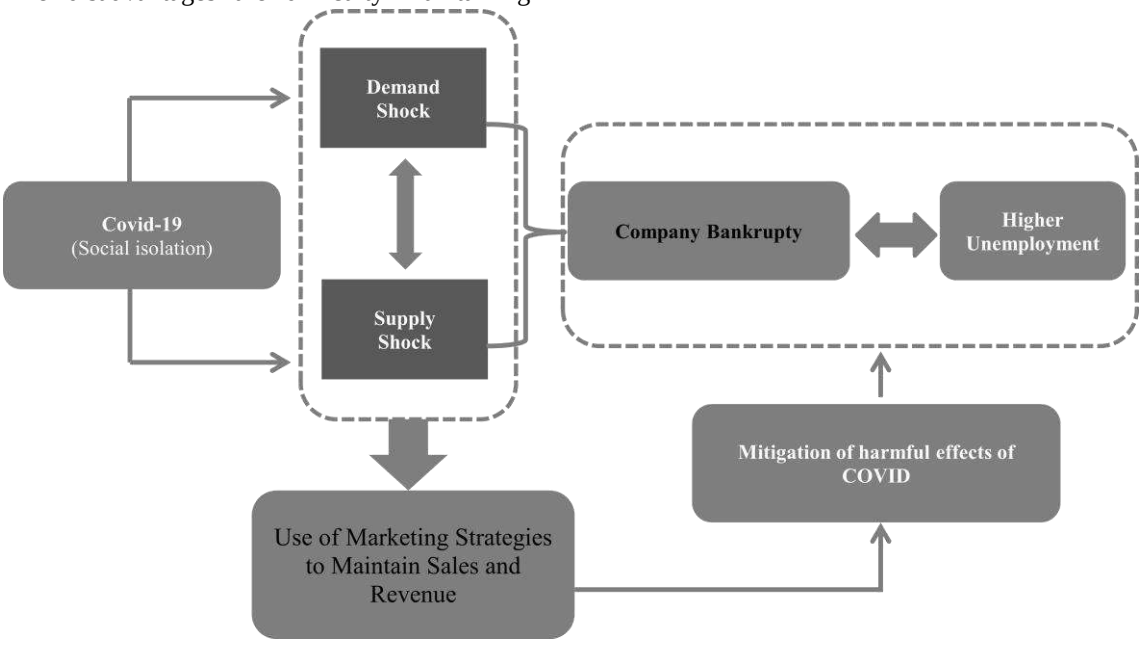
One of the most widespread e-commerce strategies today is the marketplace. According to (Hagiu, 2015), the marketplace is the sales format where the supplier sells directly to the final customer.

Marketplace works with the dynamics of a virtual mall; in this commercialization model, a company acts in creating and managing the platform and allows others to advertise and sell their products through the first. Some companies that execute this strategy in Brazil are B2W (owner of the Submarino, Americanas, and Shoptime brands) and the giant Amazon. The success of this mechanism is known since, in the year 2015, 45% of Amazon.com total sales originated from this strategy. Also, the Chinese JD.com reports annual growth of 40% in its sales through this channel. (Tian L. V., 2018)

Among the advantages of using the marketplace are greater brand awareness; reduced costs due to no need to invest in information technology (IT) in the creation and maintenance of a website; access to an expanded consumer market, and control over the definition of the final sales price of the product, allowing the supervision of the price strategy. The disadvantages are difficulty maintaining customers who work in the B2B (business-to-business) format, logistics costs, and changes in the production structure to keep up with a new sales dynamic.

The figure below summarizes some changes that occurred with COVID 19 in the Brazilian economy and its impacts, pointed below:

1) Social isolation creates barriers to the traditional way to trade based on sellers with high social contact, which must be substituted for direct sales using marketplaces or even the company site;
2) Demand shock, in a first moment the disease caused a substantial fall in the consumer demand; at this moment, consumers stopped all the acquisitions of textile products – this phenomenon was more intense in the 1st semester of 2020;
3) Supply shock, this shock occurred in the 2nd semester of 2020 when companies find difficult with their supplies;
4) Company bankruptcy, with these two shocks, many companies suffered bankruptcy during the second semester of 2020;
5) The challenge to companies survival was to develop new marketing strategies to mitigate the harmful effects of COVID ;
6) At the end of the 2021 first quarter year, the Brazilian economy had the highest unemployment rate, 14,6%, with 14,8 million people of formal unemployment . (Silveira & Carvalho, 2021)



Source: Based on (de Rezende, Marcelino, & Miyaji, 2020)

The sales function in the company has been changing due to the evolution of marketing processes and the consumer's purchasing behavior (Castro, 2017). If in the 1960s it represented only a production function, as companies knew that what was produced would be sold, today this function becomes much more complex and requires companies to make and sell what customers want and need. In this context, the concept of Relationship Marketing is highlighted, which seeks to guide strategies towards three pillars: customer orientation, coordination and integration of marketing activities, and focus on creating value for stakeholders. (CLARO, D. P., 2006).

In the Brazilian textile industry, the companies sell their products using resellers. However, with the COVID pandemics, the development of new sales channels was essential for the enterprise's survival and must be incorporated into the company's business strategy. This action played an important role in expanding sales using electronic commerce and social media. This new channel could be considered essential for the company's recovery.

There will be a strategic change when companies sell directly to consumers (B2C). This will imply strategic choices to be conducted. The enterprise needs to create value by dealing directly with consumers' choices and tastes and the new product demands generated by the electronic markets, such as higher price competition.

Table 1 presents some comparisons between these different marketing channels

Business to Business (B2B)	**Business to Consumer (B2C)**
A more intense and lasting relationship	Shorter and less intense relationships
Demand from subsequent customers	Demand-driven by choices, emotions, and tastes
Buyer-seller relationship with more significant predominance and recurrence	Buyer-seller relationship with less recurrence
More specialized customer	Less specialized customer

Source: Based on (Coda & Castro, 2019)

The decision process about which strategy to prioritize or how to work on them simultaneously is essential within a Strategic and one Marketing Plan due to the particularities and distinct target audiences that each platform presents. Therefore, understanding this theme and reorganizing sales processes is a fundamental part of a sustainable transition of the sales model in a company. Still, this transition requires knowledge and interaction with digital channels and modern sales management software.

Use of SaaS tools by Medium and Small Businesses

One of the main barriers to entry into e-commerce is the costs of building, managing, and maintaining an IT infrastructure that demands time from managers in addition to relevant financial investments. Because of this, a viable alternative in adopting these processes is a software as a Service (Saas), that is, the purchase or lease of online modules allocated in the cloud, of online sales and management platforms.

Due to the low need for investment, since these solutions are allocated in the cloud, fixed costs in hardware, software, and IT maintenance are avoided, in addition to the possibility of quick deployment of resources, making SaaS the main alternative to small and medium-sized enterprises (SMES). Therefore, the maxim of cloud computing, use what you need and pay for what you use is valid. However, as a negative aspect of this technology, there is reduced control over the security of customer data since management is not under the company's domain who hires the service. (Mladenow, Fuchs, Dohmen, & Strauss, 2012)

The Brazilian textile industry and the textile cluster in São Paulo

2020 was one of the most challenging for the segment, requiring adaptation of the production structure, sales channels, and the product portfolio, including items such as aprons, masks, coats, and other personal protective equipment. According to Pimentel, president of the Brazilian Textile and Apparel Industry Association, the sector suffered a strong retraction in the first two quarters, showing signs of recovery from the fourth quarter of 2020. (Associação Brasileira da Indústria Têxtil e Confecção ABIT, 2020)

As for the industry's future, the encouragement that developed countries have given to automation, robotization, and intensive use of the internet in production signal the increase in complexity of industry in the coming years. It begins with adopting the principles of industry 4.0 and sustainable growth parity with the Sustainable Development Goals (SDGs) of the Nations Units and with the climate agenda. The textile complex has not escaped this trend, although it is still restricted to a small and specific set of countries with the ability to invest in capital goods.

In the Brazilian textile and clothing industry, the growth of productivity compared with salaries has been considered an obstacle to the development of competitiveness. In the

period 2004/2014, there was an increase in wages not followed by productivity. (Silveira B. F., 2017)

As noticed in sectorial analyses, the observation of the increase in the wage curve concerning the stagnation of productivity (both in value (R$) and in quantity (ton)) shows the low production efficiency. The association of this effect with the performance of the workforce is not correct. The businesses in this sector have difficulties adapting to the new international competition requirements, like more integration between suppliers and industry with new technologies linked to the industry 4.0 movement. (Silveira B. F., 2017)

This fact occurs both in adapting products to these markets and investing in technologies and devices that improve the efficiency of manufacturing, innovation, and sales processes. Some of the solutions that can change this landscape are professionalization of management, investments in information technology, new sales channels, and the modernization of the productivity structure with a view to changes and new Industry 4.0 concepts.

Electronic Commerce and Marketplace

Value creation is critical for companies to achieve sustainable growth, especially when going through a severe economic crisis and demonstrating slowness in overcoming it. The expansion of technology in the process is proven to be a revenue-boosting and better-relationship resource with the client. (Seki, O Impacto da Utilização de Ferramentas Virtuais na Gestão de Pequenos Negócios, 2017)

E-commerce can be considered as an extension of traditional commerce by operating in a virtual environment of buying, selling, exchanging products and services based on the support provided by computer equipment. (Teixeira T. , 2017). In addition, this form of commerce provides changes in business structures and improvements in processes, resulting in cost reduction and new opportunities. (ALBERTIN, 1999)

The marketplace is one of the most widespread e-commerce strategies and the marketplace is the sales format where the supplier sells to the end customer . (HAGIU & WRIGHT, 2015)

Still, for (WANG & ARCHER, 2007), electronic marketplaces are where buyers and sellers conduct transactions through electronic means. Acting as a virtual mall, a company operates in creating and managing the platform and allows others to advertise and sell their products first.

Among the large companies that use the marketplace in Brazil are B2W, which owns the Submarino, Americanas, Shoptime brands, and the American Amazon. The success of this mechanism is known since, in 2015, 45% of total Amazon.com sales used this strategy. Chinese company JD.com reported 40% annual sales growth using this method. (Tian L. V., 2018)

II. MATERIALS AND METHOD

One company located in a textile cluster in São Paulo State, Brazil, was analyzed. The investigations adopted action research because one author actively participated in the company decisions during the period. Additionally, to collect more information, interviews were conducted with the leading directors of the company.

The city where the case occurred is located in a textile cluster in São Paulo state.

Embroidery emerged in the city in the late 1940s as an alternative to agricultural crises and unemployment. In the beginning, it had an extremely artisanal character and adopted intensive employment of female labor. Since 1974, when occurred the first exposition of the town textile products, small enterprises gained proportion, invested in new machinery, and in the "brand" of the municipality allowed, in 2003, in a context of available state financing lines that provided investments and expansions, the most remarkable increase experienced in this segment in Ibitinga. (FLORIAN & DE LORENZO, 2008)

The action research methodology refers to initiatives that seek to improve practice from the oscillation between acting in the practical field and the systematic study of its variables. This analysis method follows the logic of planning an action, implementing it, describing and monitoring the results, and, finally, evaluating its strengths and weaknesses. From this dynamic, it is possible to propose conclusions based on evidence and not just on the individual's subjectivity. (Tripp, 2005)

The data collection occurred from March 2020 until April 2021. This period to collect the data was critical because it portrays the period of maximum pandemic restrictions until Brazil's economic flexibility measures were adopted in 2021 (when the vaccination against COVID starts to get more regular between the population).

III. RESULTS

The company's sales process adopted two main strategies: indirect sales (B2B) and direct sales using e-commerce (B2C). In the first case, the target audiences are sales representatives and retailers, which concentrate most sales and have priority access to superior quality products and higher added value.

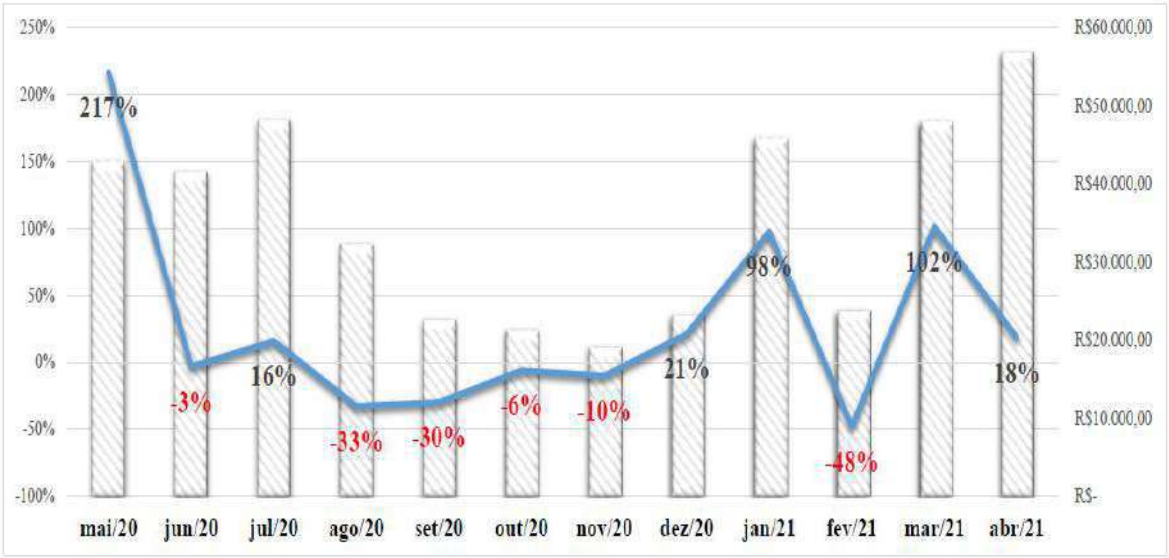
Advertising selected products develop the second sales process on online sales platforms known as marketplaces and on the website company's own. Due to the characteristics of this form of sale, the company prioritizes the advertisement of products with more competitive prices and more significant investment in design.

The shift to online sales resulted from the pandemic and the consequent trade closing as a significant driving factor. Internally, there was a lot of resistance to change the sales model, but with the pandemic lockdown, switching becomes a pivotal point to the enterprise's survival.

The table presents the leading market places company's products and a list of the fee charged individually for the intermediation of the described sales process. Each online sales platform was in descending order of representation in total online sales. In addition, the percentage value that each platform charges on the value of the product sold. Such fees are necessary when pricing, positioning, and evaluating which products will be included in the online sales strategy.

Brazilian Marketplace	**Commission Expenses (%)**
Magazine Luiza	16
Dafiti	17
Olist	19
B2W	16
Madeira Madeira	20
Capital Décor	15

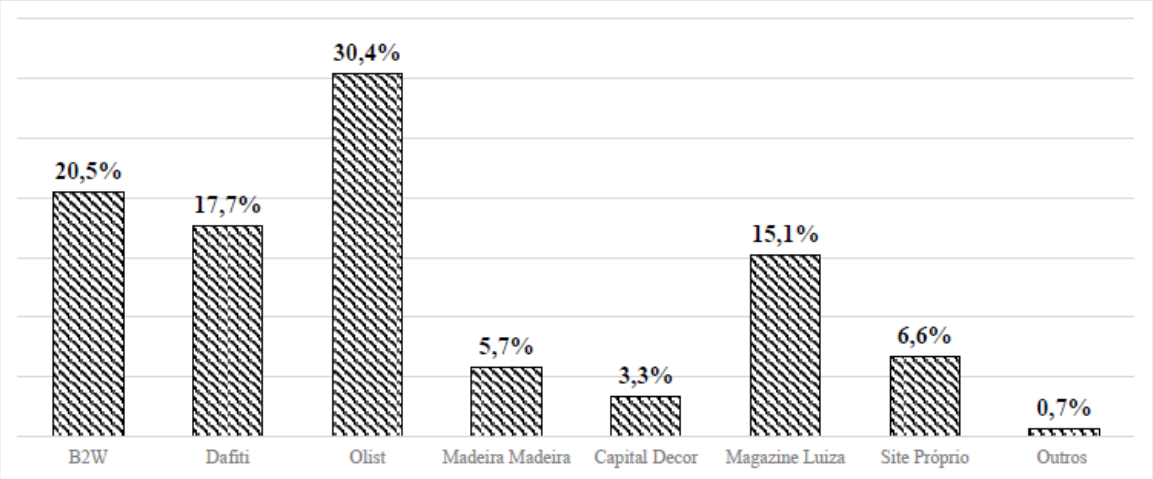
The graph below presents the e-commerce percentual sales evolution during the period analyzed (in local money). In the first six months, we can detect the substantial sales fall resulting from the COVID pandemic. After, we can notice one sales recovery yet with intense fluctuation due to the return of the traditional sales channels.



Fonte: (Casaborda, 2021)

Source: Data obtained with the company

The following figure shows the relative contribution (%) of each marketplace considering physical sales volumes.



Fonte: (Casaborda, 2021)

Source: Data obtained with the company

The marketplace channel added gross margin value to the company products compared with the traditional commercialization process (B2B), and we can notice this in the table below.

Product	**Added Margin (e-commerce)**
Blanket set	38%
Bed covers	26%
Cushion cover	14%
Duvet	40%

Source: Data obtained with the company

We evaluated the company strategy using the two sales channels: marketplace(B2C) and traditional (B2B) distributors. We conducted some interviews with the company directors and constructed one SWOT matrix based on their opinions.

Strengths	**Weakness**
The versatility of sales channels	Few workers dealing with online sales
A good relationship with retailers and distributors	Own site generates small sales
Agility to adapt to the pandemics	Dependence from marketplaces
Opportunities	**Threats**
Consumer expansion with a higher sales coverage	The emergence of conflicts between sales and distributors
Higher sales margins in the marketplace	Higher competition in prices
More contact with clients	The role played by e-commerce in the company strategy

IV. CONCLUSION

We started by asking the effects of implementing online sales channels in a medium-sized company. We can answer that three main domain are impacted : the financial, organizational, and customer relationship impact.

When evaluating the financial aspect, the data demonstrate a favorable and encouraging result of the adoption of e-commerce. During the most challenging times in the economy in 2020 and 2021, online sales revenue grew. In this sense, it is worth highlighting the increase in sales margin obtained with the adoption of the marketplace, which ranged from 14% to 40% among the five best-selling products. This fact demonstrates that e-commerce is a tool to increase sales and is also an opportunity for the company to improve its margins and gain greater profits.

E-commerce also means winning new customers. Finally, online sales promote a reduction in the company's need for cash since it is possible to receive payment for the sale in a shorter period than traditional channels. Thus, from a financial point of view, online sales are an instrument that promotes improvement in sales prices and payment terms.

Analyzing the owners' evaluation is favorable to e-commerce but divided as to its impacts. On the other hand, partners fear the effects that online sales can have on traditional sales channels, especially if there is no careful selection strategy of products. In this way, since there are opportunities to grow with online sales. The company's

partners must discuss the future of its sales and develop a strategic plan that contemplates this new reality, establishing objectives and indicators that can measure their performance.

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Characterization of the Elastic and Mechanical Properties of 1020 Steel with the Ultrasonic Transparency Technique

Caracterização das Propriedades Elásticas e Mecânicas do Aço 1020 com a Técnica Ultrassônica da Transparência

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Abstract *— In certain industrial applications it is important to characterize quickly the elastic and mechanical properties of metals. However, these measurements are usually carried out by means of mechanical tests, which demand time and samples destruction. Ultrasonic testing is a non-destructive and alternative method, which can be used to measure the elastic and mechanical properties of metals with relatively accuracy. In this study, the transmission ultrasonic technique was used to characterize a 1020 carbon steel bar. The results obtained were compared with reference values found in the literature, attesting the feasibility of a fast and low cost method to investigate low carbon steels.*

I. INTRODUÇÃO

Os ensaios não destrutivos (END's), como por exemplo, líquidos penetrantes, partículas magnéticas, gamagrafia e ensaio por ultrassom, são técnicas capazes de inspecionar um material sem a necessidade de destruí-lo ou danificá-lo. Geralmente, os END's são utilizados para verificar a condição de integridade dos materiais por meio da detecção de descontinuidades ou falhas que possam comprometer o funcionamento da peça ou do produto final. Uma vez detectadas, as falhas podem ser caracterizadas em relação à sua localização, tamanho, orientação, forma e natureza [1, 2, 3].

Os END's também podem ser utilizados para a caracterização de materiais, sendo o ensaio por ultrassom uma das técnicas mais conhecidas. Esse tipo de ensaio se destaca pela possibilidade de relacionar as medidas de velocidade de propagação das ondas ultrassônicas com algumas propriedades físicas e mecânicas dos materiais, entre elas, os módulos de elasticidade, cisalhamento e compressibilidade, o coeficiente de Poisson, a impedância acústica, o fator de anisotropia e a dureza [1, 4-7].

Na indústria, medidas de densidade e de velocidades de ondas ultrassônicas de modo longitudinal e transversal, podem ser utilizadas para a estimativa rápida das propriedades elásticas de ligas metálicas. Isto porque os resultados encontrados por meio de um único ensaio não destrutivo são muito próximos daqueles que seriam obtidos com a realização de testes destrutivos convencionais [8-10]. Entretanto, a maioria das empresas ligadas ao setor industrial ainda utilizam ensaios

destrutivos para a caracterização dos seus produtos. Neste caso, com a dificuldade de caracterizar as propriedades mecânicas utilizando um único ensaio, será indispensável a realização de outros ensaios destrutivos, como por exemplo, testes de tração, compressão, cisalhamento, torção e flexão.

Acredita-se que muitas indústrias não utilizem o ensaio por ultrassom para a investigação de materiais pelo completo desconhecimento da técnica e também pelo custo adicional com instrumentação e qualificação de um operador habilitado para o ensaio. Por outro lado, com o avanço do conhecimento na instrumentação eletrônica, dispositivos de baixo custo em relação aos equipamentos industriais e com alto grau de confiabilidade das medidas, podem ser desenvolvidos e aplicados no estudo das propriedades elásticas de materiais metálicos e não metálicos [5, 11, 12].

Entre os métodos ultrassônicos para caracterização e inspeção de materiais metálicos destacam-se os métodos de pulso-eco e da transparência [1, 2, 11]. O método de pulso-eco utiliza um único transdutor, capaz de gerar e receber ondas ultrassônicas através do material. Por outro lado, na técnica da transparência são utilizados dois transdutores separados, posicionados nas faces opostas do material, sendo um deles responsável por gerar e o outro por captar as ondas ultrassônicas [1, 2].

Recentemente, um grupo de pesquisadores do Programa de Pós-Graduação em Modelagem Computacional e Sistemas, da Universidade Estadual de Montes Claros (PPGMCS/UNIMONTES), investigou a possibilidade de caracterização não destrutiva de ligas metálicas com a técnica ultrassônica da transparência. Com o desenvolvimento de um sistema eletrônico simples, de emissão e recepção de sinais ultrassônicos, constatou-se a viabilidade do método com a obtenção de resultados satisfatórios em amostras de alumínio e magnésio, cujos valores foram muito semelhantes àqueles obtidos com ensaios destrutivos convencionais [12]. Entretanto, a viabilidade do método ainda era desconhecida para o estudo de ligas metálicas ferrosas como o aço.

Portanto, com base nos relatos descritos acima, este trabalho buscou caracterizar as propriedades elásticas e mecânicas do aço 1020, utilizando o sistema eletrônico de ultrassom desenvolvido no PPGMCS/UNIMONTES. O aço 1020 foi escolhido por representar uma das ligas mais utilizadas em estruturas metálicas, além de ser um dos principais insumos para a produção de pregos, parafusos, chapas e tubos, sendo suas propriedades elásticas bastantes conhecidas e relatadas na literatura.

II. MATERIAIS E MÉTODOS

2.1 Características e composição química da amostra

Para a realização deste estudo foi adquirida comercialmente uma barra de aço ABNT/SAE 1020, homogênea, na condição normalizada, procedente da empresa Gerdau. A barra de aço 1020 possui dimensões aproximadas de 0,01876 m de diâmetro e 0,20159 m de comprimento. As dimensões da barra foram aferidas com o auxílio de um paquímetro digital com resolução de 0,005 mm. Na Tabela 1 encontra-se a composição química do aço SAE 1020 disponibilizada no catálogo técnico do fornecedor [13].

Tabela. 1: Composição química da barra de aço SAE 1020

Composição química (%)				
Aço	C	Mn	P (máx)	S (máx)
SAE 1020	0,18-0,23	0,30-0,60	0,030	0,050

Fonte: [13]

O volume (V_{barra}) da barra foi calculado a partir do raio (r) e comprimento (c), utilizando a Equação 1:

$$V_{barra} = \pi r^2 c \quad (m^3) \qquad (1)$$

A massa da barra foi aferida utilizando uma balança digital com resolução de 0,01 g. Assim, a densidade (ρ) foi calculada por meio da razão entre a massa (m) e o volume (V_{barra}), de acordo com a Equação 2:

$$\rho = m/V_{barra} \quad (kg/m^3) \qquad (2)$$

A densidade calculada para a barra de aço 1020 foi considerada uniforme, uma vez que a amostra possui inércia constante e distribuição de massa homogênea.

2.2 Cálculo das velocidades ultrassônicas

Para calcular as velocidades das ondas ultrassônicas propagadas através da barra foram medidos os tempos de percurso das ondas longitudinais com um sistema eletrônico de ultrassom. No sistema eletrônico, que consiste no método ultrassônico da transparência, os circuitos emissor e receptor foram alimentados com fontes simétricas de 30 V e 12 V, respectivamente. O circuito emissor produziu pulsos com amplitude de 60 V e duração de 400 ns (nanosegundos), em intervalos de tempo iguais a 5 ms (milissegundos). Esses pulsos foram produzidos com um transdutor piezoelétrico de ondas longitudinais, modelo AW190, com 0,02 m de diâmetro e frequência igual a 2 MHz. Outro transdutor do mesmo modelo foi utilizado para captar o sinal pulsado no circuito receptor.

O sinal captado no circuito receptor foi amplificado com um amplificador operacional, modelo THS4271D, que foi projetado para funcionar a partir de tensões de alimentação entre ± 5 V a ± 15 V. Na Fig. 1 encontra-se uma imagem dos circuitos eletrônicos emissor e receptor dos sinais ultrassônicos utilizados no método da transparência.

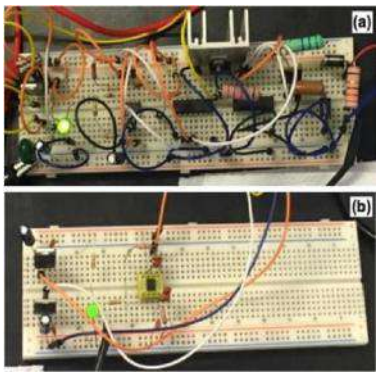

Fig. 1: Circuitos eletrônicos: (a) emissor e (b) receptor de ondas ultrassônicas

É importante ressaltar que o circuito receptor gera na saída um sinal amplificado com ganho pré-definido, diminuindo as interferências que possam prejudicar o processo de medição. Na Fig. 2 estão apresentados os transdutores alinhados nas extremidades da barra de aço 1020. Antes das medidas, as extremidades da barra foram limpas com lã de aço para remover resíduos provenientes de oxidação. O material utilizado como acoplante entre os transdutores e as extremidades da barra foi a vaselina em pasta, com valor de impedância acústica Z_{acop} = 1,5 x 10^6 kg/m^{2}s e densidade ρ_{acop} = 905 kg/m^3.

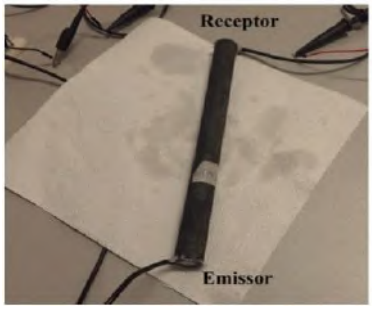

Fig. 2: Posicionamento dos transdutores para emissão e recepção das ondas ultrassônicas

A escolha do acoplante deve considerar o acabamento superficial da amostra, o tipo de material, a forma da peça e a posição em que será realizado o ensaio. Portanto, a vaselina em pasta foi escolhida como acoplante por apresentar boa aderência e viscosidade, que contribuiram para a fixação dos transdutores, uma vez que a barra possuía diâmetro um pouco menor (d_{barra}= 0,01876 m) do que o diâmetro do transdutor ($d_{trans.}$= 0,02 m). Testes preliminares realizados com outros tipos de acoplantes, como a glicerina e o mel de abelha, não foram satisfatórios, tendo em vista a baixa aderência desses acoplantes e as condições do experimento.

As medidas dos sinais fornecidos na saída do circuito receptor foram feitas com um osciloscópio digital, da marca Tektronix, modelo TBS1062. O osciloscópio foi conectado a um computador para exportação dos dados e captura das imagens dos sinais com o programa *OpenChoice Desktop*. A medida de tempo em microssegundos (μs) entre a onda ultrassônica emitida e recebida através da barra foi feita na tela do osciloscópio, como ilustrado na Fig. 3.

Fig. 3: Tempo de percurso da onda ultrassônica através da barra de aço 1020

A distância entre as linhas verticais apresentadas na tela do osciloscópio representa o tempo gasto pela onda ultrassônica para percorrer o comprimento da barra. Desta forma, para a estimativa da velocidade média de propagação da onda longitudinal (V_L) foi utilizada a Equação 3:

$$V_L = c/t \quad \text{(m/s)} \qquad (3)$$

em que:

c = comprimento da amostra (m);

t = tempo (s)

O valor médio de V_L foi calculado a partir de três medidas do tempo de percurso, obtidas com a remoção e o reposicionamento dos transdutores nas extremidades da barra de aço 1020.

Para a maioria dos materiais metálicos a razão entre as velocidades ultrassônicas de modo transversal e longitudinal é de aproximadamente 0,50 [1]. Assim, para estimar o valor da velocidade da onda ultrassônica de modo transversal (V_T) foi utilizada a razão V_T/V_L, obtida a partir dos valores de referências da Tabela 2.

Tabela. 2: Velocidades ultrassônicas no aço 1020

Referência	V_L (m/s)	V_T (m/s)	V_T/V_L
[14]	5890	3240	0,550
[15]	5899	3237	0,549

Portanto, a partir do cálculo da velocidade longitudinal (V_L) foi possível estimar a velocidade da onda ultrassônica transversal (V_T) utilizando a Equação 4:

$$V_T = 0{,}55V_L \ \text{(m/s)} \quad (4)$$

2.3 Estimativa das propriedades elásticas

As propriedades elásticas do aço 1020 foram calculadas a partir do valor da densidade (ρ) e das velocidades ultrassônicas de modo longitudinal (V_L) e transversal (V_T). Na Tabela 3 estão apresentadas algumas relações existentes entre as propriedades elásticas e as velocidades ultrassônicas, tais como, módulo de elasticidade (E), módulo de cisalhamento (G), módulo de compressibilidade (K), coeficiente de Poisson (v), impedância acústica (Z) e fator de anisotropia (r).

Tabela. 3: Propriedades elásticas em função de V_L, V_T e ρ

Relação	Referência	Equação
$G = \rho V_T^2$	[16]	(5)
$v = \frac{(V_L^2 - 2V_T^2)}{2(V_L^2 - V_T^2)}$	[17]	(6)
$E = 2G(1 + v)$	[3]	(7)
$K = \rho(\frac{3V_L^2 - 4V_T^2}{3})$	[17]	(8)
$Z = \rho V_L$	[1]	(9)
$r = 3^{1/2}\left(\frac{\rho V_T^2}{\rho V_L^2}\right)^{1/2}$	[7]	(10)

2.4 Estimativa das propriedades mecânicas com ondas ultrassônicas

O limite de resistência à tração (*LRT*), o limite de escoamento (σ_e), o módulo de resiliência (u_r), a dureza Brinell (*HB*) e a dureza Vickers (*HV*), foram estimadas utilizando as relações matemáticas propostas na Tabela 4.

Tabela. 4: Relações propostas para o cálculo das propriedades mecânicas dos aços

Relação	Referência	Equação
$LRT = -7171{,}1 + 1{,}3V_L$	[10]	(11)
$HV = (LRT - 100)/2{,}5$	[18]	(12)
$\sigma_E = 2{,}736HV - 70{,}5$	[19]	(13)
$HB = LRT/3{,}45$	[3]	(14)
$u_r = \frac{1}{2}\frac{\sigma_E^2}{E}$	[3]	(15)

As Equações 11, 12 e 13 foram obtidas por alguns autores após a investigação de diferentes tipos de aço [10, 18, 19]. Neste caso, o uso dessas equações teve como intuito verificar se as relações propostas para outros tipos de aço podem ser aplicadas na caracterização do aço 1020. Por outro lado, as Equações 14 e 15 representam as relações encontradas por meio de ensaios destrutivos convencionais para a maioria dos aços carbono [3].

2.5 Ensaios de tração e dureza *HB*

Para analisar os valores calculados de *LRT*, *HB* e σ_e, foram realizados ensaios mecânicos convencionas de tração e dureza. O diagrama tensão-deformação e o valor de dureza *HB* foram obtidos em uma máquina acadêmica de ensaios universal, modelo WP 300, que permite a exportação dos dados para representações gráfica.

Para o ensaio de tração foi produzida uma amostra cortada a partir da barra de aço 1020. Esse corpo de prova foi usinado em dimensões aproximadas de 0,05 m de comprimento e 0,006 m de diâmetro. Essas dimensões não consideram as roscas feitas nas extremidades para fixação do corpo de prova na máquina de ensaio de tração.

As medidas de dureza *HB* foram feitas em um corpo de prova na forma de disco, cortado a partir da seção transversal da barra. O corpo de prova possui dimensões de 0,01876 m de diâmetro e 0,01 m de espessura. O valor médio da dureza foi calculado com três medidas realizadas com indentador esférico de aço que possui diâmetro de 0,01 m e carga de 3000 kgf.

III. RESULTADOS E DISCUSSÃO

3.1 Medida da densidade do aço 1020

Na Tabela 5 encontra-se o valor da densidade calculada para a barra de aço 1020 por meio da razão entre a massa e o volume. O valor obtido para a densidade da barra foi o mesmo relatado na literatura para o aço 1020, que é de

7860 kg/m^3 [20]. Entretanto, os valores de densidade do aço 1020 podem variar entre 7840 kg/m^3 e 7870 kg/m^3, sendo esse fato associado a condição de tratamento do aço 1020, que pode ser laminado, recozido ou normalizado [21-23].

Tabela. 5: Densidade calculada para a barra de aço 1020

Volume (10^{-5} m^3)	Massa (kg)	Densidade (kg/m^3)
5,572	0,438	7860,49
Referência: [20]	-	7860

3.2 Valores calculados das velocidades ultrassônicas

Na Tabela 6 estão apresentados os valores calculados das velocidades longitudinal (V_L) e transversal (V_T) para a barra de aço 1020 na condição normalizada. Os resultados de V_L = 5860,7 m/s e V_T = 3223,4 m/s estão próximos dos valores de referência (também apresentados na Tabela 2), sendo constatadas pequenas diferenças inferiores a 0,65% [14, 15]. Entretanto, é importante ressaltar que nos estudos realizados por [14] e [15] a condição de tratamento térmico do aço 1020 não foi informada.

Tabela. 6: Valores de V_L e V_T calculados para o aço 1020

Medida	Tempo (10^{-6} s)	V_L (m/s)	$V_T = 0{,}55V_L$ (m/s)
1	34,80	5792,82	3186,05
2	34,40	5860,17	3223,09
3	34,00	5929,12	3261,02
Média	**34,40**	**5860,70**	**3223,39**
Desvio	**0,33**	**55,65**	**30,60**

$V_L = c/t$, c = comprimento da barra e t = tempo (s)

3.3 Propriedades elásticas para o aço 1020

Na Tabela 7 estão apresentadas as propriedades elásticas calculadas em função de ρ e dos valores médios de V_L e V_T, bem como os valores de referência relatados na literatura e as diferenças percentuais.

Tabela. 7: Valores calculados das propriedades elásticas

Propriedade medida		Valor de referência	Diferença (%)
Tempo (10^{-6} s)	34,40	-	-
ρ (kg/m^3)	7860,49	7860	0,00
Propriedade calculada		**Valor de referência**	**Diferença (%)**
V_L (m/s)	5860,70	5890,00	0,50
V_T (m/s)	3223,39	3240,00	0,51
G (GPa)	81,68	80,00	2,10
E (GPa)	209,62	210,98	0,64
K (GPa)	161,11	138 - 179	0,00
Z ($10^6 kg/m^2.s$)	46,07	45,56	1,12
r	0,95	0,90 - 1,20	0,00
v	0,28	0,28 - 0,30	0,00

O módulo de cisalhamento (G) é um importante parâmetro para a investigação do comportamento elástico do material solicitado mecanicamente pela seção transversal. No aço 1020, o valor do módulo G encontra-se em torno de 80 GPa [24]. Alguns autores demonstraram a utilização de V_L e V_T para determinação do módulo G em diferentes tipos de aço carbono, sendo encontrado um valor médio em torno de 82,10 GPa para o aço 1020 [21]. No presente estudo foi calculado para o aço 1020 um valor de G = 81,68 GPa, sendo esse resultado compatível com os valores de referências.

O valor do módulo de elasticidade (E) permite investigar a relação de proporcionalidade existente entre os valores de tensão e deformação nos materiais submetidos ao ensaio de tração [3]. Para a maioria dos aços com baixo teor de carbono o módulo E está entre 150 e 220 GPa [3, 25]. Outros autores adotam de maneira geral para os aços o valor de E = 200 GPa [26]. Para o aço 1020 investigado com ondas ultrassônicas os valores de E podem variar entre 210 a 212 GPa [21]. No presente estudo, o resultado calculado foi de E = 209,62 GPa.

O módulo de compressibilidade (K) representa a rigidez à deformação volumétrica do material. Dados publicados no Website da mydatabook.org (http://www.mydatabook.org/solid-mechanics/bulk-modulus/) mostraram que o valor do módulo K dos aços pode variar de 138 GPa a 179 GPa, dependendo da condição de processamento e tratamento térmico. Por exemplo, o aço 1020 na condição laminado apresenta um valor de K igual a 140 GPa [24]. No presente estudo encontrou-se para o aço 1020 normalizado o valor de 161,11 GPa, estando este resultado dentro da faixa de valores esperados para os aços carbono, independente da condição de tratamento térmico.

A impedância acústica (Z) representa a oposição à passagem da energia acústica através de um material, sendo esta propriedade calculada pelo produto entre a densidade e a velocidade longitudinal. O valor de Z encontrado para o aço 1020 por meio de medidas ultrassônicas é de aproximadamente 45,56 x 10^6 kg/m^{2}s

[8]. No presente estudo foi obtido um resultado próximo ao valor de referência, em que $Z = 46{,}17 \times 10^6$ kg/m^{2}s.

Para materiais perfeitamente isotrópicos admite-se que o valor do fator de anisotropia (r) é igual a 1 [27]. O valor de $r = 1$ também é adotado para os aços normalizados, mesmo conhecendo as dificuldades de se produzir um aço perfeitamente isotrópico. Entretanto, para projetos de engenharia onde se deseja determinar com precisão o valor de anisotropia, pode-se encontrar valores de r que variam entre 0,9 e 1,2 para aços de alta resistência e baixo teor de carbono [28]. Assim, o resultado encontrado de $r = 0{,}95$ sugere que o aço 1020 normalizado se apresenta como um material de tendências isotrópicas, estando de acordo com o esperado para um aço com baixo teor de carbono.

O coeficiente de Poisson (v) representa a razão entre as deformações transversal e longitudinal. Para a maioria dos aços o coeficiente de Poisson assume o valor de $v = 0{,}30$ [26]. Entretanto, dependendo da temperatura ambiente o coeficiente de Poisson pode variar entre 0,28 a 0,29 [29]. Logo, o valor de $v = 0{,}28$ calculado para o aço 1020 está de acordo com o esperado.

3.4 Propriedades mecânicas para o aço 1020

A partir da Equação 11 para aços ASTM A36, tentou-se estimar o *LRT* do aço 1020 com o valor médio calculado de V_L. O resultado encontrado de *LRT* = 447,81 MPa foi próximo do valor de referência (*LRT* = 440 MPa) apresentado no catálogo técnico do fornecedor da barra de aço 1020 [13]. O resultado também concorda o valor de *LRT* = 440,85 MPa obtido no ensaio de tração. Logo, a Equação 11, que utiliza o valor de V_L para calcular o *LRT* dos aços ASTM A36, pode ser utilizada para a estimativa do *LRT* do aço 1020 normalizado.

Para investigar a dureza do aço 1020 foi utilizada a Equação 12, a qual foi obtida depois de verificar em perfis de aços as relações existentes entre *LRT* e *HV* [18]. Neste caso, utilizando o valor de *LRT* = 447,81 MPa encontrou-se uma dureza de 139,12 *HV*. Sabe-se que os valores de dureza *HV* e *HB* podem ser facilmente relacionados, podendo ainda os valores de dureza na faixa entre 100 e 1000 *HV* assumirem valores idênticos aos de dureza *HB* [30]. Logo, a dureza calculada para o aço 1020 pode assumir o valor de 139,12 *HB*, sendo o valor de referência no catálogo da barra igual a 131 *HB* [13]. O valor obtido com o ensaio de dureza foi de 127 *HB*. Portanto, o valor medido se aproximou mais do valor de referência, quando comparado com o valor calculado com a Equação 12. Utilizando o valor *LRT* = 447,81 MPa na Equação 14, encontra-se uma dureza de 129,80 *HB*. Esse resultado também é mais próximo do valor medido do que aquele calculado com a Equação 12.

Utilizando a Equação 13 para o cálculo da tensão de escoamento (σ_e) encontrou-se um valor de σ_e = 284,63 MPa, para uma dureza de 129,80 *HB*. O valor de σ_e aumenta para 310,13 MPa, quando se admite uma dureza de 139,12 *HB*. Com o ensaio de tração foi obtido um resultado de σ_e = 304,26 MPa, concordando com os valores calculados e com o valor de σ_e = 300 MPa observado no aço 1020 normalizado [31]

Para o cálculo do módulo de resiliência (u_r) foram utilizados na Equação 15 os valores de σ_e = 284,63 MPa e E = 209,62 GPa. O resultado de u_r = 0,193 N.mm/mm^3 corresponde ao esperado para os aços com baixo teor de carbono, cujo valor de referência é de 0,182 N.mm/mm^3 [3]. Admitindo que o valor de σ_e = 310,13 MPa seja utilizado na Equação 15, o resultado de u_r aumenta de 0,193 para 0,229 N.mm/mm^3. Nesse caso, o resultado se aproxima do valor de referência para os aços com médio teor de carbono [27]. Portanto, o valor σ_e = 310,13 MPa calculado com o maior valor de dureza (139,12 *HB*) foi desconsiderado nesse estudo para a análise do módulo de resiliência (u_r).

IV. CONCLUSÃO

Os resultados desse estudo permitiram concluir que o sistema eletrônico de ultrassom pode ser utilizado para determinar os valores das velocidades de ondas ultrassônicas propagadas através de uma barra de aço 1020. Este fato foi constatado após comparar os resultados de V_L e V_T com os valores de referência para o aço 1020.

Os valores calculados para o coeficiente de Poisson (v), módulo de elasticidade (E), módulo de compressibilidade (K) e índice de anisotropia (r), se apresentaram dentro das faixas esperadas para o aço 1020. Para o módulo de cisalhamento (G), apenas uma pequena diferença de 2,10% foi encontrada em relação ao valor de referência.

Com as relações matemáticas descritas em função de V_L foram encontrados valores de σ_e = 284,63 MPa, *LRT* = 447,81 MPa e dureza = 129,80 *HB*. Esses valores estão próximos dos resultados obtidos com os ensaios mecânicos convencionais realizados. Isto sugere que as relações matemáticas aplicadas nesse estudo se adequam para a caracterização mecânica do aço 1020.

O valor do módulo de resiliência (u_r), em torno de 0,193 N.mm/mm^3, também foi muito próximo daquele encontrado para os aços com baixo teor de carbono. O resultado indica uma boa proximidade na estimativa das propriedades σ_e e E, obtidas a partir de V_L, V_T e ρ.

A similaridade entre os resultados encontrados e os valores de referência, associado à simplicidade do método

proposto, corroboram a viabilidade de utilização do método ultrassônico da transparência como técnica não destrutiva para caracterização das propriedades elásticas e mecânicas do aço 1020.

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Experiences in organic agriculture: How to stimulate a transition to agroecologically based agricultural systems

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***Abstract*—** *This study surveyed a total of 15 farmers from the Association of Organic Producers and Producers of the São Francisco Valley (APROVASF), to investigate what motivates or motivated the adhesion of these farmers to the organic production system and what were the problems encountered in maintaining the activity. It is noteworthy that the main difficulties reported were phytosanitary management, production of internal inputs, keeping the records and controls required for organic certification and maintenance of updated organic activity. Thus, it is necessary the promotion and strengthening of public policies that enable the conversion of their agricultural activities and the building of sustainable agroecosystems.*

I. INTRODUCTION

Agroecology presents different interpretations that complement each other when addressing agricultural production and field issues, being discussed beyond academia, and seen as science, agricultural practice, sustainable production and, among others, a perspective of socioeconomic inclusion [1] [2] [3]. With a view to food production, its agricultural practices and sustainable production also support some systems recognized as agroecologically based, such as the organic system, recognized worldwide, with representation through the International Federation of Organic Agriculture Movements (IFOAM), as well as having a legal framework in Brazil, which regulates the production of organic food in the national territory.

Since 2001, the Ministry of Health of Brazil has continuously made available on its website, as well as being reported in the main media in the country, results of the analysis of pesticide residues in food, carried out through the Program for the Analysis of Pesticides Residues in Food (PARA). Cases of poisoning due to the use of pesticides, as well as the occurrence of cancer favored by the presence of residues in the human body, are recurrent in scientific studies and in the care of poisoning centers throughout the country. In this scenario of distrust regarding the quality of the food offered, part of the population demands products with guaranteed origin, seeking to consume pesticide-free vegetables and animal products, finding in food with "organic seal" the guarantee of a product without pesticides, healthy and safe for family consumption. Thus, the demand for this type of product is growing, as well as increasing the adhesion of producers, when observed that in 2012, at the time of the first official registration of organic farmers and ranchers in Brazil, the number registered with the Ministry of Agriculture,

Livestock and Supply (MAPA) had around 5,934 producers [4] and today it is around 25,296 [5], although still timid when considering the diversity of foods that could be offered, as well as the number of people attracted to the cause.

Some studies show that producers are unsure of trying to convert or transition to agroecological practices [6] [7] and, seeking to understand and suggest strategies that enable the adhesion of producers to agroecologically based production systems, we sought to hear, through a questionnaire, the members of the APROVASF, which actively participates in the weekly organic fairs in the municipalities of Juazeiro and Petrolina.

APROVASF has 24 members, 12 men and 12 women, 3 of whom are registered as professionals in agricultural sciences, 2 only sell products of organic origin and the others produce in the municipalities of Juazeiro (BA) and Lagoa Grande and Petrolina (PE) and they sell their respective vegetable and fruit crops in the local market. Cultivated land varies in size between 0.23 and 10 hectares.

II. MATERIALS AND METHODS

The research is classified as exploratory and descriptive, and the data presented were collected using the Google Forms tool and had the objective of investigating the perception of the participants regarding the role of producer and/or trader of foods from organic production systems. A bibliographical review was carried out, with consultation of books published in areas related to the proposed theme and scientific articles in several databases, through the Capes and Scielo journal portal.

Twenty-two multiple-choice questions were prepared, eight with an option to complement answers and one open, available in the APROVASF group, existing in the WhatsApp instant messaging application, through a Google Forms link.

The questions aimed to identify the motivation of respondents to get involved with the organic food production system, to know the ease and obstacles experienced by certified organic producers, such as support received, job and income generation, full dedication, recognition of social image, type of agricultural exploitation, difficulties in the field production system and in compliance with legislation, perception of conventional and organic agriculture, availability of technical assistance, perception of change in life, access to rural credit and knowledge of the legislation.

III. RESULTS AND DISCUSSION

The questionnaire was answered by 17 associates, that is, 15 farmers and 2 organic food traders. Among the farmers, only three members, 2 men and 1 woman, produce food and only sell to merchants, the others, 5 women and 7 men, both produce and sell their products to grocery stores and markets by themselves, as in the organic fair in the municipalities.

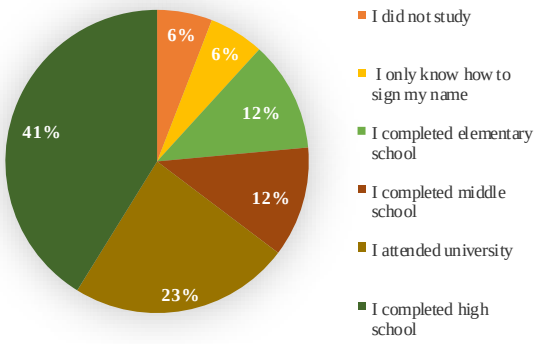

Fig. 1: Educational background of surveyed participants from APROVASF.

The group is quite heterogeneous in terms of education level (Fig. 1), with 7 associates with higher education, 4 with secondary education, 2 with complete elementary education and 2 with incomplete. One responder only knows how to sign their name, and another declared not to have studied. Among the professionals with higher education, 3 are agronomists, 2 are environmental managers, 1 business administrator and 1 mechanical engineer.

Studies on organic agriculture and its growth have confirmed a more expressive adhesion of producers with greater formal education, as demonstrated in works conducted in Poland [7], where, among organic farmers, there are more people with secondary education and higher education, including agricultural studies. These authors also claim that producers more likely to be innovative have organic certification and are more qualified and aware of issues related to the environment. However, the shift to organic farming, coming from family farming and low-education farmers, is already expressive, being a trend in Brazil, as the theme ecology and social impact is constantly reflected.

When asked about the support of family and friends on becoming an organic producer, 70.59% said they had been very supported by their family and 52.94% said they also had the support of friends. Only 11.76% of producers said

that the family was indifferent to their initiative and 5.88% had no support at all.

Among the members of the association, 80% of them have their families directly involved in agricultural activities, as shown in Fig. 2, characterizing organic and family farming, although 35.71% of these producers engage in other activities to complement the income of the family.

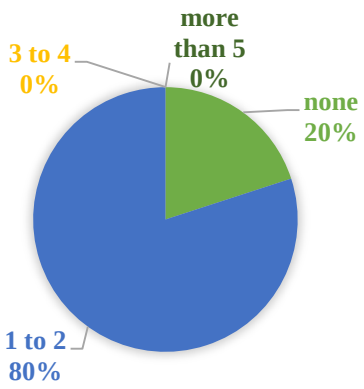

Fig. 2: Involvement of family members in the farming activities.

The results of the survey showed that more than one perspective motivated producers to practice in agroecologically based agriculture, which were focused on social values (Table 1) such as concern with the quality of the food produced, with health and with the environment, predominating on economic factors, as demonstrated in the work of Kociszewski *et al* [7], in addition to the practice of organic agriculture by ideology, as shown in Fig. 3.

Table 1- Social values that APROVASF members would like to Project.

Perspectives	Associates	%
Have a good financial situation	6	35.3
Have a standard of living similar to others in my community	2	11.8
Have a stress-free life	10	58.8
Have a decent, honorable life	11	64.7
Be recognized by everyone	6	35.3
Live in respect and communion with the environment and the beings of this planet	1	5.9
Have a quality life at work and financially.	1	5.9

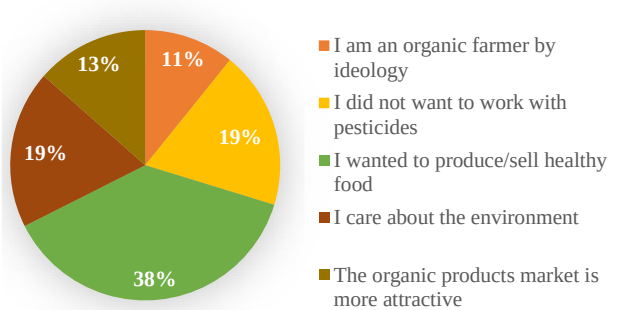

Fig. 3: Producers' considerations for adopting the organic production system.

Agriculture is practiced by all producers of the APROVASF, with 50% of those interviewed cultivating more than 11 crops, diversifying their properties, strengthening their agroecological base. All other producers have more than two crops in the field and only 3 producers practice poultry farming for family consumption.

When asked about the problems faced during the implementation and management of crops, 42.9% of farmers pointed out phytosanitary treatments, when they must deal with possible pest outbreaks, followed by the production of internal inputs (35.7%) such as manure, biofertilizers and/or mixtures for phytosanitary use and, among others, 28.6% mentioned having problems acquiring certified seeds and/or seedlings for planting. . It is noteworthy here that all producers know the time of harvest, as well as how to harvest the food they produce. Fig. 4 graphically presents these results.

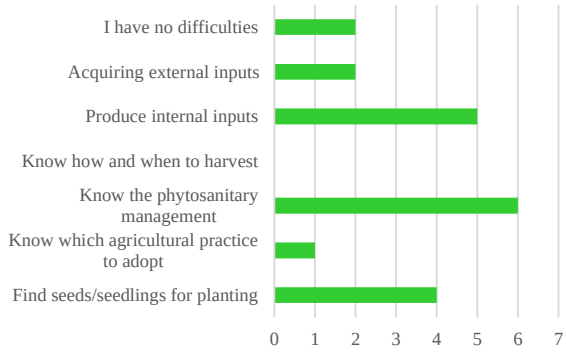

Fig. 4: Producers' answers about the difficulties faced in dealing with the crops.

Among the producers who answered the questionnaire, 71.4% went through the experience of conventional agriculture and when asked to compare the expenses

between the two types of agriculture, 42.9% stated that in the organic production system the cost of production of crops is smaller, as can be seen in Fig. 5.

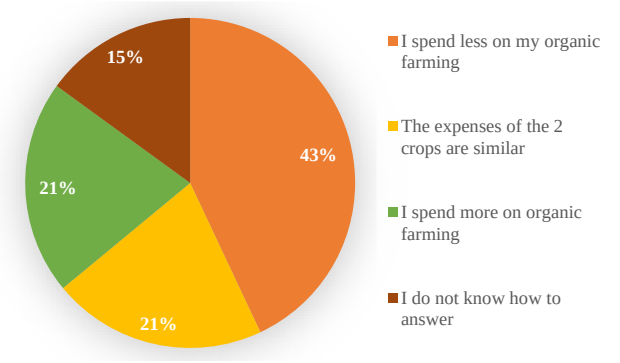

Fig. 5: Producer responses when comparing expenses incurred in conventional and organic crops.

In the question to identify the difficulties of the organic food producer, 53.3% indicated that documenting activities, filing notes and recording purchases and sales, among other procedures called "paperwork for certification", requires effort and a lot of work. 33.3% feel uncomfortable with the criticism received from conventional producers for having adhered to the organic production system. These data are represented in Table 2.

Table 2: Main difficulties encountered by certified organic food producers.

Difficulties	Organic farmers	%
Convince people that the production really is organic	1	5.56
Difficulty in hiring qualified labor	1	5.56
Low marketing demand	1	5.56
There are no difficulties	1	5.56
Deconstructive criticism received from conventional farmers	5	27.78
Respect the certification standards for dealing with crops	1	5.56
Meet document requirements for certification	8	44.44

It is relevant, then, to raise awareness about means and norms of organic production that insert these farmers into an ecological culture, in organic certification and that provide them with better marketing conditions and means. In an essay, Bomfim [8] challenges the educator to make use of a truly emancipatory education, of dialogue and learning with the student in total consonance with the environment in which he is inserted: "... the human being is made in the experience in society, being constantly challenged by socialized nature to transform it and transform itself".

As for technical assistance (TA) of the 15 producers who participated in the survey, only 13 producers answered this question, and 53.85% do not receive guidance from professionals in the agricultural sciences, 7.69% pay for the service, 15.38 % have TA made available by the federal government, since they are land reform settlers, 7.69% have support from the APROVASF technical team and 15.38% are professionals in the area.

When asked about the quality of life based on adhering to the organic production system, with the option of choosing more than one answer, 73.4% of respondents reported seeing a healthier family. As a result, 40% stated that their finances had improved, 20% declared that they were constantly discouraged and 13.3% claimed that expenses in the countryside increased.

As for rural credit, only 1 producer had access to bank financing, however, through a credit line which does not value the benefits, at least environmental, that agroecologically based agricultures promote.

Table 3: Responses from producers regarding the understanding of technical issues of organic production.

Organic production	True	Untrue	Right answer
Organic food, fresh/processed, must be produced following the Brazilian legislation for organic agricultural production system	16	1	True
The use of unauthorized production inputs at any stage of production and/or storage of organic food is prohibited	16	1	True
It is prohibited to use pesticides and synthetic mineral fertilizers	17	0	True
The use of biological control products is prohibited, as well as simple micronutrients and soil correctors, such as limestone and gypsum	1	16	Untrue

As the area is organic, there is no need to use soil and water conservation practices	2	15	Untrue
Biofertilizer tank waste can be disposed of anywhere on the property, once it has been fermented and no longer causes contamination	6	11	Untrue
Organic areas must have windbreaks to protect them from internal and external contamination	15	2	True
There is no need to have documents and record the activities carried out in the organic areas	2	15	Untrue
For the producer to certify his area, just communicate to his association and the city hall, who provide the necessary documents	1	16	Untrue
Among the documents required for certification are: organic management plan, sketch of the area, analysis of the water used on the property, soil analysis and record of activities carried out in the production of crops	17	0	True

Of the 17 survey participants, only 1 responded that they had no knowledge of the Brazilian legislation that deals with organic production, that is, Law 10,831 of December 23, 2003, Decree 6,323 of December 27, 2007 and complementary acts [9] [10]. 14 members said they had intermediate knowledge and 4 said they knew the legislation. In Table 3, referring to practical issues about the legislation, there is an almost absolute understanding of the issues addressed.

IV. CONCLUSION

Despite the difficulties encountered regarding the availability to perform services and use technologies in the organic production system, as well as the lack of technical assistance and rural credit, producers are satisfied with the work developed and acknowledge the improvement in family health. It is noteworthy that agroecologically based agriculture is recognized as interdisciplinary, it goes beyond the rural area, it dialogues with public health, social inclusion and job and income generation, among others. The transformations in the social and economic sphere, triggered by the change in the production system to ecological agriculture, imply the introduction of new knowledge, including agronomic, and these must, above all, seek to bring to the producer a change that makes life constructive and decent. Feasible public, educational, social, and marketing policies, which motivate society to participate in the transition process, and direct the recognition and appreciation of food produced in accordance with the environment, being socially fair, encourage, strengthen and further expand production and consumption of these foods. Therefore, it is recommended:

To foster agricultural research with a focus on food production through agroecologically based production systems;

Strengthen educational institutions within the scope of agroecological practices, government agencies, farms, business associations, as well as citizens interested in promoting agriculture in the country to improve the diffusion and promotion of technologies;

To stimulate knowledge and understanding of the relevant legislation by society, which enables greater security in the existing relations between the countryside and the city;

To make the agroecological approach explicit in a theoretical and methodological proposal so that technicians have agroecological knowledge to share with families, and

To train producers and reduce bureaucracy with organic certification to encourage an agroecological transition.

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We are grateful to APROVASF, which contributed to this study, which intends to assist the reformulation of public policies regarding technological development and technical assistance to make agroecologically based agriculture viable, in the São Francisco Valley.

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The *Abin-fo'o* and The *Mandele* Dances in the Bafut Kingdom: Some vital Issues Presented in Cultural Festival Activities and its Evolution and benefits from their Onset to the Twenty First Century

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***Abstract*—** *As objective, Bafut is a tribe that migrated as far back in the Seventieth Century from the Northern part of Cameroon via the Eastern Grassfields to Bamenda, found in the Western Grassfields today, North West Region of Cameroon. Actually, the Objective of this article seeks to show and explain some number of cultural dancing groups which among them is the Mbinfo'o known as the Fon dance that is always performed in an annual festival that comes up at the end of every year. More so, in the kingdom palace is found another dance called the Mandele dance usually performed and reserved just for the prince and princesses of the Village. Due to some changes these dances has experience evolutionary mutations thus giving their full flesh substances that has been admired internally and internationally hence bringing some advantages into the country and the society or tribe.*

As method, to better bring out this cultural heritage history, we concentrate very much on oral, and written sources that could best expound on these two mention dances. Also, it will be vital for us to say or give as result that, these dances have, as among, the several advantages, shown that the existed an interrelationship advantage as far as cultural festivals are concern in the Grassfields political, economic and socio-cultural domains and derived or has as importance to the entire country and the tribe itself. In this article it should be noted that some names of items and places has been spelled differently but all meaning the same.

INTRODUCTION

Long time ago a group of people left the northern part of Cameroon due to diverse reasons among which was drought of Sahara Desert which they were calledTikar and finally arrived their present side via the Eastern Grassfields of Cameroon. Just north of Bamenda today is the large Tikar community of Bafut, traditionally one of the most powerful of the Grassfields kingdom. Thefons (local chiefs) palace here is home to the representative of a 700-year-old dynasty and is a fascinating insight into Cameroons traditional culture.The palace compound consists of numerous buildings including the houses of the fons 150 occupied by so many wives (not all of whom are presently in residence), and the sacred Achum building, a shrine which is off-limits to everyone except the fon and his close advisors. In front of the palace compound are several stones marking the burial sites of nobles who died, hence reservation and preservation of some patrimony. Serving the fon, was the Takumbeng House, which holds the fons ceremonial drum.The imposing colonial building

above the palace is now a museum. Its holds many interesting (and slightly scary) carring, traditional costumes and weapons.In every late December in each year, Bafutusually holds a huge four-day celebration to mark the end of the years ancestor worship with masked dancing and drumming. Within the Royalty is a dance call *MandeleNfor* of the Prince and Princesses. Bafut also holds a large market every eight days (every country Sunday) following a worship and respect of the gods that protects the people and activities like the dances.[1]It should be noted that Bafut is a well organised society with a vision for her rich patrimonial preservation and enhancement of cultural values for continue encouragement and improvement of internal and external developments. This is usually done following the Bafut Calendar which that the people strictly follow. Here, the question that need an answer is to know, what is the historical context and all what surrounds the AbineNfor and Mandele festivals couple with its importance and consequences in and out of Bafut society?To better answer this question it will be interesting to analyse the following aspects;Conceptual framework of the study and contextual history narration of Bafut Kingdom, Manifestation evolving within and around of the Abinfo'o and the Mandele dance activities, The evolution of the Abin-fo'o and the Mandele dances in the Bafut fondom, and finally, The importance and Consequences of the Abin-fo'o and Mandele Dance.

I-Conceptual framework of the study and contextual history narration of Bafut Kingdom

This study has some key and veritable words that deserve good mastering for the enlargement of our understanding. Furthermore, some narration of historical background should also be given to know where this people originated and finally inhabited Bafut. It should be noted that all about them came from outside as they preserve their status till the 21 th century today.

A-Conceptual framework of the study

Mandele Dance: This is orchestrated by the fon and put in effectiveness by the Prince and Princesses of the Bafut palace, sons and daughters of the fons. They function in several circumstances attached to the running and administration of the palaces. It started during the reign of NforNebasisu who rule from 1552 to 1570 as successor of MforFeurlu consider the territory of Mbebili and Bukarithat, then constituted the fondom as to small to him. He decided and expanded the territory Beyond and Bukari which he created the Mandele Dance which intension was to animate to motivate and encourage the Bafut warriors during the wars of expansion. The sound of birds head in the river *Muchwine* of 12 birds melodies became the memorizing songs of the dance dominated by flute and drums. Later the mandele dance became official used during the Grass Cutting festivals to construct the fons house Achum and also during the mandele dance the traditional priest also pray to the ancestors to provide in all homes a beautiful harvest. This dance is performed once a year in June beginning in Yijong day to ending Mumita'a which is the Bafut native Sunday unlike the Abine-Mfor. These dances is situated in certain month of the year as can be seen in the Bafut calendar;January to December in Bafut Language:1-January- San Nboo,2-February-san Ababe,3-March-San Ntsumbeng,4-April- San Bwiimfo, 5-May-San Mikwene,6-June-San Mandele,7-July-San Mbu u ansaneloo,,8-August- San Nkoonji'I,,9-September-San Ayoo-ni-mfen,10-October-san Ntsyabe,11-Novenber-San Aloo,12-December-San Abene. The sixth month is the month of Mandele while December month the twelve month is the month of Abene*Mfor*.[2]

Abine-Mfor: The dance is an annual cultural festival that usually take place at the end of each year in the Bafutfon palace plaza. It took place in December every year in that is characterize with the following aspects; Honour to the ancestors by offerings sacrifices, libation, Dancing, feasting, exchange of traditional gift amongst Bafut people, Ritual parades and displays by manjong societies hence a way of preserving the village and tribes patrimony, Family reunions and meetings, General fanfare and jubilation in the Bafutfondom are other methods. They orchestrated this festivaland consisted of, 6 traditional drum of various sizes,4 flutes, a choir,2elephant tusktrumpets, Traditional iron foot rattles. They are four songs that characterize the music formed for dancing which are *Lele, Akwarehsong, Sawa song, Boom song.* The first three songs from tikari were introduced into Bafut by *M for Feurlu* that is Chief Feurlo'oand the fourth song(Boomsong was received from Bali Kumbat and introduced in Bafut by the MforAbumbi I who reigned from 1852 to 1932. Finally, at the end of Abine-Mfor are performed, Mandele, Ngwa-ba'a, Ndong-mambang, sang-mandele, Afeurth, Ndanjem, lele and Akwareh which Mandele is that of the Prince and Princesses.[3]

Festival: It is a season of rejoicing like in public celebrations such as the Christmas and Easter season

[1]Fon palace Cameroon, lonely planet, file///E/fons%20palace-%20cameroon,lonely planet%20Attraction%2020lonelyplanat.htm.andfile:///E:/Fon's%20Palace%20_%20Cameroon%20Attractions%20-%20Lonely%20Planet.htm

[2]His Royal Majesty Abumbi II Fon of Bafut, *The Customs and Traditions of Baful*, Press Book, Press Print, Limbe, 2016, p.

[3]His Royal Majesty Abumbi II Fon of Bafut, *The Customs and Traditions of Baful*, Press Book, Press Print, Limbe, 2016, p.

which are church festivals that marked series of performances, ofmusic, drama given periodically call festive or feast day, such feasting activities are the Abine-Mfor and Mandele dances in the Bafut Kingdom.[4]

Cultural: the word originated from the word culture which is institution hence advanced development of the human powers, development of body, mind and spirit by training and experience, evidence of intelligence intellectual development of science, art and human society. Particular form of intellectual development, Art, social institution, belief, characteristics of a community, race hence the Abine-Mfor and the Mandele dance are cultural institutions that preserve and enhance development.[5]

`[4]L E Hornby, *Oxford Advanced Learners Dictionary of English*, p316.
[5]Ibid, p.210.

B-contextual historical narration of Bafut Kingdom

` Bafut tradition traces its dynastic origins to the Ndobo or Tikari areas. From the reign of Firloo, the first Fon of Bafut, it has operated as a fondomor kingdom, using traditional power structures**.** Upon their arrival from Banyo dated 600 years ago and from Tikari at least 400 years ago, the Bafut people built the current "old palace" of Mbebili, also known as NtohFirloo. It still contains the tombs of the first three Bafut kings Firloo, NebasiSuh and Ambebi.The Fon's palace, and thus the centre of Bafut's traditional power, was later moved to its current location, and by the time of the German annexation of the Cameroons in the late nineteenth century, Bafut had roughly assumed its present make-up.Bafut had a population of 80,305 in 2005, but is now estimated to have over 100,000 inhabitants. It is primarily an agrarian region.

Picture: The Old Bafut Palace at hilltop of.

Picture: A stone for scarify in the Old palace at Mbebili. MbebiliBafut (Patrimony).

Source: Author Courtesy pictures

Picture: An Aerial View of the Land of Bafut

Source: Author Courtesy picture

Geographically, Bafut is situated about twenty kilometres northwest of Bamenda, in the Mezam Division, and covers an area of roughly 340 km^2.It is located in the Western Grassfields geographic region - which includes Cameroon's Northwest Province and surrounding grassland areas. Bafut is the most powerful of the traditional kingdoms of the Grassfields, now divided into 26 wards along a 10 kilometre stretch of the "Ring Road" that trails along a ridge above the Menchum Valley. The population is settled in three main zones.At the centre are

the people of *Mumala'a* (heart of the country) clustered around the Fon's palace who refer to themselves as the real Bafut (*Bufu*). This name can be applied to the whole chiefdom.To the south is the *Ntare* (ridge area). To the north is the *Mbunti* (lower) which descends abruptly to the Menchum river valley.

Linguistically, the major languages are the Bafut language and Cameroonian Pidgin English, though Mundum, Mbuhnti and French are also spoken. The Bafut language is classed within the Mbam-Nkam section of the central branch of the Niger-Congo family along with other nearby languages such as Bali Nyonga, Bamum and Pinyin. Bafut is famous for, being the venue of the Annual Dance of the Fon (local chieftain) or the AbineMfor. The location of the palace of the Fon of Bafut, the residential dwelling of the Fon and his wives and counsel which is now a UNESCO World Heritage Centre and houses a museum. (seeFon of Bafut and a section on the Palace of the Fon and Queens).

Picture: The Fons House Achum and Houses of Queens

Source: Authors Courtesy picture

Pictures: The Palace constructed by the Germans using Bafut slaves

Source: Author Courtesy Photo

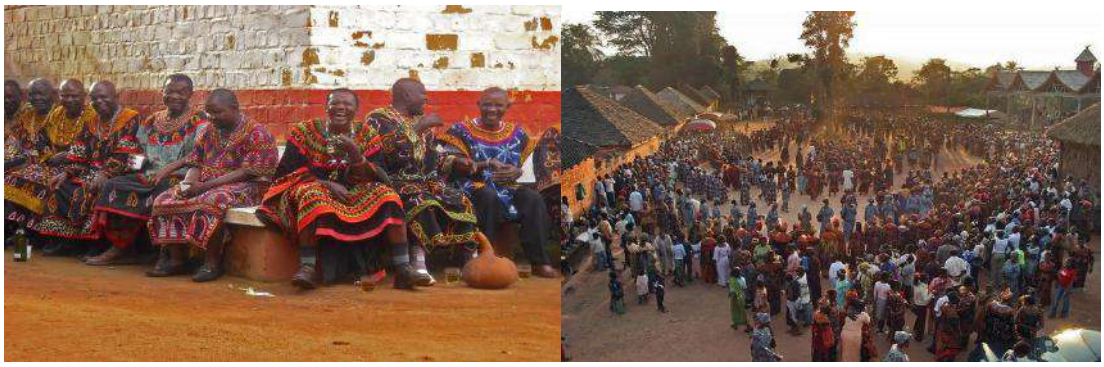
II-Manifestation evolving within and around of the Abinfo'o and the Mandele dance activities.

A-AbineMfor in the Bafut traditional festivals

From the appellation *AbineMfor*, it is the fon dance, who is the king and man the activities that surround the Abin – fo'o. It is a festival that takes place at the end of every year. the month of December. According to the month of the Bafut calendar, san Abin –Fo'o.Abin – Fo'ohas different spellings as seen and comes up at the fons palace plaza called Sani – Abin –Fo'o and done at the palace within a period of a week, starting at the eve of the market day "Lika" and the market day "Jong". During this period, the Bafut secret societies and the Kwifon send out priests to the different shrines where it is beliefs there, Bafutt for cohabiting the ancestries to worship and appease before the activities of the Abin–Fo'o,[6]the immediate market day that follows according to the calendar, some rituals are performed at the heart of the palace by the secretary of the palace, At sunset of this day the notables and others jointed or come together at the palace to perform the dance Abin–Fo'o after having undergone through a lot of maneuvers to put in place to standard, the Abin – Fo'o.[7]

[6]Interview with Tanda Augustine, in Yaoundé, on 2 March 2021.
[7]Ibid.

Picture 85: Some Notables in Bafut Palace during the Fon Dance preparation and BafutFon Dance *AbineMfor*



Source: Authors Courtesy picture

Picture: Head of Juju used during the Abine-Mfor Dance

Source: Author Courtesy picture

Furthermore, it is done for four days and on the firth day, activities are concluded. The "Jong" which is the day of worship and sacrifices is also concluded on this day. At sunset of the worship and sacrifices, dances are dance by members of royal and secret societies done for a short time which could be between or about five to ten minute for each group. The Mfor(Fon) of Bafut as head of the society or community is the host, passing and programming activities for the next day. It continued up to the fourth day which of display by Mayong groups demonstrating their wear – like activate as they fought during the Bafut – German wars and tribal wars like,lale, Nda – Mukong, Nda – Atawa, NdaNgo'o and several others. Activities on this fourth day are form done and dust. Those who have done much to the Society ofBafut are decoratedfor example some were given cup and red feathers, they were given or received gift and were also rewarded with tittles. The LaleChaire demonstrate it notion as planned around the community comes back to join the Orchestral to dancing and feasting for several hours. On the filth day, only members of the royal family and some few others like notable comes out to dismantle or concluding the affairs of the society,license putting end to the festival; to the citizen in the year which they look forward for the next year. This is a folk –loris; cultural development activity that is handed from one generation to other and depicts importance essences. This Abin-Fo'o on the filth day in the week as planned and performed, it should be noted that, the day of the Abin-Fo'o marked the end or crowned all activities of the year but the commoners have great note and role to play. This has been a cultural stance blue to the fact that it is a culture that has or pasted on from one generation to the other or to generation upon generation.[8]Many children come out, learn to chant, dance and song while some comes to witness and learn all about the Abin-Fo'o or The Bafut cultural annual festival performed towards the end of the year. It should be noted that no year has ever gone by and pass without the Abin-Fo'o activity and dance, not carried out except in the recent war period in Cameroon; civil war between the Government forces against secessionist Ambazonian forces.[9]

B-Mandele dance in the Bafut traditional activities

The name Mandele, came from the ancestors meaning a social activity organized every year at mid of the years called *san Mandele* around or in the month of

[8]Interview with Tanda Augustine, in Yaoundé, on 2 March 2021.

time, to early July fixed in the Bafutcalendar; san Mandele always future in the above said month. It is a festival in that, the Bafut community headed by the royal family comes out known as the period of hunger with food items reserve in the band "Mukwere". Only some food items such as cocoyam, groundnut and palm wine brings all to either and share to all present and the involved. In effect, this managed by the members of the Royal family or Royal birth and line decendance. Both male and female; princess and princesses mandate and moderated by his magesty the Fon of Bafut to all the society and shines.[10]**see pictures**

The Mandele dance activity usually takes place at the Bafut palace for a period of four days every San Mandele (mandele month) made up of the princess and princesses. The items like groundnut are distributed to every one of the day for the people present in the community to take home. All those present must atteast take something home as culture depicts. It should be noted that, it has move from the Bafut palace folklore dance during the Tikaris presence at the San Festive hall at the Bafut Royal palace.[11]

[9]Ibid.

[10]Interview with Tanda Robert, in Yaoundé, on 2 March 2021.

[11] It started and has spread in several antennas. The Tanda appointed by the fon control the activities outside the palace

Picture: Mandele Drums Prince on flutes and Princesses preparing to display

Source: His Royal Majesty Abumbi II Fon of Bafut, *The Customs and Traditions of Bafut*, Press Book, Press Print, Limbe, 2016.

As well as the practical manifestation of the dance, the Mandele dancers comes out only when their palm wine has been given. They use palm wine called "Fohoo Mandele."[12] The wine helps very much as it raised the anxiety and awake everyone to be into and for the activity dance. It should be noted that everyone is in his or her traditional dress called "egalier". All those who are present be on their legs thus a traditional respect to the dance. Their flute and drums (**see items**) give a nice rythme that all dance. follow with singing or chanting of songs in the traditionallanguage or dialet very meaningful.[13]

[12]It is whitewine that is use and spray on the musical instrument and the dancing area. It is to appease the gods and the people

[13] Interview with Ghe George Tanda, Bonaberi-Douala on the 04-03-2021 at 18.20pm

Picture: Mandele Dance Activities in Action

Source: His Royal Majesty Abumbi II Fon of Bafut, *The Customs and Traditions of Bafut*, Press Book, Press Print, Limbe, 2016.

Moreso, the day of Mandele dance festival is a day of feasting and eating only traditional dishes like Achu being a passionate meat of the people or tribe ones. It should not be forgetten that cooked groundnut can never be exempted from this dance occation. When sharing, the cocoyams is put inside basket "kikah". White-stuff and oil are put inside calabashes that has been wrape with the pearlings or backs of plaintains stems and then it is follow with sharing. Goats and chickens are killed for general eating or consumption. In this dance a commoner can not take part but no initiation is done as far as the Mandele dance is concern. The flute is often or had a long rope which the dancers, each, turns it while blowing and sound of different sort joining or coverging giving a complet sweet rythm hense all is force to dance or provoked to dance inline following the rythms of drums, flute and singing of a traditional songs in traditional dialect.[14]

III- The evolution of the Abin-fo'o and the Mandele dances in the Bafut fondom

A-The Abin-fo'o

The annual festival that grouped all the various group in the Bafut kingdom has greatly evolved with the passing of times from the precolonial, colonial and post-colonial era. Abin-fo'o started before the coming of the Tikar group fleeing from horrors left behind. It was during

[14] Interview with Tanda Augustine in Yaoundé on the 02 march 2021 (he is a chief protocole officer of the bafut royal palace, secretary of the bafut royal family « cheuch-meufor » member of the Takumbeng and as secretary. He is named "Nchuala'a" a person that the sountry is in his hands or rest in him and no one else.

the annual dance that the Bafut king who was not generous has to out the aborigine that occupied the hills of Mbebili under the leadership of the chief Nebachi. As from thence, the dance continued at the discovered environment devised by the Tikar chief. Since then the precolonial people continued the dance at the Bafut plaza. As our research predicts and depicts many at this time dance necked since the existed no cloths and the eldest in the kingdom use plaited leafs from the raffia and palm bushes.

Additionally, when time keeps passing and event continued to evolve, the dance became matured. The spirit of the people were seen in them during the colonial days when the palace made up of bamboo and raffia roofing, sundry bricks and zinc or zinc-ties has greatly improved the palace and plaza where the people do their dancing.[15]

The Abin-fo'o has been greatly spice, up dated instrumentally, organizational wise, and mental and spiritual no how, the culture remains unchanged but maturity super-improved. Many do dance now annually with their dress called "Nto-o Koh" during the colonial and post-colonialtill now our days.[16]

B- Mandele dance

The first occupant or indigenes that the Tikars met at the Mbebili site knew no such important of the princess and princesses of the kingdom. The Mandele dance was introduced by the Tikar chief or king called Firloo that left the Eastern grassfieds 600 years ago. When the king had several wives and including the already had, to put them together as one the princess and princes started the Mandele group dance as a means to unit them. From the various palaces belt the dance has gone as far as in other towns like Douala Yaounde, Kumba and others.This dance as gone as far as long distance countries like America. The noble or Royal birth are doted everywhere today in Cameroonian towns cities and abroad. This dance nowadays serves as a forum to put them together, knowing their identity due to the expansion of the people and growth of the huge kingdom. Their external movement has led to the organization of the people home and abroad. This dance is noted keep expanding to various dimension in the world.[17]

IV- The importance and Consequences of the Abin-fo'o and Mandele Dance

There are many and varied circumstances of importance ofAbine-Mfor and Mandele dances in Bafut, Cameroon and abroad or internationally. These importances has given way to some consequences originating from the dances.

A-The Importance of Abine-Mfor Dance

1-Internally (Abin-fo'o)

The identification of the people as their return home.annually is often appreciated as love ones and family comrade see each other after a long period of time in separation or isolation as such it brings together in and strengthens the unity of the people. It gives and paint the picture of collaboration between and amongst the citizens of Bafut. It sells the image of the people and village within and out of the village. It also teaches the young grown-up on issue concerning their culture.[18]

2-Externally (Abin-fo'o)

The Abin-fo'o brings Bafut people of Bafutorigin or decent in their numbers. Europeans, Americans and Africans in and out of Cameroon to come see or witness the dance in the Bafut plaza. The culture is sold abroad as utensils such as ceremonial drums, flute, fibers bag, baskets, hand and foot rattles, and the egalier or Nto'oKoh are sold, this brings in income into Bafut and Cameroon. Of more important, the beauty, love and togetherness of the people is seen or viewed.[19]

3-The Importance of Mandeledance

Firstly, it put by bringing all the royal birth together to express their problems, seek for solutions and better their lives and that of the societies. This dance has been able to make those of the royal birth to love themselves and leave in harmony as one since the world is now a global village and globalization is the team of the 21th century. The dance has left the palace to different towns in the country even externally. It portrays the culture of the Bafut people and sells their images. It brings the princess and princesses together and other well-wishers. Additionally, the dance actually entertains due to the thrilling natural beating of the dance to the people, public and members. It brings revenue into the society and free will donations to appreciate the dance and dancers during their display. Such gift in terms of money are recovers from dancers from a leaf place at the middleof the dancers. Usually, some gift in land and money is given to the best dancers of or amongst the princess and princesses.this also helped to improve on the lives of the noble birth in Bafut educationally wise in the society.[20]The site is an important part of the history and culture of the Bafut population in the northwest region of Cameroon, and continues to

[15] Interviews with Achefor in Yaoundé, 02-3-2021
[16] Ibid
[17] Interview with TandaMandelle, Bonaberi, Douala, February 20-03-2021

[18]Ibid.
[19]Interview with Che George Tanda, in Douala, on 2 March 2021.
[20] Interview with Tanda Augustine, in Yaoundé, on 2 March 2021.

function as a Centre for religious rites and ceremonies. The violence and destruction to the Bafut Palace threatens the safety and identity of the Bafut people and the maintenance of their distinctive cultural traditions. As such it deserves protection from the Republic of Cameroon and pressure from organizations and governments to restore damaged structures and return stolen artifacts.[21]

B-The Consequences of the Abine-Mfor and the Mandele dances of Bafut

The two dances and others found in the Bafut kingdom has boasted the cultural image of the people at home and abroad. It should be noted that due to this rich values as per say has attracted several tourists that has visited the cultural patrimony of the town of Bafut. While some look at it importance some has developed negativistic attitude towards this value.

1-Bafut Became a Cultural Centre for UNESCO Development

Due to the Abine-Mfor, Mandele and others like the Mansoh and Manjong dances, attracted Countries like U S A, Germany, Britain and France with some Governmental organisations and non-governmental organisation to work in partnership with Bafut in several aspects, the dances has sell the image of the town of Bafutas such Bafutis well known and identify, has become a centre for UNESCO Development through the Mayorwho set-up a climate change and agricultural research unit within the council, to educate farmers and local youth on the most productive and sustainable modern farming techniques to guarantee no food shortage which is recognised usually in the month of June every year. This encourage the subsequently joined to the World Council on Climate Change, ICLEI - Local Governments for Sustainability, and has been hailed by the Cameroon government as a "*national green hero*".The *Bafut Council Eco-City Project* has become a signature programme of the council. The project has been designed to host a *Sustainable Technologies Park and Cross-Cultural Education Hub* for local and international volunteers. This Non-Formal Youth Education Programme create young Social Entrepreneurs and Young Farmers Clubs, consisting of trained environmental technicians with the knowledge and skills to develop and execute strategies for achieving sustainability, within the framework of the Millennium Development Goals (MDGs) at scale and enterprise business models hence due the dances the image of Bafut is worldwide for development.[22]

2-Cultural Link to International Organisation

Furthermore, due to the rich and attractive culture of Bafut much supports has come from organisations, *The Bafut Eco-City 2020 Project* is the most urgent sustainable development challenge facing the *Bafut* municipality. It's lack of capacity to link with World Climate Change (WCC), International Council for Local Environmental Initiatives (ICLEI) and other international organisations in developing educational and public awareness programmes with respect to the conservation and sustainable use of biodiversity has been the major setback.*Bafut* has subsequently established a new mission statement and Sustainable Development Plan that better encompasses the new *Eco City Vision* and specifies what are the wishes to achieve through this vision. Moreso, due to the dances, Bafut is famous for the following touristic attractions:

The venue of the Annual Dance of the Chief (local chieftain) or the ***Abin e Mfor***..

The location of the palace of the Chief of *Bafut*, which covers the residential dwelling of the Chief and his wives, counsel which is now a UNESCO World Heritage Centre and houses a museum.

The nearby location of the botanical garden of Savanna Botanic Gardens, which is noted as naturalist *Gerald Durrell* help plan, is also located near the town.

The presence of the *Bafut* market, which is very vibrant in the area; occurring every eight days to trade in fruits, spices, vegetables, meat and animals.[23]

3-The Arts Council of the African Studies Association (ACASA)Againstattack on cultural Values.

The Arts Council of the African Studies Association (ACASA)—an independent professional association which exists to facilitate communication among scholars, teachers, students, artists, museum specialists, collectors, and all others interested in the arts of Africa and the African Diaspora—condemns the violent aggression perpetrated by the Republic of Cameroon against the Palace of Bafut, a site included on UNESCO's Tentative List of World Heritage Sites since 2006. Human Rights Watch reports that "On September 24, 2019, soldiers from the Rapid Intervention Battalion (BIR) attacked and looted the Royal Palace in Bafut, North-West

[21]CAA endorses its affiliate society, the Arts Council of the African Studies Association (ACASA), in condemning recent reports of theft, property damage, as well as violence at the Palace of Bafut in Cameroon.

[22]-Interview with Tanda Augustine, in Yaoundé, on 2 March 2021

[23]-Bafut Palace https://www.inf.org/project/bafut-palaceWorld Monuments Fund Pictures

region. FonAbumbi II of Bafut protested the aggression in a letter dated September 24, 2019 and addressed to the Governor of North West Region. In addition to causing damage to buildings within the palace and perpetrating violence against those who had been neither charged nor tried in a court of law, these troops representing the authority of the State took away, historical objects from the palace museum away.[24]

4- Bafut Remain a Cultural Heritage Attraction

According to the World Monuments Fund, the palace "embodies Bafut cultural identity and remains a centre for religious rites and traditional ceremonies like the Abine-Mfor and Mandele dances. Over 50 houses are clustered around the site's spiritual core, Achum Shrine, are used by the Fon (king), his wives, and the royal court." The palaces and museums of the North West Region of Cameroon serve as invaluable repositories of the long-standing traditions and material cultures of these vibrant kingdoms. These palaces and associated sites—where ritual practices have long been performed—foster and house the heritages, both tangible and intangible of these communities. The violent destruction and looting of such a site may be understood as an attempt to erase the cultural identity of the Bafut population, Cameroon and the outside World hence an abuse to global patrimony. As a site listed on the Tentative List of World Heritage Sites, Bafut Palace is recognized as holding even greater than just local significance, constituting a primary locus of cultural heritage for the entirety of Cameroon, and indeed the world. The Cameroonian State must treat these places as the internationally significant cultural heritage sites that they are.

5-A Cry for protection of cultural obligation as a state project

ACASA calls on the Republic of Cameroon to protect sites of cultural heritage as required by being party to the 1954 Hague Convention for the Protection of Cultural Patrimony Property. According to Article 4(3) of the aforementioned convention, it is the obligation of the State "to prohibit, prevent and, if necessary, put a story to any form of theft, pillage or misappropriation of, and any acts of vandalism directed against, cultural patrimony property." In light of this international obligation, the Cameroonian State should bring to justice and punish appropriately those responsible for this heinous act just to prohibit them for such further act. Furthermore, every effort must be taken to return looted items of cultural heritage to the palace museum of Bafut.[25]

CONCLUSION

Finally, Conceptual framework of the study and contextual history narration of Bafut Kingdom, Manifestation evolving within and around of the Abinfo'o and the Mandele dance activities, The evolution of the Abin-fo'o and the Mandele dances in the Bafut fondom, and finally, the importance and Consequences of the Abin-fo'o and Mandele Dance are the axis in which this article rotates**.** The Better World Cameroon's (Ndanifor) Permaculture Ecovillage Demonstration Land Trust in Bawum is a major contributor to the operations of the Bafut Ecovillage Vision 2020 working with the aim of reconnecting Bafut Youth to their cultural heritage. Also with the goal of striking a balance between economic, social and environmental needs.Bafut image is in Better World Cameroon joined Action in Ecovillage Vision 2020, to actively promote culture, indigenous knowledge systems related to soil fertility, providing rehabilitation and long term care to plants and animals through a climate campaign. Better World Cameroon works closely with the Cameroon Government and Global Ecovillage Network in Africa to protect natural heritage sites and cultural development through Permaculture Education and Social support as a means of preserving Path of Cameroon Patrimony. Since 2000 Better World Cameroon has adopted Bafut and devoted to transitioning it to resilience. Bafut Permaculture Ecovillage as support structure for implementing Bafut Eco vision 2020. The Sustainable Development Goals in Cameroon envisions Bafut as a centre for international partnerships. The nearby location of the botanical garden,Savanna Botanic Gardens, which noted naturalist NgwaChe Francis now of blessed memory, Help Plan, is located near the town. The presence of the Bafut market, which is a very vibrant one in the area with a lot of patrimony values sold in it, occurring every eight days, selling fruits, spices, vegetables, meat and animals and fabricated cultural materials.[26]

The town of Bafut is probably best remembered as the place where the famous naturalist Gerald Durrell came on two animal-collecting expeditions in 1949 and 1957. Durrell wrote two accounts - *The Bafut Beagles* and *A Zoo in My Luggage*, on his travels in Bafut, he created a mini-TV series, *To Bafut with Beagles*. Due the richness

[24]CAA News Today, CAA Endorses ACASA's Statement Concerning Destruction of Cultural Patrimony in Bafut, posted by CAA — Dec 16, 2019 and (https://www.hrw.org/news/2019/10/11/world-heritage-site-attacked-cameroon#)

[25](https://www.wmf.org/project/bafut-palace)

[26]Interview with Tanda Augustine, in Yaoundé, on 2 March 2021.

and beauty attractions, on September 24, soldiers from the Rapid Intervention Battalion (BIR) attacked and looted the Royal Palace, in Bafut, North-West region.[27]This has been seen as an error but destroying the dreams of the following important personalities who are cultural patrimony Developers; Paul Biya, President of the Republic of Cameroon, Henri EtoundiEssomba, Ambassador of the Republic of Cameroon to the US, Peter Henry Barlein, US Ambassador to the Republic of Cameroon, NarcisseMouelle Kombi, Minister of Arts and Culture for the Republic of Cameroon, UNESCO. The fon of Bafut called on the indulgence of the above to make them aware because he is just a care taker, protector of Bafut patrimony which he needs to inform them, to protect Cameroon cultural heritage as promulgated by them and put under his care.[28]What actions can be suggested and put in to practice to preserve Bafut Cultural heritages and that of the entire grassfields and the country Cameroon?

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Human Sexuality: A Report on Paraphilias and the Reality of Sexual Behavior in Porto Velho, Rondônia, Brazil

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Keywords ***—Human Sexuality, Masochism. Paraphilias. Perversions. Sadism. Voyeurism.***

Abstract— *This study was carried out in the second semester of 2017 as an investigative activity of the discipline "Human Sexuality" in the Psychology Course of the Federal University of Rondônia, with field research carried out in the city of Porto Velho. This article presents a descriptive study on some types of sexual perversions also called paraphilias. A survey study was conductedwith semi-structured interviews with two subjects. Paraphilias are sexual attitudes different from those accepted by society, that is, they are forms of pleasure displaced to objects that are not very common from a sociocultural point of view. Paraphilic people only obtain full sexual pleasure when in the presence of the directed object or in the different way of treating and / or being treated like masochism and sadism. They present themselves in various ways, as well as the selective choice of their peers, eating / manipulating certain things, observing, smelling among others. Here we will deal with some approaches on masochism, sadism, voyeurism and other paraphilias. In the field research, two participants were interviewed, Participant I was male and 22 years old and Participant II was female, 24 years old. The answers obtained in the interviews are interspersed in the various items and pointed to a reality in which the subjects manifest themselves as inserted in certain types of paraphilia. What is evident is the fact that all paraphilias, although considered as "something unusual", integrate different types of human behavior whose direct interest is in the pursuit of sexual pleasure.*

I. INTRODUCTION

Paraphilias, were commonly called sexual perversions, are sexual attitudes different from those accepted by the majority of the population, that is, people who practice them, end up not having a so-called normal sexual life and their sexual preference for perversions ends up making such a sexual life. in something very exclusive of yours.

With the exception of pedophilia, all other attitudes can be present in people with an active and considered normal sex life. We can consider the desire for these perversions as being a different way of seeking pleasure without being characterized as a disorder.

In order to be pathological, this preference must be considered in a great intensity and only exclusive, in other words, the person cannot obtain pleasure as previously and only obtains satisfaction only when practicing the perversions. This exclusivity is thus characterized because the individual excludes what is said to be normal. People with paraphilia can have only one or more types.

Question 7 - Did you talk about your fetish, how do you experience it in your daily life, in your relationships?	
PARTICIPANT	**ANSWERS**
I	*Naturally the friendships that I have share with my practice, they send me videos of slutty and when I have idle time I also send slutty to these people, every day I end up seeing it and it gives me a certain satisfaction, people with things in common , but I think that outside the group I would be scolded, as has happened a few times.*
II	*I live in a natural way, like my husband also likes to watch porn movies and we always end up watching together, I watch at least one a day I participate in several WhatsApp groups if I don't see one during the day I feel incomplete, I particularly I only gave my husband a chance just because he had a beard, I find that very attractive in men.*

Question 8 - Would you feel ashamed if you were scolded?	
PARTICIPANT	**ANSWERS**
I	*I am not ashamed, but I would feel that I do not accept people are very "puritanical" (being sarcastic), they generally do not accept the different, it happened at once I am in a group talking about slutty, whoring, everyone was talking about ... and I thought that maybe I had the freedom to show an innocent video of exotic, creative sexual positions and they were offended and scolded me I felt sad, but then it passed, the context was propitious, but it was bad.*
II	*Didnotanswer*

Question 10 - How did you discover these fetishes and start enjoying pornography?	
PARTICIPANT	**ANSWERS**
I	*The fetishes were doing, and pornography, I had an uncle, in fact I have a schizophrenic uncle. , stole his vsh tapes, magazines and posters from him, put together a collection and traded on the black market with the kids in my neighborhood for their magazines, video game.* *My mother hired the secretaries to work at home, while they washed clothes I hugged them from behind, there was no ceiling in my house still under construction I went up to the house to spy on the young and wonderful secretaries taking a shower, it was discovered that they were beaten up, even so they did not I wanted to do it with the secretaries like the magazine and the VHS that I watched stolen from my uncle, in the 90s there was a lot of libidinous program like Gugu's bathtub, songs with whoring in the lyrics that started right there.*
II	*I found out when I met my husband he showed me these videos to be honest I was a little ashamed before nowadays I can't live without, my cell phone even lives with a full memory just because I have a lot of videos to be honest I prefer to delete a photo with my husband or any other file than deleting a video (laugh)*

These paraphilias are only practiced by a small part of the population, but as their frequency is too much, that is, paraphilic behaviors are repeated and thus the number of victims of attacks increases.

Such conditions will only be taken into account as a disease when they are the individual's only and exclusive form of sexuality, and if his attempt to seek other sexual practices is unfavorable or fails, leading the individual to continue practicing these acts.

1.1. Masochism

The term masochism is a reference to the Austrian writer SacherMasoch, author of "The Venus of the Skins" (1895), a novel that describes the contract with a woman he loved, for six months he would be his servant. The novel describes the pleasure obtained through suffering, making the name masochism synonymous with pleasure obtained through pain, which can be caused by physical or moral pain.

Since its beginning at the end of the 19th century, it arouses curiosity only in the scientific context, the possible articulation of pain with pleasure causes perplexity, considering that it encompasses two areas, pain and pleasure that are opposite adding other emotions as well as affliction, passion, submission, among others, these sensations can be combined in such a way that their coexistence, even if considered contradictory, becomes indispensable in the sexual relationship of the dominant and dominated.

In 1886, KraffEbing published an encyclopedia that aimed to catalog a selection of sexual behaviors that deviated from what was considered normal and natural. Among the behaviors raised, one of them was "masochism", using SacherMasoch as a basis. It emerged as a scientific term as a sexual aberration, a work that caused great repercussion throughout Europe in the 19th century (FERRAZ, 2008), it is noteworthy that Ebing uses an exclusively biological parameter of reproduction to define deviant sexual behaviors, that is, all natural pleasure must correspond to the preservation of the species and any behavior that deviates from this pattern must be considered a sexual pathology. (KRAFFT-EBING, 1895)

From this logic KraffEbing (1886), defines masochism as being an aberrant sexual practice, being profiled in the vicinity of sadism, both of which have a fine line between pain and pleasure, and sadism is characterized by the act of inciting pain and humiliation to the other and masochism for the pleasure of being fragile and submitting to the loved object. (KRAFFT-EBING, 1886/1895)

Freud (1905/1996) who read the works of KraffEbing (1886) considers masochism as the most common of perversions as a passive form, making it link with the first point of his work in the *Three Essay* (entitled *The sexual aberrations*), which launches the hypothesis that there would be: on the one hand, an aggressive autonomized component in human sexuality in which sadism would be the clearest representative, and on the other hand, passive behavior towards life and the sexual objective that would be masochism, being thus both constructed universal characteristics of sexual life. With this in mind, Freud disagrees with Ebing in relation to his stance on sexual perversion as a deviation from the reproductive function and for the author is legitimate of the sexual instinct, that is, Freud considers that perversion will be rather the evidence of characteristics of "exclusivity and fixation "in the act or object fully replacing the normal sexual act. (FREUD, 1905/1996, p.153).

Thus, the paraphilias as a whole are faced with the question of the pursuit of sexual pleasure essentially. Among the responses of the participants we find some findings, such as:

Question 11 - Do you consider yourself sexually satisfied?	
PARTICIPANT	**ANSWERS**
I	*Well lately I have not been practicing sexual intercourse, but I consider my fuck good, so far none have complained and usually when I had asked again, but I spent a period dating, then I never ran after having sex as if I were the only one meaning of life, but I'm right, kkkhahahaha, one of the reasons for my relationship to end was because I wanted sex all the time, the partner wasn't always available, she worked and me too, she arrived tired, maybe I had the shit of high anxiety, there was a time when we didn't go out anymore, we just met to have sex and the relationship started to lose meaning, it was just about sex, and it destroyed the relationship.*
II	*Yes, I am totally fulfilled, my husband and I always make concessions where one pleases the other, I particularly always try to innovate, we love to watch some videos before starting our relationships.*

Question 12 - Do you consider yourself a compulsive sexual person when you are with someone in the relationship?	
PARTICIPANT	**ANSWERS**
I	*Maybe, well, I was a lot like that, but maybe today with maturity I would be an understandable person, I would try to understand, today I think that both of them have to want it, but sometimes a no for a woman is a yes, like "I fucking insisted"! kkkkkk, a maybe is no and a yes is a no, we mature and become more connected in these things, but I'm still a little silly.* *Maybe the person does not want the number of times I want, after I had contact with culture, study, etc. I've changed a lot.*
II	*A lot, between me and my husband I am much more compulsive I want all the time I don't have bad weather, there are times when my husband says I'm very very horny, having times to make excuses for not having sex, since I always ask him I'm available (laughter).*

Question 13 - Do you think your partners were also satisfied?	
PARTICIPANT	**ANSWERS**
I	*Yes of course, there is nothing more pleasant than feeling the waterfall, the warm all wet running down my foot ...*
II	*Yes, of course, at least and what he demonstrates and speaks.*

So, masochism places itself as an object to the other that must be violated, either emotionally or bodily, the only and complete enjoyment consists not only of being violated, but in knowing and realizing that the activity and the place in which they were placed in domination / subjugation providing enjoyment also to those who are violent. Deleuze (1983) comments in his book "Presentation by SacherMasoch" "the masochistic contract not only expresses the need for the victim's consent, but also the gift of persuasion, the pedagogical and legal effort by which the victim educates his executioner", being thus the perverse person only places himself as an object that serves the desire of another.

In the perverse structure the objective is to enjoy, with the masochist it is not different, he just experiences otherwise, since the individual puts himself in a position of offering to the enjoyment of the other, the masochistic enjoyment focuses on servitude and obedience to the phallic power of the individual. another, which occurs through subjugation, in the way it is by who dominates, that is, how it establishes this relationship, in the use of control and punishment instruments such as whips, straps, belts, among others.

Freud in 1924 deals with masochism in his article "The Economic Problem of Masochism", which will contradict his theory of the pleasure principle, as it is a principle that "regulates life" as explained by the masochist's search for pain and suffering ?! To answer this paradox, the author begins and introduces three forms (*erogenous, feminine and*moral) with which the masochist presents himself as the first, would be the primary or erogenous masochist, which is explained through the "fusion" and "defusion" of the death drives, that is, when faced with the death drive, the libido (life drive) eliminates much of the death drive directed at objects in the external world, however, the other would remain inside the organism, with the help of sexual excitatory solidarity between pain and pleasure, would have been fixed libidinally, and would be this is erogenous masochism, which would take the organism itself as its object.

The second way in which masochism is presented is the feminine, it concerns the passive action, in the active-passive relationship, in the typical situation of the female condition, that is, to be castrated, to be the object of coitus, which serves to prepare for the sexual act, or is performed as an end in itself. He relates to the infant, as a subject who actually wants to be treated as a naughty and mean child, who needs to be reprimanded by some authority, or any adult raised by the parents. The masochist seeks suffering, but also punishment or someone who imposes limits on him, which is related to the paternal function of recognizing a hierarchy, someone who establishes a relationship of power over him through the obedience he must pay to the other. We can also do this reading, since it takes us to the last and most important way,

Having confused the interpretation of masochism as an "unconscious guilt feeling", in the 1924 article, Freud substitutes the term for the expression "need for punishment" emanating from the Super-Self, or from parental powers. The Super-Self appears at the moment of

the parents' introjection (and consequently its severity, its control and power over the child) in the Self, overcoming and dissexing using the Oedipus Complex. However, in masochists, there is a regression of Moral towards the Oedipus Complex and the Self finds a way to feel pleasure through displeasure, due to a need that can only be satisfied through punishment and suffering. Repression is closely linked to guilt, which can be seen in the relationship between the Self and the Super-Self, the latter having the function of establishing moral conscience.

In the ICD 10 (International Disease Code 10) the masochist is found in "Personality Disorders of Sexual Preferences" (represented by item F65.5 Sadomasochism) which includes paraphilias which include "Preference for sexual activity that involves pain, humiliation or subservience. If the subject prefers to be the object of such a stimulus, there is talk of masochism; if you prefer to be the performer, it is sadism. Usually, the individual gets sexual arousal for both sadistic and masochistic behavior ". As for the DSM-V (Diagnostic and Statistical Manual of Mental Disorders V) it is also found in paraphilias, differentiating the agent - which can be the subject himself who ties himself or another person - and citing acts that are characterized humiliation, sales placement and more.

According to Salvador (2017) It is common to find people who grew up without having received praise or words of encouragement. Many of them lived with criticism and aggressive words. These people grow up with the idea that they are inadequate, they will never be good enough and with that comes the insecurity and fear of not being an adult capable of achievement.

The criticisms, the perception of incapacity, the repression suffered, the lack of affection make the person get used to the suffering. So, the masochist is not one who likes to be beaten or suffering, but one who has been hampered in his possibility of satisfaction. Thus, suffering becomes something familiar, accepted and even desirable, because it represents something that the masochist already knows.

Salvador (2017) reports important steps to take one of them is the establishment of a healthy sexual life and the balance of libidinal energy, is in psychotherapy, whose therapist must indicate the mechanisms of defense of the masochistic character and can point them to the client , pay attention to the environment in which the individual lives and if it is necessary to have a transformation in that environment so that that individual is no longer stimulated.

Question 4 - Do you feel you have any other fetish, for example, choking or being asphyxiated by your partner?	
PARTICIPANT	**ANSWERS**
I	*Well I like women who are a little crazy, in the sense of ... being sadistic maybe gives me a certain pleasure in sex, in the act, I think this is a fetish that I have. For example, I had a girlfriend that she wasn't that much in bed, she pulled my hair once, then she felt sorry because my skin was very white, she felt sorry for me, but I like these things because I understand her that the person is enjoying you know ?, I like things like that when you scratch my back, pull my hair while doing a cunnilingus (licking vagina).*
II	*No, I suffered aggression once when I was younger and I absolutely do not want this act to happen again, I hate aggression in sex.*

1.2. Sadism

Sexual sadism consists of performing acts in which the individual derives sexual excitement from the victim's psychological or physical suffering. He acts according to his sadistic sexual desires with a partner who either consents or does not suffer pain or humiliation. Fantasies or sadistic acts may involve activities such as: tying, spanking, whipping, burning, administering electric shocks, raping, stabbing, strangling, torturing, maiming or even killing their victims (MURIBECA, 2009).

Sadism, a term coined by Krafft-Ebing based on the texts Marquês de Sade, was defined by him at the end of the 19th century, as the pleasure experienced in cruelty inflicted on another (MELLOR, 2005). In psychoanalysis, sadism finds its definition in an association of sexuality and violence exercised on the object, where the one who inflicts pain enjoys the identification of the suffering object. Put another way, sadism is understood as a sexual perversion in which satisfaction is linked to the suffering or humiliation of others (MURIBECA, 2009).

In the origin, we are perverse, and the Oedipus complex is that, in its function of normatization, of introducing the norm, of the law, to repress these drives or not, making the individual neurotic, or not, depending on the effectiveness of the incidence of norm imposed by oedipal triangulation (DONOSO, 2011).

Question 5 - Do you like doing this with your partner too or just receiving it?	
PARTICIPANT	**ANSWERS**
I	*I like to receive and I also like to do, maybe that thing to hang, or I like to do with my partner, but lovingly in common agreement, not aggressively, hang to give a tug of hair, talk to a slut, dirty words at the ear I think it's interesting.*
II	*Didnotanswer.*

> We have always recognized a sadistic component in the drive, as we know, it can become autonomous and govern, as a perversion, the sexual aspiration integrates the person. And one of what we call "pre-genital organizations" also stands out as a partial drive (FREUD, 190, p.52).

There are often moderate degrees of sadism and masochism in the sexual relationships of healthy people and mutually compatible couples often seek these activities with their partners. For example, the use of silk scarves to simulate moorings and soft spankings during sexual activity are frequent practices among couples who consent and are not considered sadomasochism (DONOSO, 2011).

Many sadists interact with a consenting partner, who may exhibit sexual masochism. In these relationships, humiliation and spanking are simply simulated, with participants knowing it is a game, carefully avoiding real humiliation or injury. The fantasies of total control and dominance are often significant and the sadist can tie and gag his partner in a very elaborate way.

People feel anguish for their behavior or are unable to perform functions due to their behavior, they take these acts to the extreme, sometimes causing serious physical or psychological injury or even death, the acts involve partners who did not give consent, when practiced with partners who have not given consent, sexual sadism is considered a crime and is likely to continue until the sadist is apprehended.

Sexual sadism is not synonymous with rape, a complex mixture of sex and power over the victim. Sexual sadism is diagnosed in less than 10% of rapists, but in 37 to 75% of people who have committed sexually motivated homicides. Sexual sadism is especially dangerous in people who also have antisocial personality disorder.

Question 9 - Did you say that you like to pat yourself at the time of the relationship, more spicy things, how does this happen in your sex with your partners?	
PARTICIPANT	**ANSWERS**
I	*Well, casual sex hasn't happened to me yet, meeting a girl in one night and having sex at the same time and all, all my experiences and I try to get to know her slowly, then creates intimacy and rolls, I'm very shy actually, in the first sex we get to know each other, if it's nice for both of us, we repeat, from the moment that intimacy is created in bed, things become more chili, then I try a few pats, I say that she can also feel free with me too to fulfill your wishes, minus the finger in the rectum, nor rapo there that is not to confuse things, if you are going to mow the lawn it is because there will be kkkkkkkk.*
II	*Didnotanswer*

1.3. Voyeurism

Voyeurism was identified as one of the various forms of perversions described as anomalies of the sexual instinct, in the last decades of the 19th century, by pre-psychoanalytic authors (CARNEIRO, CORDEIRO, CAMPOS, 2005). Voyeurism according to DSM-V (2014, p. 685) is "spying on other people in private activities", that is, it is characterized by a recurrent excitement when observing someone naked, undressing and / or in full sexual activity, without your consent.

> The paraphilic focus of Voyeurism involves the act of observing individuals, usually strangers, without suspecting that they are being observed, that they are naked, undressing or in sexual activity. The act of observing ("peeking") serves the purpose of obtaining sexual arousal, and usually no sexual activity is attempted with the

> observed person (...) Often, these individuals fantasize about a sexual experience with the observed person, but this is rarely occurs in reality. In its severe form, the act of spying is the exclusive form of sexual activity (DSM-IV, 1996, p. 547. Apud CARNEIRO, CORDEIRO and CAMPOS, 2005, p. 5)

Carneiro, Cordeiro and Campos, (2005) brings Freud's findings in the definition of the term voyeurism as being a form of privilege in seeing something forbidden, because the tendency to see the naked sex of the other is an old component of the libido and the drive scopic originates in the modesty of the other in the face of childish curiosity. "In voyeurism, the privilege of observing without being observed involves the feeling of taking possession of the observed, asserting oneself about it without the threat of rejection and making it captive." (2005, p. 4).

Question 3 - Have you paid anyone? In the sense of having satisfaction in watching, expiating by having sex?don't fuck.	
PARTICIPANT	**ANSWERS**
I	*Man like that, I like to be the protagonist of the thing, of course I feel a satisfaction in watching porn videos in the comfort of my home, but what I really like is being the non-spectator protagonist.*
II	*Not*

What intrigues this and the various paraphilias is the fact that sexual pleasure is not found in the sexual act itself, but in several other object media, as in the case of a voyeur, his sexual arousal is directly linked to observing people in their private practices just when these individuals do not know that they are being watched. Differently from what was found in the collected interviews, there were those who called themselves "addicted to watching porn videos", but this practice is not included in the pathological voyeur, as he is not content to observe through the mediation of the screen, whether from cell phones, televisions and even the agreement of the people observed to know that they are being recorded for others to see.

Question 19 - Do you feel judged by voyeurism or your fetishes?	
PARTICIPANT	**ANSWERS**
I	*These are things we don't talk about openly with those we don't have intimacy with*
II	*Yes, a lot, there was a time when I was in the college corridor and a girl saw me watching some videos and I was extremely embarrassed, but it was just this time, more than that for me it doesn't make any difference.*

Question 20 - Do you think people would look at you differently?	
PARTICIPANT	**ANSWERS**
I	*Yes, maybe they thought me vulgar, evil, vile, etc.*
II	*Didnotanswer*

Question 21 - Would you like it to be different?	
PARTICIPANT	**ANSWERS**
I	No to me it makes no difference
II	Didnotanswer

II. OTHER TYPES OF SCHEDULES

The search for pleasure often leads to the practice of some unusual but highly important behaviors for the person who practices them.

The interview participants manifest themselves as follows

:

Question 14 - Have you ever made any more exotic spicy orders?	
PARTICIPANT	**ANSWERS**
I	*Already*
II	*Well, in my relationship and well balanced and meet all your spicy desires, because it was healthy without physical or verbal aggression because as I said before I had a traumatic experience, because if I do not answer the request if I have aggressive behaviors.*

Question 16 - Have you ever received a request that was not answered?	
PARTICIPANT	**ANSWERS**
I	*Now, the fingerprint thing in the anus, because it moves a lot with all that socially constructed imagery of masculinity, this is a taboo that I don't give up, for the symbolic., That's why my ass is like Tony Ramos, so as not to confuse things , suddenly there in the blowjob the mine wants to lower the tongue more I would say: Whoa there! Kkkkkkkkk*
II	*Did not answer*

Vampirism - it is when the individual feels sexual satisfaction in contact with human blood, usually the individuals affected by this paraphilia have the idea that the ingested blood will bring him powers. It is more common in male individuals, and according to some experts it can be triggered from traumatic events experienced in childhood.

Case: Ted Bundy is described as a vampire and a monster that scared the United States. He was an American serial killer who had great prominence in the media. He raped, kidnapped and killed 30 people in addition to practicing necrophilia and drinking the victims' blood. He is described as one of the worst serial killers in US history.

Dendrophilia - it is when the individual feels sexual attraction to plants, trees, and there may be sexual contact or not, occurring also by means of masturbation, when fruits or vegetables are inserted in the intimate parts.

Hierophilia - is the sexual desire and attraction for religious people or religious objects, such as crosses and bibles that can be used in the act of masturbation, which can occur even during services or masses. In monotheistic religions, individuals who have this paraphilia tend to feel guilty for committing such an act or simply feel the desire, while in polytheistic religions people are already more tolerant and even encouraged in some rituals that incorporate religion and sex, such as fertility rituals .

Trichophilia - sexual arousal by human hair, especially those on the head, but they can also be pubic hair, underarm hair, having numerous variations in color, size, texture, and may also be related to the arousal caused by plucking. hair removal or body hair removal.

Fetish Transvestism - it is when the heterosexual man has the need to wear feminine clothes in order to get pleasure, get excited and even to be able to perform sexual practice. Outside these contexts, the man who has this paraphilia dresses in normal clothes. At the moment and that he prefers to spend more time wearing women's clothing, there may be a gender disorder, such as transsexualism.

Podolatria - is the sexual desire for feet, which can be seen by the podolótro as if they were the buttocks or the breasts. The person who has this fetish, feels pleasure through the manipulation of Organs genitals with the feet or with the simple act of kissing, caressing or massaging them, among others, also varying in the types of feet, size of the same and of the fingers, if it is dirty or clean.

Infantilism - it is when the individual feels pleasure and excitement when being treated like a baby or a child and dressing with children's clothes and accessories. Infantilism is not to be confused with pedophilia, as the individual has no sexual desire for children and there is no sexual act with them, but the desire to be a child. It may be related to childhood trauma

or when there is the presence of a newborn that causes a lack of affection or attention given to the infatilist.

In the interviews with the subjects, we found the following findings:

Question 1 - Do you think you have any type of paraphilia or sexual fetish?	
PARTICIPANT	**ANSWERS**
I	*Maybe something that fits with voyeurism, I don't know if it reaches that much, but I like watching adult movies, pornographic content, I also like to do a lot, watching them also gives me some satisfaction.*
II	*Pogofilia (Beard fetish); Voyeurism (pleasure in observing intimacy) because I am addicted to watching porn videos; Agorafia (attraction to copulate in open places or outdoors).*

Question 2 - Do you feel that you can only have sex if you watch porn?	
PARTICIPANT	**ANSWERS**
I	*No, I like to see as much as I do, but in reality I prefer to be the protagonist, but I spend a large part of my free time watching pornography, I am part of groups on whatsap that colleagues always send this type and content, I try not to watching the videos, but that gives me a certain satisfaction, I tried to leave this group but I couldn't, it is a cooler video than the other, I also send videos to these friends in the group, we really comment on everything.*
II	*No, but I admit that it is something that helps me a lot to excite me.*

Question 6 - What is your perception about these fetishes or about having a possible paraphilia?	
PARTICIPANT	**ANSWERS**
I	*It can be harmful if someone in whom people are investing this libido feels impaired, is not in common agreement, is uncomfortable or disrespects someone's will, but if there is a common agreement right, and the person is functional, it doesn't hurt anyone , I think it's totally healthy, for example a sadist and a masochist can understand each other very well, or better if both were sadomasochists, but the big problem would be for example in the case of a rapist abuser ... then they would be a big problem, for the victims and also that person who at one time or another would be arrested.*
II	*I thinkit's normal*

III. FINISHING

As noted, various disorders all have a common goal, the search for sexual satisfaction, whether it be observing strangers (Voyeur), applying painful punishments to their partner (Sadism) or also receiving these punishments (Masochism). The search for this pleasure makes the individual use only that way of feeling sexual pleasure.

Several theories are related when talking about these paraphilias, from precepts of the Oedipus Complex theory to the lack of a power figure during childhood. It is known that a large part of these disorders are affected in childhood and that they are brought into adulthood over time.

With the advancement of generations, sexual practices considered differentiated and outside the normal standard of a given time, are leaving this stigma behind and making it a little more common practice. However, such behaviors are placed on alert when it becomes the only source for their satisfaction with risky practices that lead, in several cases, to serious injuries, mutilations and even the occurrence of deaths. Consequently, the individual, by not treating his perverse behaviors (psychotherapy), can be arrested and suffer punishment according to the law.

Question 17 - Have you ever felt forced to do something you did not want to please your partner?	
PARTICIPANT	**ANSWERS**
I	*Watching a whole movie and then having sex, as a prerequisite, I hated it lol* *It was rare but there were days that I was not in the mood to fuck, but she was, I think from the side that a relationship is both the two donate, so I donated to her.* *But even though she and I were working, after the fire burned, it was very good.*
II	*Yes, more in an old relationship, 1st boyfriend not with my current husband the 1st boyfriend housed me to do oral sex with violence in which he had physical strength to interrupt and a very bad experience that I had and right after forcing my head on his penis he tore my clothes and practiced sex with me by force I was literally abused.*

What we can see with the production of this article was the prevalence of respondents in enjoying porn videos and the erroneous name of this taste of voyeurism, that is, when asked about having some paraphilia, the respondents answered among others the voyeurism by watching adult videos. , but what is called a paraphilia is the fact that sexual pleasure is directed towards object media not common among society, that is, the peak of sexual pleasure of paraphilic people is directly linked to "foreign" media and not in the sexual act itself .

Question 18 - Did you feel fulfilled when practicing a sexual fetish?	
PARTICIPANT	**ANSWERS**
I	*Yes, I had a partner who didn't have the practice of sitting on top of it and doing that hitchhiking, so I suggested she agreed, mine took me crazy, especially when she started to become an ace.*
II	*Yes, I always feel fulfilled when my husband meets my requests, and he had a very interesting story, that practically sexual activity in a totally unusual place that I admit I was very scared because it was my job but after the first time, always that we can do this adrenaline rush and wonderful.*

The pleasure of the voyeur is in observing without people, knowing their private intimacy, this is the pathological voyeur, since the interviewees are observers mediated by cell phones, televisions, with which videos are recorded for these purposes, in which the protagonists they know that they are being recorded and for the purposes that are being recorded, that is, there is consent to be observed, so it is not a satisfactory target for a voyeur. It may be a gateway, but not the symptom itself.

Other types of paraphilia were not addressed in this study. Among them, Tricophilia, Podolatria, Infantilism, Zoophilia, Coprolaquia, Urolaquia, Necrophilia, among others, which demands the need for further investigation.

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The flow of sound pathways through the music network: introduction and analysis of music connections

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***Abstract*—** *In this paper, the concept related to the music connections is presented. It concerns a detailed analysis of the creative processes related to music composition. An innovative geometrical-based approach aimed to trace, analyze and understand the melodic and harmonic music processes has been introduced. In particular, the connections graph representing the geometry of the harmonic space which includes all the potential music paradigms and sonorities is presented. This diagram allows to map and analyze the human composition processes by observing its geometric superposed trajectories. An interactive software application tool (via hardware connected to the instrument of each musician) has been made in order to determine and handle the melodic and harmonic connections. The present application can be employed to view and analyze the music transient passages along with a song or improvisation through geometrical figures. The present application provides a real-time view of the flow of sound pathways through the music network which is constantly expanding. Its shape and size depend on the musician's subjective knowledge.*

I. INTRODUCTION: THE AIM OF THE PRESENT STUDY AND THE MAIN SOFTWARE FUNCTIONS

The music concept introduced in the present paper is not related to a specific type of instrument but has a more general aim. It involves chords, scales, and more in general any generic group of notes. Scales and chords can be considered as the melodic and harmonic subgroups in which the set of 12 notes is organized. In some terms, scales and chords represent the result of an iterative study process through "trials and errors". Scales and chords can be finally employed to reduce the number of attempts, to minimize the number of "trials and errors". The algorithm implemented in the calculation program of the present study is able to map harmonic and melodic movements involving groups of notes arbitrarily played in real-time (or typed on a pc-keyboard) by the musician. From this process, geometric graphs are automatically drawn (a network of interconnected nodes) in which each node represents, in general, a specific musical scale or a specific chord. These maps can be employed for performing the melodic and harmonic analyses (any sort of music investigation) of any kind of tune. With these maps, it is possible to draw melodic and harmonic movements on graphs instead of on pentagrams. The graphs' shape is arbitrary since it is given by the arbitrary choice related to nodes placement. The interconnections between nodes are not arbitrary. The interconnections are computed by the program according to the algorithm described in the present study. The interconnections determine the graphs' shape, depending on where the competent nodes are chosen to be placed. These graphs are not intended to replace the pentagram but are intended as an auxiliary device to see and analyze the music transient passages through the music geometrical network. These graphs can

be employed to recognize recurring patterns in music, and also to represent and better explain the reasons behind specific melodic and harmonic choices. These graphs can be also intended as an auxiliary device for the visual detection and prediction of innovative unexplored harmonic and melodic solutions/ways in the human composition process. More generally, this system is not dependent on the instrument played by the musician, representing in synthesis a geometric vision (divisible into different sub-networks) of all possible interconnections between different groups of frequencies (these groups are arbitrarily considered by the individual musician, so they depend on the subjective degree of knowledge of the musician himself who, as he learns, will enrich his graphic-musical network).

Music treatises connected to math and art are those by the Yusef Lateef [1] theory (which is extrapolated by the Coltrane notebook), Arnold Shoenberg [2, 3], Nicolas Slonimsky [4], and numerous other studies [5, 6, 7, 8]. The innovative aspect introduced and analyzed in the present paper is represented by the possibility of building a network in which all the music scales (and chords) are mutually interconnected. A specific algorithm has been designed to trace the connections among scales (and chords, more in general generic groups of notes). This algorithm has been implemented in an interactive software application tool via hardware connected to the instrument of each musician. The present method considers each chord as generated by specific degrees of different scales as well as an autonomous entity (a generic group of notes) and completely unrelated to one (or more) specific scale. The main chords constituted by three notes (triads) can be interconnected by following a parsimonious voice-leading approach (i.e. two triads that have two common tones are mutually connected, while the third tone changes by one generic scale step). According to the present method, the parsimonious voice-leading approach can be adopted for connecting triads, quadriads (chords of four notes) and more in general all the chord and scale types (more in general any group of one up to twelve notes). One of the advantages carried out by the method introduced in the present study is related to the fact that connections can include whatever music scale and chord type (more in general any generic group of notes). The same paradigmatic logic to connect the triads (or whatever chord type) has been used to connect the scales (more in general any group of one up to twelve notes). Thus each scale has been considered as a container of chords (or better, each scale is like a big chord that can be subdivided into its singular components that are the chords). Chords and scales are in turn represented in a condensed/synthetic manner through the use of different symbols and colors. Chords and scales constituted by the same or a different number of notes can be reciprocally interconnected by following the specific logic that has been presented in the next sections through the main examples. In this way, the interconnected chord and scale patterns confer an original representation of the 2D music network (that could also be considered as a 3D music solid network). The network's shape depends on the number of chords and scales considered by the musician.

The methodology implemented in the in-house built software by the Author of the present study is aimed to calculate what concerns chords and scales and their mutual interconnections (starting from scale harmonizations on several levels). The methodology reported in the present study can demonstrate how there will be almost no distinction between scales and arpeggios (chords) or a single note. Generic groups of notes are considered and treated in the same manner by the software, regardless of whether the groups of notes are specifically chords or scales.

The software can provide bold insights since the use of the computer has the advantage of detecting the mutual relationships between generic groups of notes in an automated way. At the same time, the automated process makes simpler the task of the musician in discovering new relationships. The software allows performing a space-time discretization of musical pieces calibrated on the subjective preparation and knowledge of the user musician, amateur or professional. As the user learns, he becomes able to receive information of increasing detail level.

Some of the answers provided by the software are summarized in the following:

- the software allows the user to choose the environment of scales and chords to be considered and handled by the process. This feature allows the user to deal with familiar scales and chord types, according to the knowledge and goals that the musician-user wants to reach.

- the software provides the list of all the scales mutually similar at the melodic level (i.e. based on the number of notes in common between the compared scales). Any type of scale (which in turn generates chords) can be investigated.

- the software provides the list of chords that can be generated by the chosen scale starting from each note of the scale itself (scale harmonization starting from each degree of the scale).

- the software provides a list of all the scales harmonically connected to the scale chosen by the user. By

harmonically connected, it means that each scale can be connected to others through the chords it generates on each of its degrees and that at the same time are in common with other scales (for instance the *C major/ionian* scale is harmonically connected to the *G major/ionian* scale because both generate and therefore share the *Am, Am7, Amadd4, Amadd9, C6, Cadd9, Cmaj, Cmaj7, Em, Em7, Emadd4, G6, Gadd4, Gadd9, Gmaj* chords (pivot chords); many other examples of this kind exist).

- the software provides the list of all the chords melodically similar in absolute terms (i.e. regardless of the scale, in a way completely unrelated to a reference scale and the related and potential harmonic areas) to any type of chord chosen by the user, having a certain fundamental (namely the reference first degree of the chord and denoted by number 1; the fundamental can be the bass note of the chord or not). Even if the scales did not exist and only notes and generic groups of notes (i.e. chords) were assumed to exist, the *Em7* chord (here reported as an example) is in any case melodically similar to the *G6* chord based on the number of notes in common between these two chords. Many other relationships of this type exist in the comparison between chords (or any generic groups of notes) at the melodic level, considered as autonomous entities and completely unrelated to one (or more) specific scale.

- many interesting relationships between chords exist also at the harmonic level: the software provides the list of chords that can be generated by the chosen chord starting from each note of the chord itself (chord harmonization starting from each "degree" of the chord).

- the software provides a list of all the chords harmonically connected to the chord chosen by the user. By harmonically connected, it means that each chord can be connected to others through the chords it generates on each of its degrees and that at the same time are in common with other chords (for example the *Cmaj7* chord is harmonically connected to the *G6* chord because both generate and therefore share the *Em* chord on their third and sixth-degree respectively; many other examples of this kind exist).

- The software provides the list of all the chords which do not allow a harmonic connection among the scales chosen by the user. These chords are not in common between scales since they are specific and proper of a specific scale besides of course the *12 notes chromatic scale.*

- For each scale and for each chord chosen by the user the software provides the list of the scales and chords included in that scale and that chord. Furthermore, for each scale and for each chord the software provides the list of the scales and chords in which that scale or chord is included. This because each scale and each chord can be included by other bigger scales and chords if all the notes of the smaller scale and smaller chord are in common with the bigger ones.

- the software provides the list of the scales and chords which include a single or a generic group of single notes chosen/played by the user.

- the software provides the list of the scales and chords which include a single or a generic group of chords chosen/played by the user.

- the software provides the list of all the chords (and also scales) which are equal but have different names (inversion substitutions in case of chords and rotation of the main scale in case of scales).

- the software provides the graphic and time-dependent network constituted by the considered chords and scales which are melodically connected since similar in terms of common notes. This time-transient network can provide useful information for the real-time analysis of the played song or improvisation, according to the time interval adopted in the analysis. Then, deeper analyses by adopting different time intervals can be performed after the song or improvisation is performed.

The software represents, in a synthesized manner, a useful tool for harmonic and melodic analyses of songs. These analyses can be performed also through the pictorial consultation of the graphic network that changes with the evolution of time, contextually to the subjective choices made by the user in the setting of inputs to the program.

II. FUNDAMENTAL MUSIC SCALES AND CHORDS STRUCTURES

The scale types (and the related *modes*) considered in the present study are reported in the following list. The structure of these scales in terms of interval related to their tonic (namely the reference starting note of the scale and denoted by number 1) has been specified in Table 1:

Table.1: Structure of the scale types in terms of interval related to their tonic (1)

Scale type	Structure
Major scale (ionian mode)	*1 2 3 4 5 6 7*
Melodic minor scale	*1 2 3b 4 5 6 7*
Harmonic minor scale	*1 2 3b 4 5 6b 7*
6 notes blues scale	*1 3b 4 4# 5 7b*
Whole-tone scale	*1 2 3 4# 5# 7b*

Half-step/whole step diminished scale	*1 2b 3b 3 5b 5 6 7b*
Whole step/half-step diminished scale	*1 2 3b 4 5b 5# 6 7*
Augmented half-step minor-third scale	*1 2b 3 4 5# 6*
Augmented minor-third half-step scale	*1 3b 3 5 5# 7*
Messiaen mode #3 (Rotation 1)	*1 2b 2 3 4 4# 5# 6 7b*
12 notes chromatic scale	*1 2b 2 3b 3 4 5b 5 5# 6 7b 7*

It has to be noted that among the scales presented, each *major* (*ionian mode*), *melodic minor*, *harmonic minor*, *6 notes blues* scale can be transposed within an octave by adopting twelve different tonics and thus obtaining twelve different scales for each scale type, each with a different tonic. The same does not happen for the *whole-tone*, the *half-step/whole step diminished*, the *whole step/half-step diminished*, the *augmented half-step minor-third*, the *augmented minor-third half-step*, the *Messiaen mode #3 (Rotation 1)*, the *12 notes chromatic* scales. In particular, the structure of these scales limits the transposition process (indeed these are also known as *Modes of limited transposition*, [7]). In particular, the *12 notes chromatic scale* does not allow any transposition since, if transposed, the same starting scale would be obtained. Therefore only one *12 notes chromatic scale* exists (whose tonic can be conventionally referred to *C*) that is the mother scale which includes and generates all the other scale and chord types. To cover an octave two *whole-tone* scales are needed and sufficient (whose tonic can be conventionally referred to *C* and *C#*). To the same aim, two *whole step/half-step diminished* scales are needed and sufficient (whose tonic can be referred to *C* and *D*), one *half-step/whole step diminished* scale is needed and sufficient (whose tonic can be referred to *C*), two *augmented half-step minor-third* scales are needed and sufficient (whose tonic can be referred to *C* and *D*), two *augmented minor-third half-step* scales are needed and sufficient (whose tonic can be referred to *C* and *D*), four *Messiaen mode #3 (Rotation 1)* scales are needed and sufficient (whose tonic can be conventionally referred to *C*, *C#*, *D*, *Eb*).

Many other typologies of scales exist, but for the sake of brevity they are not needed in order to introduce the present method. The scales incorporate, thus generate different types of chords. The types of chords considered in the present study are constituted by three and four notes. They are here reported in terms of interval structures related to their fundamental (1) in Table 2:

Table.2: Structure of the chord types in terms of interval related to their fundamental (1)

Chord type	**Structure**
dim	*1 3b 5b*
m	*1 3b 5*
5b	*1 3 5b*
maj	*1 3 5*
5#	*1 3 5#*
m/add9b	*1 2b 3b 5*
5b/add9b	*1 2b 3 5b*
add9b	*1 2b 3 5*
m/add9	*1 2 3b 5*
add9	*1 2 3 5*
m/add4b	*1 3b 4b 5*
dim/add4	*1 3b 4 5b*
m/add4	*1 3b 4 5*
m/add4#	*1 3b 4# 5*
dim7	*1 3b 5b 7bb*
m7/5b	*1 3b 5b 7b*
m/maj7/5b	*1 3b 5b 7*
m6	*1 3b 5 6*
m7	*1 3b 5 7b*
m/maj7	*1 3b 5 7*
m/maj7/5#	*1 3b 5# 7*
5b/add4	*1 3 4 5b*
add4	*1 3 4 5*
add4#	*1 3 4# 5*
7/5b	*1 3 5b 7b*
maj7/5b	*1 3 5b 7*
6	*1 3 5 6*
7	*1 3 5 7b*
maj7	*1 3 5 7*
7/5#	*1 3 5# 7b*
maj7/5#	*1 3 5# 7*

The main chords constituted by three and four notes presented in the above list are needed and sufficient to completely denote the sound of each scale from which these chords are generated. Many other typologies of

chords exist (also constituted by five or more notes), but for the sake of brevity, they are not needed in order to introduce the present method (also because they can be thought as the superposition of two or more main chords constituted by three and four notes: for example, the chord *maj7/9* type has not needed to be presented in the above list since it can be easily obtained by mixing/superposing the *maj7* and *add9* types). Suspended chords (*sus* type) have not been considered, as well as incompleted chords without the third (*no3* type), without the fifth (*no5* type), some chord *inversions* (characterized by having a constituting chord note, which is different from the fundamental, placed as the bass note) and *slash chords* of the same chord type (characterized by having any different note from the fundamental which is placed as the bass note).

2.1 SCALES HARMONIC STRUCTURE

The harmonizations of the scales presented in the previous section can be obtained (not reported for the sake of brevity) by means of the main chords constituted by three and four notes introduced in the previous section. The tonic (the first degree of each scale) that can be chosen to present each scale is the *C* note (starting note and common reference of each scale in order to distinguish and highlight the differences among the scales in terms of structure).

By observing the scales' harmonic structure, it is possible to find out the property related to employing scales that do not generate/include the target chord. This property can be generalized as follows:

- scales (more in general generic groups of notes) that do not generate/include the target chord can, in general, be employed over the target chord together with some of the scales in which they are included into only if the containing (bigger) scales generate/include the target chord.

It has to be specified that the scales and chords considered in the present study are all included in the *12 notes chromatic scale*. Focusing on the scales, there are no further mutual inclusions among the other scales considered (*12 notes chromatic scale* excluded). More specifically, it has to be noted that the *12 notes chromatic scale* can generate any chord type. Thus, the *12 notes chromatic scale* can generate all the potential melody patterns that can be sustained by all the chord types which are all generated and included in the *12 notes chromatic scale*. Therefore the *12 notes chromatic scale* can be freely employed over all the chord types and, more in general, on all the potential chord progressions. The particular structure related to the *12 notes chromatic scale*, including and generating all the harmonic and melodic material, would justify the employing of whatever scale on any chord type. This because all the scales and chords are generated and included in the *12 notes chromatic scale*. The musician's subjective taste will place a limit on the free-usage of the *12 notes chromatic scale* since very often it does not allow to confer a clear and organized sound to the harmonic and melodic processes. This is one of the reasons for which other scale types constituted by a lower number of notes exist.

It is important to notice that the *minor pentatonic* scale (not considered in the list reported in the present study for the sake of brevity) is included by the *6 notes blues* scale. For instance, the *C 6 notes blues* scale includes the *C minor pentatonic* scale that is constituted by the notes: *C Eb F G Bb*. The *C minor pentatonic* scale generates the *Eb6/9* chord on its third degree (its third degree is denoted by the name *Eb major pentatonic* scale that corresponds to the *Eb6/9* chord arpeggio).

Other two important functionalities related to the present method are reported hereafter:

- the method allows finding out all the potential scales that generate each chord, i.e. it is possible to detect all the different scales (among those considered by the system since chosen by the user-musician) that can be potentially employed over the same chord type and, more in general, on the same chord progression (see the examples reported in Section 6 of the present paper).
- Viceversa, it is also possible to detect all the scales (among those considered by the system and chosen by the user-musician) that include the chords that potentially can sustain the same melody pattern: the given melody pattern is in turn generated by the same different potential scales that generate its sustaining chords.

An investigation purposely limited to 4 chord types can be conducted by considering the *maj7, 7, m7, m7/5b* chord types.

Considering each chord individually, according to the calculations based on the scale/chord relationship, all the available standard 12 notes could be used over such chord types even if from an aesthetic point of view some subgroups of notes could be better than others. This is because the *12 notes chromatic* scale generates these chords. Even if the *12 notes chromatic* would not be considered (bypassed/avoided) by the system, all the 12 notes can be covered in any case by considering as a whole the group of notes which constitute all the scales that generate/include each of these chord types. Once again it has to be noted how the *12 notes chromatic scale* can

generate all the potential melody patterns that can be sustained by all the chord types which are all generated and included in the *12 notes chromatic scale.*

The chord harmonization (starting from each "degree" of the chord) related to the main chords constituted by three and four notes presented so far can be obtained (not reported for the sake of brevity).

III. DESCRIPTION OF THE GENERAL ALGORITHM TO FIND OUT THE RELATIONSHIPS BETWEEN CHORDS/SCALES

The general algorithm adopted for finding the relationships between chords/scales/single or generic groups of notes is described hereafter:

- Starting from a certain note, whatever note can be chosen after any other one since two notes differ for 1 note.

Considering this statement it is possible to present the general algorithm based on the parsimonious voice-leading approach and building the related graph's network. More in general, the algorithm compares the single or generic groups of notes at the same *k* number of notes (if two compared groups of notes are originally characterized by a different *k*, the additional uncommon notes have not to be taken into consideration by the process). To be declared similar and thus connected, two generic notes or groups of *k* notes must have at least (*k*-1) common notes. When two different single notes are compared *k*=1. Therefore whatever two different single notes result to be similar (thus connected) in any case since they obey the general criteria for which they have (*k*-1)=0 common notes.

- Considering different groups of notes of the same or a different number of notes, it is possible to present the general algorithm to derive some interesting relationships between different notes, scale types, and chord types.

Given two different sets A and B each having a certain number of elements (A can have the same or a different number of elements of B), the following relationships can be written by superposing or subtracting the two different sets:

A+B=A if B already included in A (1)

A+B=B if A is already included in B (2)

A+B=C if A and B are not included in each other even if they share some or no elements in common (3)

(A+B)-B=E if A and B share some or have all the elements in common (4)

(A+B)-A=F if A and B share some or have all the elements in common (5)

A-B=A if B is not included in A and do not share common elements (6)

B-A=B if A is not included in B and do not share common elements (7)

A-B=D if A and B share some or have all the elements in common (8)

(A-B)-B=D-B if A and B share some or have all the elements in common (9)

(A-B)-A=D-A if A and B share some or have all the elements in common (10)

(A-B)-B=A-B if B already included in A (11)

(B-A)-A=B-A if A already included in B (12)

From these general properties written among different sets A and B, it is possible to find out some interesting relationships between different notes, scale types, and chord types:

- A-B=D if A and B share some or have all the elements in common (13)

C_major scale – C_major pentatonic = (F + B) (14)

C_major scale – C_Melodic minor = E – Eb (15)

C_major scale – D_Melodic minor = C – C# (16)

C_12 notes chromatic scale – C#_Whole-tone scale= C_Whole-tone scale (17)

C_12 notes chromatic scale – Eb minor pentatonic=C_major scale (18)

In these examples the groups of notes A and B can be declared similar and thus connected since the two sets A and B have at least (*k*-1) common notes when compared at the same *k* number of notes. The last examples concerning the *C_Whole-tone scale* and the *C_major scale* show how the resulting group of notes (D= *C_Whole-tone scale; C_major scale*) can be viewed as generated by the subtraction of two groups of notes (A= *C_12 notes chromatic scale* and B= *C#_Whole-tone scale; Eb minor pentatonic*) which are not necessarily connected to D (the *C#_Whole-tone scale* and the *Eb minor pentatonic* are not connected to *C_Whole-tone scale* and *C_major scale* respectively). In particular, it has to be noted how the *Eb minor pentatonic* is the farthest scale from the *C_major scale* since they have no common notes (when compared at the same *k* number of notes).

- A+B=C if A and B are not included in each other even if they share some or no elements in common (19)

C_Whole-tone scale + C_Augmented half-step minor-third scale = C_Messiaen mode #3 (Rotation 1) (20)

C_Whole-tone scale + D_Augmented minor-third half-step scale = C_Messiaen mode #3 (Rotation 1) (21)

These last examples, together with the one reported hereafter, show how the same resulting group of notes can be obtained by applying different operations between different sets which are all easily derived from the general relationships written so far.

Cmaj7 + D minor pentatonic=C_major scale (22)

E minor pentatonic + D minor pentatonic=C_major scale (23)

Cmaj+Cmaj7 + C major pentatonic + D minor pentatonic =C_major scale (24)

Cmaj7– Em= C (25)

Cm7– Ebmaj= C (26)

Cmaj – (E + G)= C (27)

Cm– (Eb + G)= C (28)

(C+G) – G= C (29)

C_12 notes chromatic scale – D_major scale – A_major scale – F#_major scale = C (30)

C_12 notes chromatic scale – D_ Melodic minor – Ab_ Melodic minor – F#_ Melodic minor = C (31)

C_12 notes chromatic scale – Ab_ Harmonic minor – F#_ Harmonic minor = C (32)

These examples demonstrate how the same note or group of notes emitted can be the result of different parallel processes. This also would highlight how what is not played secretly helps to define what is played.

IV. THE REAL HARMONIC CONNECTION DEGREE BETWEEN DIFFERENT SCALES

Even if the described general algorithm is adopted for finding the relationships between generic groups of notes, in the present section the generic groups of notes are constituted by scales.

- The present software allows finding the number of common chords (also known as pivot chords) between the scales. This number expresses the *harmonic connection degree number* between the different scales. The same procedure can be applied for finding the number of common chords between the chords. In this case, the number expresses the *harmonic connection degree number* between the different chords.

A first example (not reported for the sake of brevity) can consider the above main chords constituted by three and four notes and the scale types presented so far. Only the *harmonic connection degree numbers* related to the *C major (ionian)* scale have been reported, even if the general algorithm implemented in the software tool can manage whatever type of scale having any tonic. Therefore the comparison process has been performed internally to the software among all the scales considered in the system and chosen by the user.

It has to be noted that the harmonic similarity level among scales (and in general among generic groups of notes) is expressed by the *harmonic connection degree number*. The compared scales are classified from the highest to the lowest *harmonic connection degree number*. The *C Ionian* scale (as well as any other considered scale, except for the *12 notes chromatic* scale) has a harmonic link with some of all the other scales when the above main chords of three and four notes are considered. It can be noticed that the *5b/add4* is the only chord type (among those chosen by the user) that does not allow any harmonic connection among the scales chosen by the user. The *5b/add4* chord type is not in common between scales since it is specific and proper of the *Messiaen mode #3 (Rotation 1)* scale besides of course the *12 notes chromatic scale*. Then the *real harmonic connection degree number* between the different scales presented so far can be introduced. Some general properties can be summarized in the following list:

- The *real harmonic connection degree number* is different from the *harmonic connection degree number*. The *real harmonic connection degree number* has been obtained by considering the *basic chords*.
- A *basic chord* is a particular chord type constituted at least by two and a maximum of three notes. The *basic chords* are conceptually different from the main chords constituted by three and four notes presented so far; the *basic chords* are not explicitly presented but only used and reported in the text as background information. By taking into account all the existent *basic chords* (whose names are not reported in a list for the sake of brevity) it is possible to derive the *real harmonic connection degree number* between the different scales since these chords constitute the base, the foundation for all the other chords (all the other chords constituted by four or more notes can be

considered as the superposition of two or more *basic chords*). Each *basic chord* contains the minimum group of notes needed to derive all the other chords and in general groups of notes by combining (superposing) different *basic chords*.

- The *real harmonic connection degree number* expresses how many *basic chords* are in common between two different scales, thus univocally represents the real harmonic connection's level between different scales.
- In general, the *real harmonic connection degree number* and the *harmonic connection degree number* do not coincide. These can coincide if the *basic chords* are exclusively taken into account in the harmonic comparison investigation. Only the *real harmonic connection degree number* is needed and significant to quantitatively represent the real harmonic connection's level between different scales.
- The classification related to the compared scales from the highest to the lowest *harmonic connection degree number* (not reported for the sake of brevity) would coincide with the one denoted by the *real harmonic connection degree number* (not reported for the sake of brevity) only if all the *basic chords* were taken into account and included in both the harmonic comparison investigation types. Only the *basic chords* are strictly needed to compute the *real harmonic connection degree number* because the *basic chords* constitute the base, the foundation, for all the other chord types.

In this case, since all the existent *basic chords* have been considered, the *C Ionian* scale presents a harmonic link with all the other scales considered in this study except with the *Eb 6 notes blues* scale. In this case, all the *basic chords* allow a harmonic connection among the scales chosen by the user since at least one *basic chord* is in common among all the scales. It has to be noted that, as clarified in the previous Section, it is no needed that the different scales (and in general the different generic groups of notes) have the same number of notes for the scale harmonic comparison process. The harmonic comparison process can be carried out also among scales constituted by a different number of notes. From a mathematical point of view, it is possible to highlight the following property:

- scales that originally have a lower number of notes also have a lower number of generated chords. Therefore the scales that originally have a lower number of notes tend to have a lower *real harmonic connection degree number* by their nature, despite their high melodic connection level with the bigger scales to which they relate to.

In fact, the scales that have a lower number of notes are often included and similar to the bigger ones. This concept introduces the *melodic connection degree number*.

4.1 THE MELODIC CONNECTION DEGREE BETWEEN DIFFERENT SCALES

In the previous section, the scales have been harmonically compared detecting the *real harmonic connection degree number*.

- As seen, the scales generate, thus include, the chords. In turn, each scale, being the container of the chords that it generates, can be considered as a bigger chord constituted by the notes of the scale itself. The *12 notes chromatic scale* is the biggest container since it includes and generates all the other scale and chord types.
- In their turn chords can also be considered as groups of notes, thus as little scales contained (or generated) by bigger scales. Thus chords can be harmonically and melodically compared as well as the scales. Then chords (being little scales) can be directly compared also with scales. When the chords are harmonically compared, the *real harmonic connection degree number* and the *harmonic connection degree number* are detected (as well as for the scales).
- In general, the present method allows to melodically compare all the chords and scales, thus detecting the *melodic connection degree number*. From now on and within the present Section, the chords will be referred to the term scales indifferently. Groups of notes would represent a more general and precise term; the term "scales" has been chosen for the sake of brevity.
- The *melodic connection degree number* expresses the number of scales that are similar to each scale. The *melodic connection degree number* represents in an absolute manner, the melodic level of connection among scales. A scale characterized by a high *melodic connection degree number* has a high corresponding number of connected scales. Specifically, it has to be noted that the chords are

generated/included into the scales, thus unavoidably connected since similar to the scales from which are generated.

- It has to be specified that the scales and chords considered in the present study are all included (thus similar and connected) in the *12 notes chromatic scale*. Focusing on the scales, there are no further mutual inclusions among the other scales considered (*12 notes chromatic scale* excluded).

The melodic comparison process is carried out by the algorithm implemented in the software tool for all the scales considered in the system (these are chosen by the musician user while playing any instrument or typing on a pc-keyboard). The algorithm compares the scales at the same number of notes *k* (if two compared scales are originally characterized by a different *k*, the additional uncommon notes have not to be taken into consideration by the process). To be declared similar, two scales of *k* notes must have at least (*k-1*) common notes.

A first example (not reported for the sake of brevity) considers the melodic comparison among the scale types presented so far. For the sake of brevity, only the *melodic connection degree numbers* related to each scale type having the *C* note as the tonic have been reported. Anyhow, the general algorithm implemented in the software tool can manage whatever type of scale having any tonic. The comparison process involves all the scales taken into consideration by the system (these are chosen by the musician user while playing any instrument or typing on a pc-keyboard). The scale types are those presented so far.

- Remember that the scales that originally have a lower number of notes tend to have a lower *real harmonic connection degree number* by their nature, despite their high melodic connection level (*melodic connection degree number*) with the bigger scales to which they relate to.

The scales that have a lower number of notes are often included and similar to the bigger ones. For example, the *C major (ionian)* scale is melodically connected to the *D 6 notes blues, E 6 notes blues, A 6 notes blues, B 6 notes blues* scales, as well as the *F Ionian, G Ionian, C Melodic minor, D Melodic minor, A Harmonic minor, Eb Messiaen mode #3 (Rotation 1)* scales despite the *C major (ionian)* scale has a lower *real harmonic connection degree number* related to the *6 notes blues* scales (and a higher *real harmonic connection degree number* related to the *Ionian, Melodic minor, Harmonic minor, Messiaen mode #3 (Rotation 1)* scales).

- In most of the cases involving scales having the same number of notes, the scales melodically connected (for example those connected to the *C major (ionian)* scale) provide a corresponding high value of the *real harmonic connection degree number* (those related to the *C major (ionian)* scale). This because in general, scales melodically similar are also harmonically similar (compatibly with the number of notes and consequently of chords generated by each scale considered in the comparison process). Among the scales of 7 notes melodically connected to the *C major (ionian)* scale, the *F Ionian, G Ionian, C Melodic minor, D Melodic minor, A Harmonic minor* scales having the same number of notes (7), provide a correspondingly high value of the *real harmonic connection degree number*.

A second example (not reported for the sake of brevity) considers the melodic comparison process involving all the chords (that are treated as little scales) constituted by three notes presented so far. As for the previous example, for the sake of brevity, only the *melodic connection degree numbers* related to each chord having the *C* note as the fundamental have been reported, even if the general algorithm implemented in the software tool can manage whatever type of chord (scale/group of notes) having any fundamental. The comparison process involves only the chords of three notes presented so far and taken into consideration by the system (these are chosen by the user/the musician while playing any instrument or typing on a pc-keyboard).

- It has to be taken into account that the software allows detecting the chords (and also more in general the scales or any group of notes) that in some cases are characterized by the same notes despite their different names. These involved chords can be of the same family or not. In both cases, they constitute examples of the *inversion substitution* type. Among the chords of three notes presented, the *inversion substitutions* detected by the software and related to each chord having the *C* note as the fundamental have been reported hereafter:

$$\boldsymbol{C5\# = E5\#} \quad (33)$$

$$\boldsymbol{C5\# = G\#5\#} \quad (34)$$

It can be noted how the *melodic connection degree numbers* that denote the connection level among scales are preferably presented separately from those specific among chords (although at the beginning of the present Section it was stated that the chords would be referred to the term

"scale" indifferently). This because, as it will be presented in the next section, the graphs/diagrams that express the *melodic connection degree numbers* result to be conveniently represented distinctly in order to obtain an optimized graphical representation. Being the number of connections very high, their trajectories tend to excessively superpose each other.

- Therefore one or more graphs for the *melodic connection degree numbers* among chords and one or more graphs for the *melodic connection degree numbers* among scales have been traced separately. On the other hand, it has to be kept in mind that each chord has a melodic connection with each scale in which is included (hence similar) and more in general each chord has a melodic connection with each similar scale. These connections among chords and scales have not been explicitly presented in the graphs of the present study but they have been reported in the text as background information.

Remember that each chord takes part also in the *harmonic connection degree number* determination, as seen in the previous section.

- For the sake of completeness, among all the main chords constituted by three and four notes presented so far, the *inversion substitutions* related to each chord having the *C* note as the fundamental have been reported in the following list:

C5# = E5# (35)

C5# = G#5# (36)

Cadd9b = Dbm/maj7/5b (37)

Cm/add4b = Em/maj7/5# (38)

Cdim7 = Ebdim7 (39)

Cdim7 = Gbdim7 (40)

Cdim7 = Adim7 (41)

Cm7/5b = Ebm6 (42)

Cm7 = Eb6 (43)

C7/5b = Gb7/5b (44)

For the sake of completeness, among all the main chords constituted by three and four notes presented so far, the *Harmonic connection degree numbers* related to the *C major* chord can be obtained (not reported for the sake of brevity), even if the general algorithm implemented in the software tool can manage whatever type of chord having any fundamental. From the *Harmonic connection degree numbers* related to the *C major* chord inspection, it is straightforward to notice how the *Cmaj* chord has a harmonic link with 12 of the 31 chord families presented at the beginning of the paper.

V. THE NETWORK OF MUSIC CONNECTIONS

In this section, the network of the music connections among chords and scales has been presented. As stated in the last section, these graphs and the related connections can be traced by taking into account the *melodic connection degree number*. These graphs/diagrams express the *melodic connection degree numbers.* The number of connections among scales/chords corresponds to the *melodic connection degree number* related to each scale/chord. The music universe is constituted by notes, scales, and chords. As stated in the previous Section, chords can also be considered as generic groups of notes, thus as little scales contained (or generated) by bigger scales. Thus chords can be harmonically and melodically compared as well as the scales. Then chords (being little scales) can be directly compared also with scales. The chords are generated/included into the scales, thus unavoidably connected since similar to the scales from which are generated. For the sake of representation clarity of the present study, it has been chosen to keep distinct the music universe as seen/focused on the scales from the music universe as seen/focused on the chords. Therefore two distinct graph types (one focused on the scales and one focused on chords) will be separately presented in order to have a good quality view of the whole music universe and its constituting mutual relationships/interconnections. The two graph types coexist and, even if distinctly presented as autonomous graphs, they are implicitly connected and constitute the network of the music universe. The connections graphs have been conveniently represented distinctly (i.e. one or more graphs for the melodic connections among chords and one or more graphs for the melodic connections among scales) in order to obtain an optimized graphical representation (being the number of connections very high, their trajectories tend to excessively superpose each other). It has to be stressed that the present approach has been followed exclusively for the sake of a better representation clarity related to the study reported in the present paper even if the software considers and treats the generic groups of notes in the same manner, regardless of whether the groups of notes are specifically chords or scales.

The existent connections among chords and scales have not been explicitly presented in the present paper but these can be detected as the result of employing the chords investigation function of the software (i.e. given the scale name this function gives the chords included in that scale while the trajectories between similar scales or similar

chords generated by that scale are highlighted). It has to be specified that the graphical feature related to the chords investigation function has been adopted ad-hoc exclusively for the sake of a better representation clarity related to the study reported in the present paper.

These graphs allow detecting all the potential melodic and harmonic choices, i.e. all the potential music paradigms and sonorities. These diagrams allow to map and analyze the human composition processes by observing their geometric superposed trajectories. By assuming a polar coordinate system (r, θ), scales/chords of the same family are arbitrarily placed at the same radial (r) coordinate (by adopting the same arbitrary symbol/marker type). The term family identifies the general name of the scale/chord type without specifying the tonic/fundamental of the scale/chord; for example the *Harmonic minor* scale family and the *maj* chord family. Scales/chords of the same family but characterized by a different tonic/fundamental assume a different arbitrary angular coordinate (θ). Therefore, scales/chords of different families have different radial coordinates (and different symbol/marker types). These scales/chords can be connected to scales/chords of other families according to the connections specified by the computed *melodic connection degree number*. Scales/chords of different families but having the same tonic/fundamental share the same color that is shown in the graphs (twelve different colors are used in general). The key concepts used to represent and decode the graphs presented in this section are summarized in the following list:

- Generic groups from 2 to 12 notes (chords and scales) are considered by the present method and can be represented as symbols and mutually interconnected according to the *melodic connection degree number* to generate the music network.
- Each group of notes (chords and scales) of the same family is represented in a condensed/synthetic manner by the same symbol/marker type.
- Generic groups of notes (chords and scales) of the same family and having a different tonic/fundamental are placed at the same radial coordinate (same symbol/marker type) but assume a different arbitrary angular coordinate (different color).
- Different families of chords and scales are arbitrarily placed at different radial coordinates (different symbols/markers).
- Chords and/or scales of whatever family having the same tonic/fundamental share the same color.
- Lines for tracing the connections between similar scales and similar chords are employed.
- Each connection line is constituted by the two colors of the corresponding connected symbols/markers.
- As the musician plays a scale (or digits the scale name), the software gives the chords included in that scale (chords investigation function). The played scale and the chords generated/included in that scale are highlighted in each graph together with the trajectories between similar scales or similar chords related to the scale played (or digited). It has to be stressed that the graphical feature related to the chords investigation function has been adopted ad-hoc exclusively for the sake of a better representation clarity related to the study reported in the present paper.
- As the musician plays in real-time (or digits) a series of N notes or N chords (or a single $N=1$ note or chord), the software shows the scales (among those considered by the system and chosen by the user-musician) that include all the N notes or N chords of the series (or the single note or chord). This is the scales investigation function through which these scales are highlighted in each graph together with the trajectories between their similar scales or similar chords related to the played N notes or N chords.

The graph that expresses the *melodic connection degree numbers* among chords of the major (*maj*) and minor (*m*) families is presented in Fig. 1 as the first example:

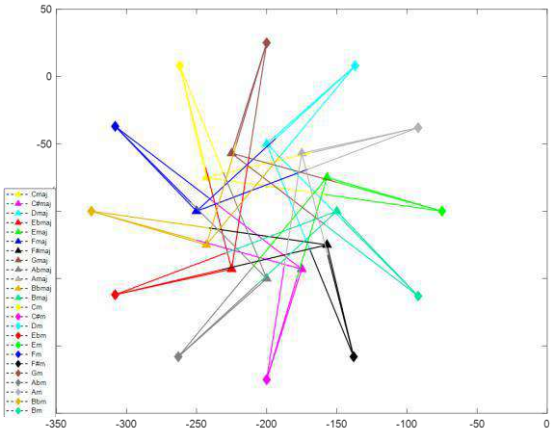

Fig. 1: Melodic connection degree numbers among chords of the major (maj) and minor (m) families.

The graph that expresses the *melodic connection degree numbers* among scales of the major (*ionian*) family is presented in Fig. 2.

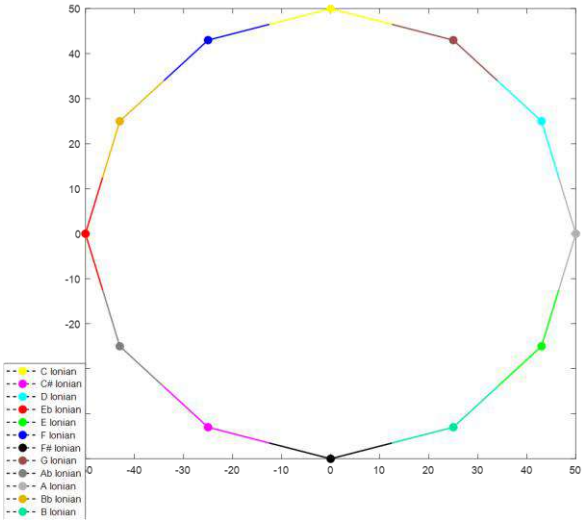

Fig. 2: Melodic connection degree numbers among scales of the major (ionian) family.

It can be noted that the graph in Fig. 2 represents the conventional circle of fifths (clockwise direction).

From these first two simple graphs, it is possible to detect and underline the existent background connections among chords and their similar scales, so far not explicitly presented. As the chords investigation function is employed, given the scale name (the software can also recognize the scale played by the musician in real-time) this function gives the chords included in that scale (scale harmonization starting from each degree of the scale). The played (or digited) scale and the chords generated/included in that scale are highlighted in each graph together with the trajectories between similar scales or similar chords related to the played scale. The graphical feature related to the chords investigation function has been adopted ad-hoc exclusively for the sake of a better representation clarity related to the study reported in the present paper. For instance, if the investigation is limited to the major (*ionian*) scales and the chords of the major (*maj*) and minor (*m*) families, when the *C major (ionian)* scale is played, it is possible to detect the chords included in the *C major (ionian)* scale together with all the highlighted trajectories between similar scales or similar chords related to the played scale. It has to be noted that the highlighted trajectories are exclusively between similar scales or similar chords and that only the played scale and the chords generated/included in that scale are highlighted (see Fig. 3). This is the representation of the *C major (ionian)* scale harmonization built with the chords of the major (*maj*) and minor (*m*) families (see Fig. 3). In addition, all the trajectories between similar major (*ionian*) scales or similar chords of the major (*maj*) and minor (*m*) families are highlighted when the *C major (ionian)* scale is played. This is a suitable way to explicitly represent the existent connections among chords and their similar scales avoiding the excessive superposition of connections trajectories, as shown by Fig. 3. It is interesting to notice that among the chords of the major (*maj*) and minor (*m*) families, all the highlighted trajectories between similar chords represent some examples of *diatonic substitution* type related to the played *C major (ionian)* scale (*Cmaj* is similar to *Em* and *Am*; *Fmaj* is similar to *Dm* and *Am*; *Gmaj* is similar to *Em*; *Dm* is similar to *Fmaj*;*Em* is similar to *Gmaj* and *Cmaj*; *Am* is similar to *Cmaj* and *Fmaj*).

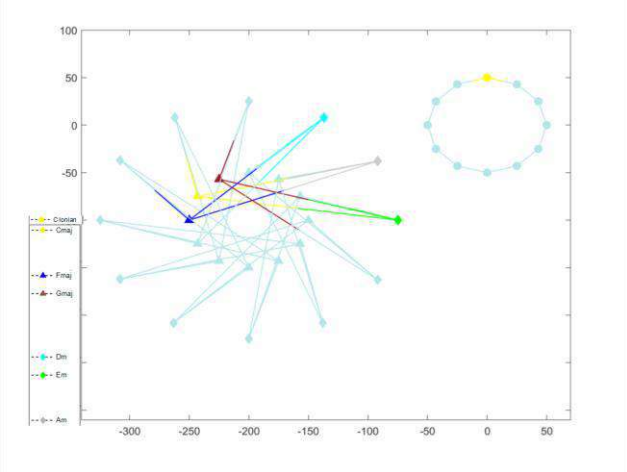

Fig. 3: Representation of the C major (ionian) scale harmonization built with the chords of the major (maj) and minor (m) families together with all the highlighted trajectories between similar scales or similar chords related to the C major (ionian) scale.

This kind of substitution involves similar chords included/generated by the same scale and takes place when the tonal scales of seven notes (*major/ionian, melodic minor, harmonic minor, harmonic major, double harmonic* and other scales) and all the existent bigger scales which contain them are considered. The graph that expresses the *melodic connection degree numbers* among the chords constituted by three notes of all the families considered in this paper is presented in Fig. 4 (the network of the music universe as seen/focused on the chords constituted by three notes of all the families considered in this paper).

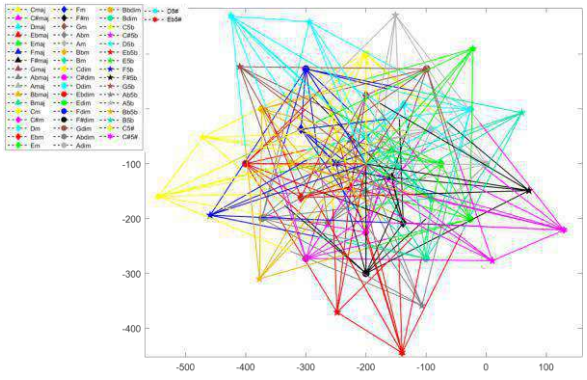

Fig. 4: The music universe as seen/focused on the chords constituted by three notes of all the families considered in this paper.

The graph that expresses the *melodic connection degree numbers* among scales of all the families considered in this paper is presented in Fig. 5a (the network of the music universe as seen/focused on the scales of all the families considered in this paper).

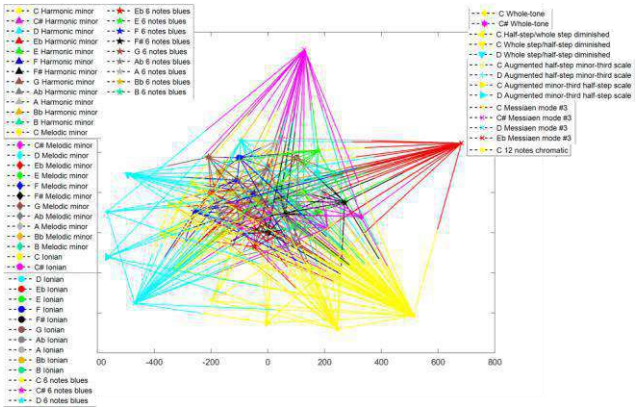

Fig. 5a: The music universe as seen/focused on the scales of all the families considered in this paper.

Remember that generic groups of notes (chords and scales) of the same family and having a different tonic/fundamental are placed at the same radial coordinate (same symbol/marker) but assume a different arbitrary angular coordinate (different color). Different families of chords and scales are arbitrarily placed at different radial coordinates (different symbols). Therefore the shape assumed by each graph is arbitrary because it can be chosen by the musician-user subjectivity through the assignment of the polar coordinates (r, θ) for each scale/chord as previously explained. For this reason, the shape of each graph can vary but the connections among the nodes (the scales/chords represented by their marker and color) constituting the music network remain the same and consistent, according to the *melodic connection degree number* related to each scale/chord, regardless of the assignment of the polar coordinates (r, θ). For these reasons the same graph reported in Fig. 5a can be equivalently represented by the one shown in Fig. 5b since the symbols (and colors) related to the scales are arbitrarily chosen and placed.

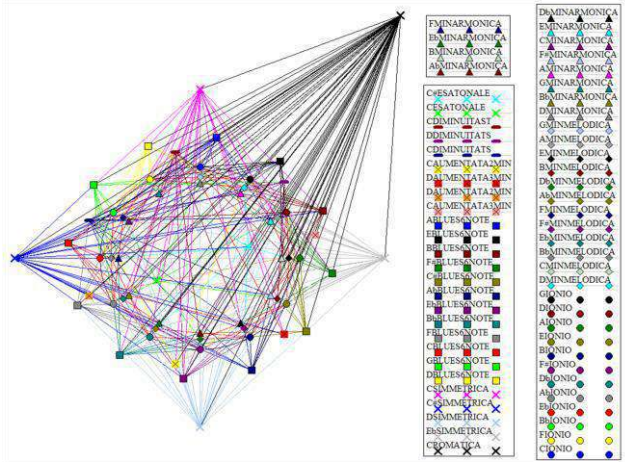

Fig. 5b: An alternative view of the music universe as seen/focused on the scales of all the families considered in this paper.

Fig. 5c shows the same graph shown by Fig. 5b without the *12 notes chromatic scale* included.

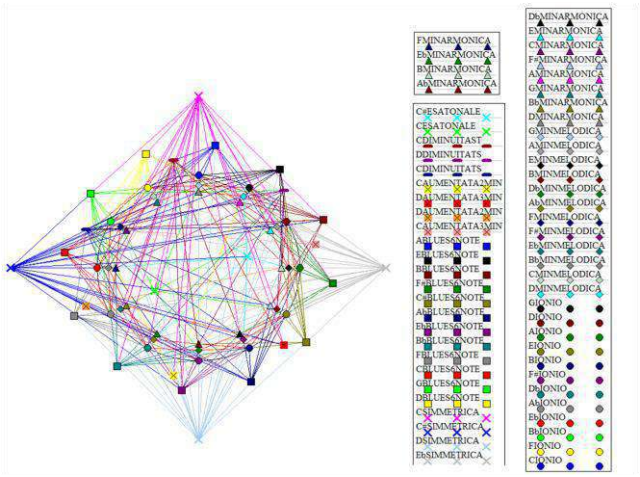

Fig. 5c: The music universe as seen/focused on the scales of all the families considered in this paper, without the 12 notes chromatic scale included.

It can be noticed how these graphs are not easy to visualize when all (or almost all) the scale/chord families are considered together in the same graph. In this case, the whole graph represents the result of the superposition of different graphs each having a lower number of scale/chord families. For this reason, each smaller graph expressing the *melodic connection degree numbers* among scales is analyzed and singularly presented hereafter as well as the one expressing the *melodic connection degree numbers* among chords. Through the series of the following smaller graphs, it is possible to demonstrate how the graph (Fig.5a) that expresses the *melodic connection degree numbers* among scales of all the families considered in this paper is the resultant of the sum (superposition) of different smaller graphs (Fig.2, Fig. 6 to 13) each containing a lower number of scale families. Fig. 14 summarizes this concept, where the superposition (+) of all the smaller graphs on the right-hand side of the equation confers the overall complete graph on the left-hand side of the equation (=), according to the relationships written in Section 3 about superposing or subtracting two different sets. Each smaller graph can be considered as a part and autonomously used in the composition process and music analysis.

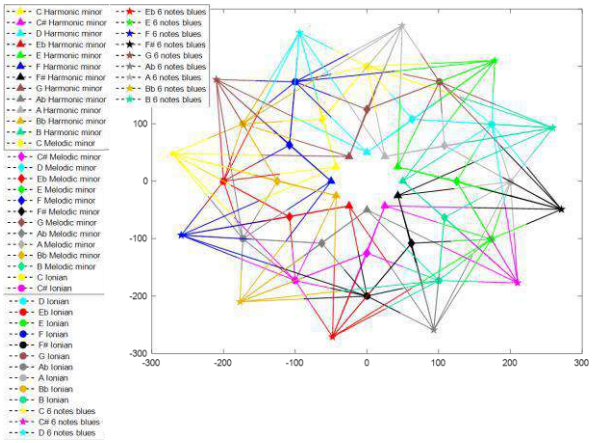

Fig. 6: Harmonic minor, Melodic minor, Ionian and 6 notes blues scales.

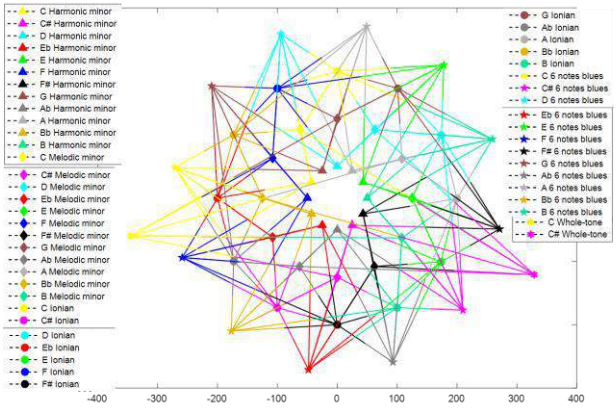

Fig. 7: Harmonic minor, Melodic minor, Ionian, 6 notes blues and Whole-tone scales.

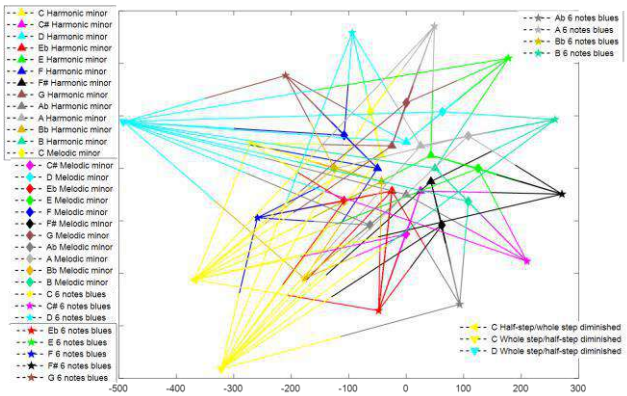

Fig. 8: Harmonic minor, Melodic minor, 6 notes blues, Half-step/whole step diminished and whole step/half-step diminished scales.

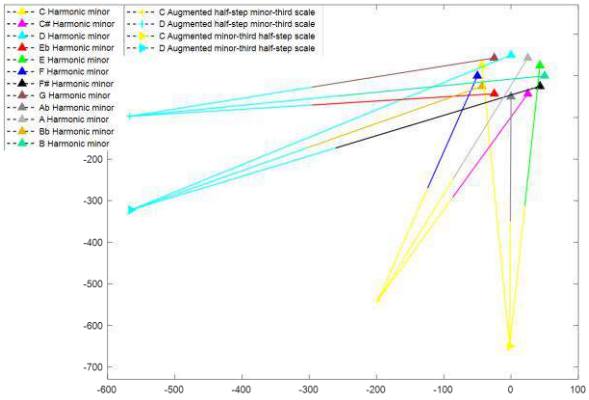

Fig. 9: Harmonic minor, Augmented half-step minor-third and Augmented minor-third half-step scales.

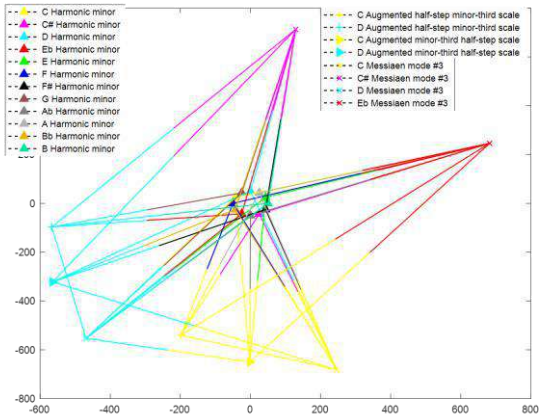

Fig. 10: Harmonic minor, Augmented half-step minor-third, Augmented minor-third half-step and Messiaen mode #3 (Rotation 1) scales.

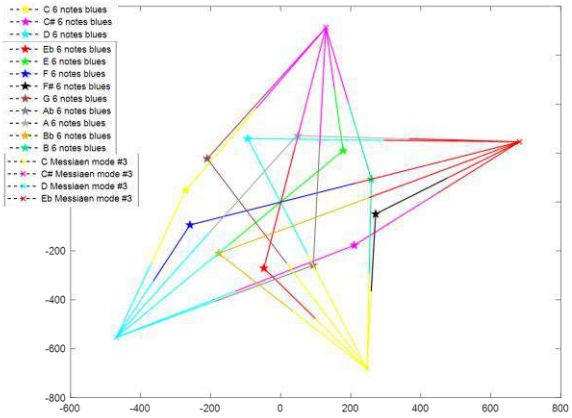

Fig. 11: 6 notes blues and Messiaen mode #3 (Rotation 1) scales.

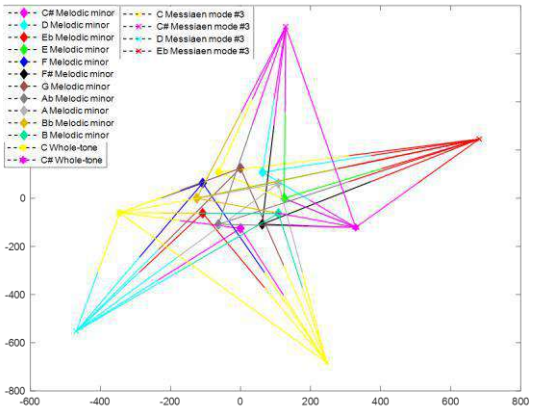

Fig. 12: Melodic minor, Whole-tone and Messiaen mode #3 (Rotation 1) scales.

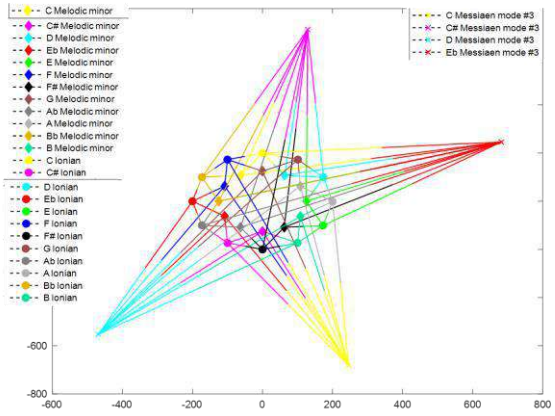

Fig. 13: Melodic minor, Ionian and Messiaen mode #3 (Rotation 1) scales.

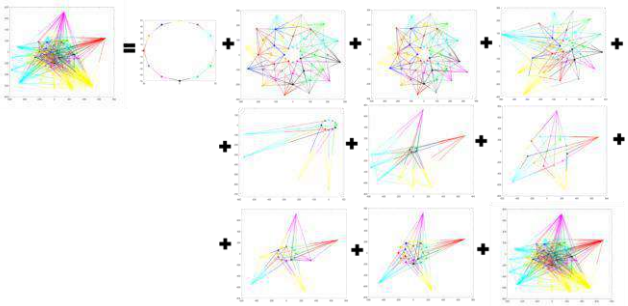

Fig. 14: The graph that expresses the melodic connection degree numbers among scales of all the families considered in this paper is the superposition (+) of different smaller graphs.

The same procedure is applied to demonstrate how the graph (Fig.4) that expresses the *melodic connection degree numbers* among the chords constituted by three notes of all the families considered in this paper is the resultant of the sum (superposition) of different smaller graphs (Fig.1, Fig.

15 to 20) each containing a lower number of chord families. Fig. 21 summarizes this concept, where the superposition (+) of all the smaller graphs on the right-hand side of the equation confers the overall complete graph on the left-hand side of the equation (=). Each smaller graph can be considered as a part and autonomously used in the composition process and music analysis.

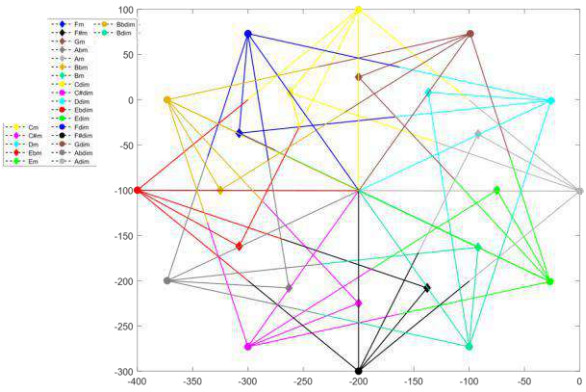

Fig. 15: Minor (m) and diminished (dim) chords.

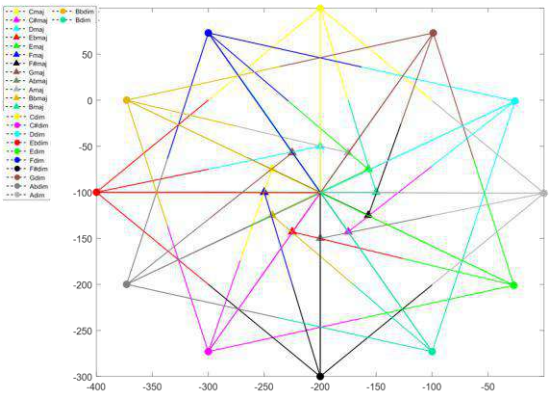

Fig. 16: Major (maj) and diminished (dim) chords.

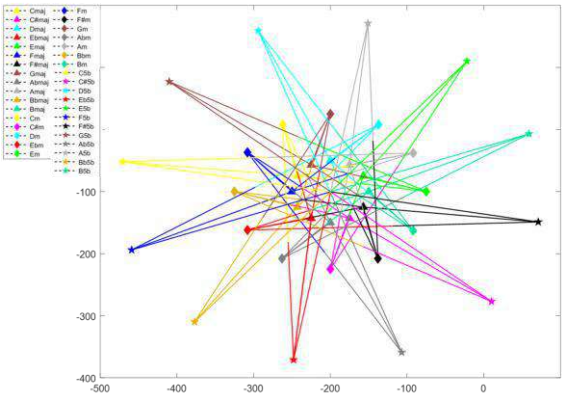

Fig. 17: Major (maj), minor (m) and diminished fifth (5b) chords.

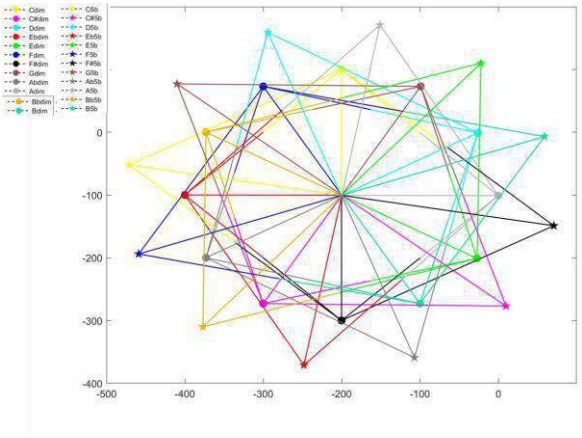

Fig. 18: Diminished (dim), and diminished fifth (5b) chords.

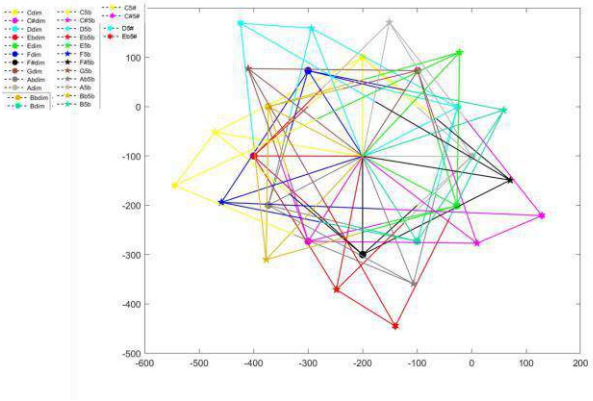

Fig. 19: Diminished (dim), diminished fifth (5b) and augmented fifth (5#) chords.

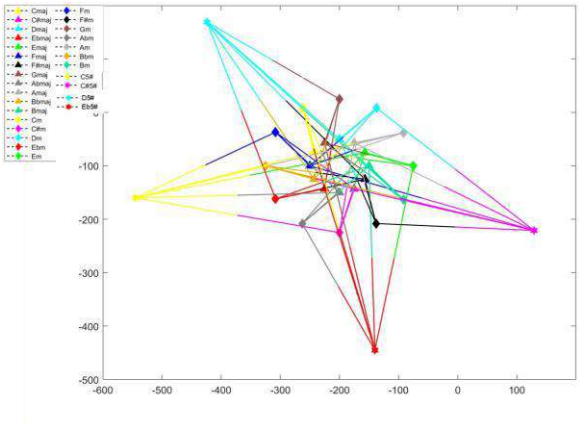

Fig. 20: Major (maj), minor (m) and augmented fifth (5#) chords.

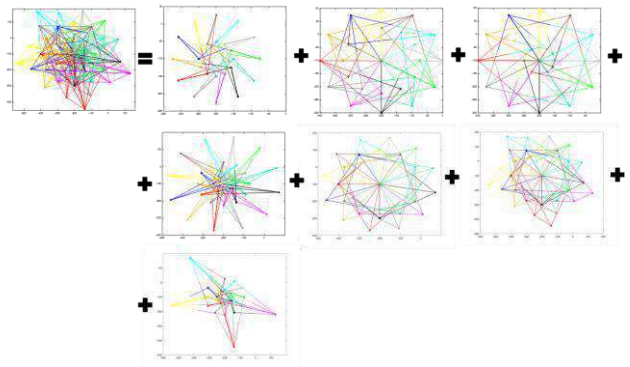

Fig. 21: The graph that expresses the melodic connection degree numbers among chords constituted by three notes of all the families considered in this paper is the superposition (+) of different smaller graphs.

A final consideration to the graph that expresses the *melodic connection degree numbers* among the chords constituted by two and three notes (*basic chords*). For the sake of brevity and simplicity, this graph has not been presented (the whole graph would be excessively full of symbols and superposed connections to be presented in a paper) but it is important to take into consideration the following concept: as stated, as the chords investigation function is employed, given (played or digited) the scale name, this function gives and underlines the chords included in that scale while the trajectories between similar scales or similar chords related to the played (or digited) scale are highlighted (exclusively for the sake of a better representation clarity related to the study reported in the present paper).

- It can be noted that each trajectory/pathway between the connected *basic chords* is part of one or more scales that include/generate those *basic chords*.
- Therefore to summarize, each symbol in each graph that expresses the *melodic connection degree numbers* among scales represents each scale in a condensed/synthetic form, as well as each linear feature related to the pathways/trajectories between connected *basic chords* is part of one or more scales (more than one scale can share the same pathway/trajectory between connected *basic chords*).

The same concept can be partially expressed by the graph that expresses the *melodic connection degree numbers* among the chords of the major (*maj*) and minor (*m*) families highlighting the *C major (ionian)* scale, as reported by the example in Fig. 3. Indeed, similar highlights to those shown in Fig. 3 are obtained if the major (*maj*) and minor (*m*) families highlighting the *G major (ionian)* scale are considered in the graph, as shown by the following Fig. 22.

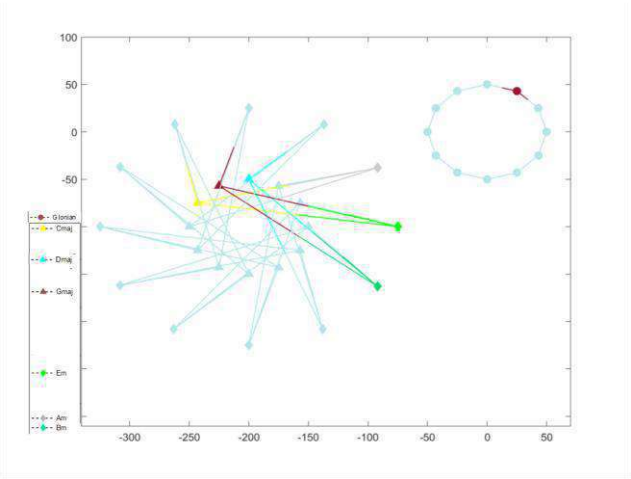

Fig. 22: Representation of the G major (ionian) scale harmonization built with the chords of the major (maj) and minor (m) families together with all the highlighted trajectories between similar scales or similar chords related to the G major (ionian) scale.

As it can be observed in Fig. 22 and Fig. 3, among the chords of the major (*maj*) and minor (*m*) families, the *C major (ionian)* and the *G major (ionian)* scales share the pathways/trajectories between the connected chords related to *Gmaj-Em*, *Cmaj-Am*, *Cmaj-Em*. Indeed these chords (and the related connections) can be generated/included by both the *C major (ionian)* and by the *G major (ionian)* scale.

The music universe is constituted by notes, scales, and chords. As stated before, for the sake of representation clarity, the network of the music universe as seen/focused on the scales is kept distinct from the network of the music universe as seen/focused on the chords. The present paragraph of the present Section is aimed to summarize the general concept related to the network of music connections focusing on the scales. Fig. 23 explicitly shows the main concept. For a better representation clarity, the arbitrary angular coordinates (θ) which distinguish the scales of the same family characterized by a different tonic adopted in Fig. 23 are different from those assumed and shown in the homologous Fig. 5a and Fig. 6 (which are similarly presented together in Fig. 23).

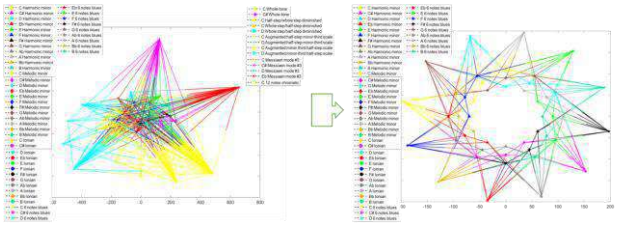

Fig. 23: The music universe as seen/focused on the scales of all the families considered in this paper (a). When appropriately filtered, the Harmonic minor, Melodic minor, Ionian and 6 notes blues scales turn out (b).

An example of the sound pathways constituting the music universe focused on the most useful scales adopted by a musician is reported hereafter. In particular, the sound pathways constituting the music universe focused on the most useful scales employed by Allan Holdsworth and reported in the "Just for the curious" book [8] are briefly presented and graphically reported. The names related to these scales have been assigned accordingly to those commonly employed (even if they are differently called in [8]). Some of these names have been already adopted in the previous sections of the present paper. The structures of these scales are summarized in Table 3:

Table.3: Structure of the scale types considered by [8] in terms of interval related to their tonic (1)

Scale type	Structure
Major scale (ionian mode)	*1 2 3 4 5 6 7*
Melodic minor scale	*1 2 3b 4 5 6 7*
Harmonic minor scale	*1 2 3b 4 5 6b 7*
Harmonic major scale	*1 2 3 4 5 6b 7*
Whole-tone scale	*1 2 3 4# 5# 7b*
Half-step/whole step diminished scale	*1 2b 3b 3 5b 5 6 7b*
Whole step/half-step diminished scale	*1 2 3b 4 5b 5# 6 7*
Messiaen mode #3 (Rotation 1)	*1 2b 2 3 4 4# 5# 6 7b*
Bebop major scale	*1 2 3 4 5 5# 6 7*
Harmonic minor scale+6 notes blues scale	*1 2 3b 4 4# 5 6b 7b 7*
Bebop dominant scale	*1 2 3 4 5 6 7b 7*
Melodic minor scale+Dorian scale	*1 2 3b 4 5 6 7b 7*
Melodic minor scale+ Harmonic minor scale	*1 2 3b 4 5 6b 6 7*
Melodic minor scale+4#	*1 2 3b 4 4# 5 6 7*
Melodic minor scale+Mixolydian scale	*1 2 3b 3 4 5 6 7b 7*
Minor pentatonic scale+3+6	*1 3b 3 4 5 6 7b*

These scales have been suitably transposed and graphically presented in Fig. 24 that shows the network of music universe focused on the scales as seen by Allan Holdsworth. The subdivision of the entire graph shown in Fig. 24 into groups and subgroups of graphs (like the one presented in Fig. 14 of the present paper) will be presented hopefully in a subsequent study. Being the network of Fig. 24 constituted by a high number of symbols (markers) and lines of different colors which are difficult to distinguish, the legend has not been inserted in Fig. 24.

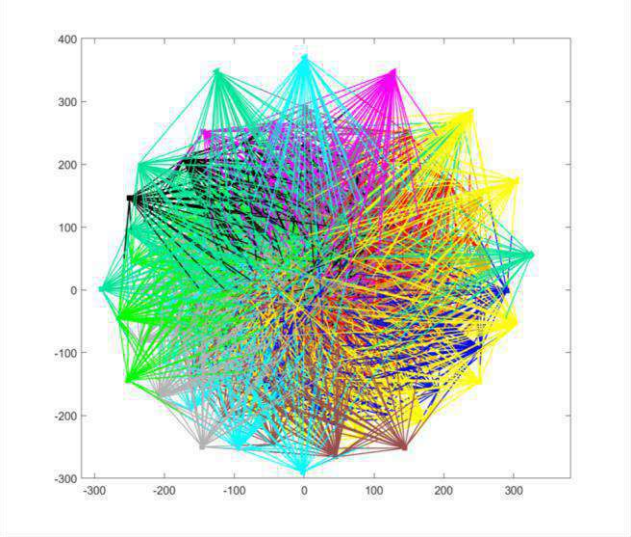

Fig. 24: The music universe as seen/focused on the scales of the families considered by Allan Holdsworth and reported in [8].

VI. THE FLOW OF SOUND PATHWAYS THROUGH THE MUSIC NETWORK

In this section, the transient process related to the flow of sound pathways through the music network is presented. As stated before, the connections graphs express the *melodic connection degree numbers* among scales/chords of all the families considered in this paper and include all the chromo-harmonic structures. These graphs allow representing all the potential melodic and harmonic choices, i.e. all the existent potential music paradigms and sonorities. The flow of sound pathways through the music network origins when a series of single notes or chords are played by the musician user. Under

these circumstances, some parts of the graph begin to be intercepted by the sound emitted by the instrument played by the musician. Therefore some parts of the graph begin to be highlighted like a target as the sound is emitted in real-time by the instrument. This because the present software application tool is connected to the instrument played by the musician via a hardware interface. As the musician plays (or types on a pc-keyboard) a series of *N* notes or *N* chords or a single note or chord (in this case *N=1*), the software receives and recognizes the signal constituted by the series of *N* notes or *N* chords from the instrument via the hardware interface (unless typed from the pc-keyboard). The signal receiving and recognizing process takes place for every finite number *N* of notes or chords (*N* can be varied during time). Among the functions implemented in the software, this is aimed to show the scales (more in general generic groups of notes that can be scales and chords) which include the series of *N* notes or *N* chords (or a single note or chord) played in real-time by the musician (or typed on a pc-keyboard). As the scales investigation function is employed, it gives and underlines the scales, among those considered by the system since chosen by the user-musician for the analysis, that include all the *N* notes or *N* chords of each series. These scales are highlighted in each graph together with the trajectories between their similar scales or similar chords (related to the played series of *N* notes or *N* chords).

For instance, when the *G major* chord (*N=1*) or arpeggio (that is the series of *N=3* notes related to the *G major* chord) is played within each finite time interval Δt, it is possible to detect the scales among the families considered in this paper that include/generate the *G major* chord or arpeggio within each finite time interval Δt, together with the trajectories between similar scales (related to those which include/generate the played *G major* chord or arpeggio) or similar chords (related to those which include/generate the played *G major* chord or arpeggio and constituted by three notes of the major (*maj*) and minor (*m*) families; the graphical feature related to the highlighted chords constituted by three notes of the major (*maj*) and minor (*m*) families which are exclusively considered and distinctly represented in the scale investigation function has been adopted ad-hoc for the sake of a better representation clarity related to the present study in order to obtain an optimized graphical representation).

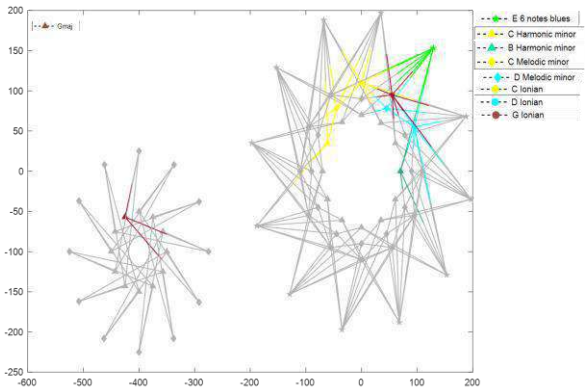

Fig. 25: Representation of the G major chord or arpeggio through the pathways/trajectories between scales. The trajectories between similar scales (related to those which include/generate the played G major chord or arpeggio) or similar chords (related to the played G major chord or arpeggio and constituted by three notes of the major (maj) and minor (m) families) are highlighted.

For the sake of brevity and a better representation clarity, the scales reported in Fig. 23 (b) are exclusively considered in this section for the present investigation. Fig. 25 shows the representation of the *G major* chord or arpeggio (played within each finite time interval Δt) through the pathways/trajectories among the nodes of the network of scales and chords (generic groups of notes). In addition, the trajectories between similar scales (related to those which include/generate the played *G major* chord or arpeggio) or similar chords (related to the played *G major* chord or arpeggio and constituted by three notes of the major (*maj*) and minor (*m*) families, for the sake of brevity and a better representation clarity) are highlighted when the *G major* chord or arpeggio (more in general when one or more notes/chords) is played within each finite time interval Δt.

The finite interval Δt is the time in which each series of *N* notes or *N* chords has to be analyzed. The musician user can choose and set the finite number *N* of notes or chords in the software tool instead of Δt. This last procedure corresponds (it is equivalent) to set the finite time interval Δt. The lower is the finite number *N* of notes or chords (the time interval Δt is too short) compared to the time signature of the executed tune (if any), the higher is the detail level provided by the scales investigation function which detects the sound pathways among the nodes of the network of scales and chords. If *N=1* (the Δt is so short that it corresponds to *N=1* executed note/chord for each Δt), the completed and detailed list containing all the scales that include each played (or typed) note/chord is provided and figured in the graphs. This high level of

detail could be excessively punctual and unuseful for the music analyses. On the other hand, if the finite number N of notes or chords is too high (the time interval Δt is too long) compared to the time signature of the executed tune (if any), the provided list containing all the scales and chords that include the series of notes/chords could be too poor and again unuseful for music analyses. The finite number N of notes or chords (or equivalently the time interval Δt) has to be sufficiently great and suitably matchable to the time signature of the tune (more in general, of any group of notes played) to allow the related music melodic and harmonic deep analyses. In this last case, a suitable average of the sound pathways is equivalently applied, since only the scales (and chords) that include each series of N notes/chords (within each suitable Δt) are provided and usefully figured in the graphs.

Four test cases aimed at showing the scales investigation function are reported here below. For better representation clarity, the graph that expresses the *melodic connection degree numbers* among scales reported in Fig. 23 (b) has been chosen to represent the music-transient process related to the chord progression of each Case. This graph does not include the scales related to the *Modes of limited transposition* considered in the present paper but exclusively involves the *Harmonic minor*, *Melodic minor*, *Ionian* and *6 notes blues* scales. Additional analyses that include the *Modes of limited transposition* considered in the present paper will be addressed hopefully in a subsequent paper.

Case#1 is characterized by the following quite ordinary chord progression:

Table.4: Chord progression related to Case#1

Am	*Cmaj*	*Gmaj*	*Em*

It is possible to graphically represent the chord progression related to Case#1 for three different N values ($N=1$, $N=2$, $N=4$). Since Case#1 is characterized by the chords of the major (*maj*) and minor (*m*) families, similarly to what presented in Fig. 25, the graph that expresses the *melodic connection degree numbers* among chords of the major (*maj*) and minor (*m*) families and the graph that expresses the *melodic connection degree numbers* among scales reported in Fig. 23 (b) are presented together in this investigation. These graphs are aimed at representing the music-transient process related to the chord progression of Case#1 for the three different N values. Case#1 related to $N=1$ is shown in Figs. 26 to 29. It has to be specified that in this Section, some colors used for highlighting markers and the related connection lines are different from those previously reported in Fig. 1 and Fig. 23 because the grey color has already been employed as the transparence neutral color for all the no highlighted markers and lines. It has to be noted that the graphs which exclusively show the no highlighted markers conceptually represent the mutual interconnections and logical patterns that have already been traced and that had been waiting to be intercepted/tracked like a target as the sound is emitted in real-time by the instrument played by the musician.

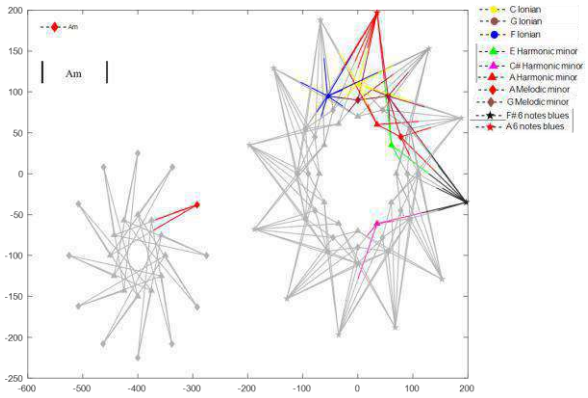

Fig. 26: Case#1 related to N=1, 1st bar.

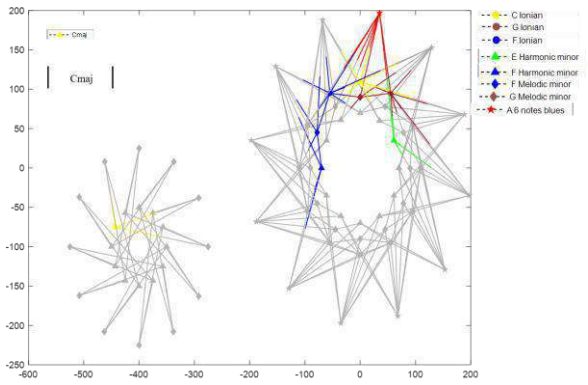

Fig. 27: Case#1 related to N=1, 2nd bar.

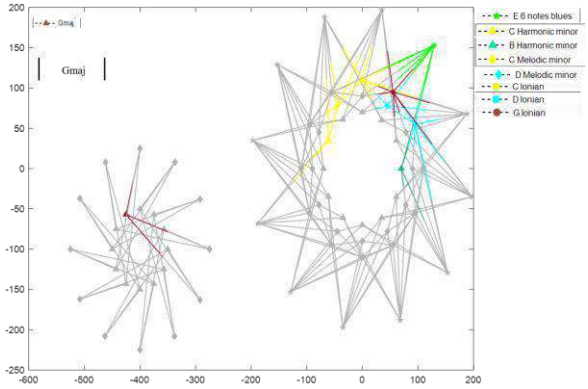

Fig. 28: Case#1 related to N=1, 3rd bar.

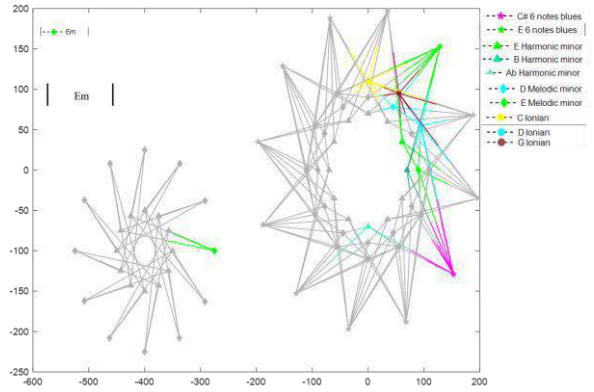

Fig. 29: Case#1 related to N=1, 4th bar.

Fig. 30 summarizes the whole music-transient process related to the chord progression denoted by Case#1 for *N=1*.

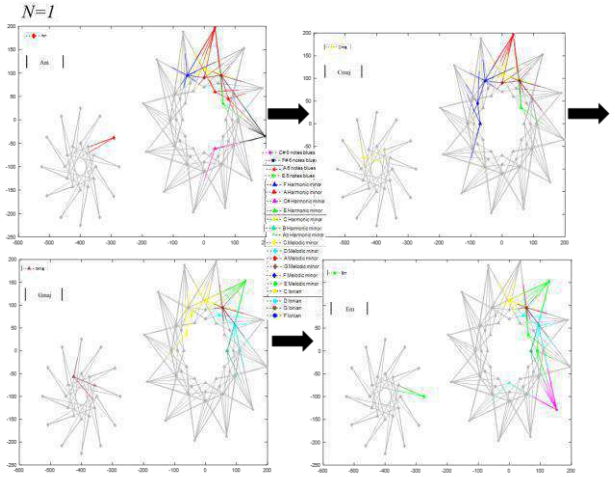

Fig. 30: The flow of sound pathways through the music network related to the chord progression denoted by Case#1 for N=1.

Case#1 related to *N=2* is shown in Figs. 31 and 32.

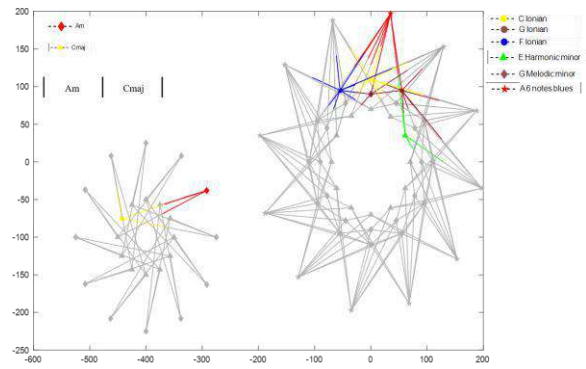

Fig. 31: Case#1 related to N=2, first two bars.

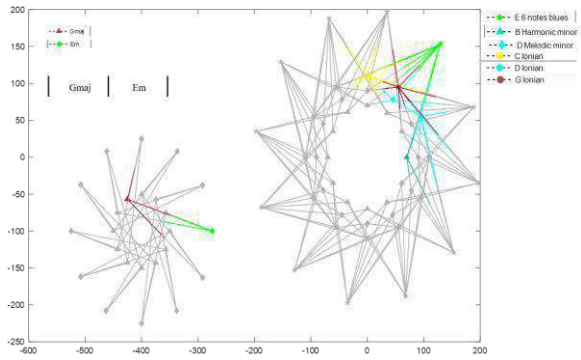

Fig. 32: Case#1 related to N=2, last two bars.

The whole music-transient process related to the chord progression denoted by Case#1 for *N=2* is summarized by Fig. 33.

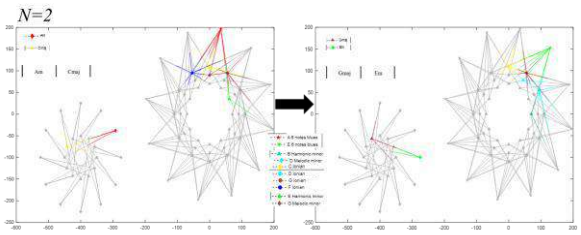

Fig. 33: The flow of sound pathways through the music network related to the chord progression denoted by Case#1 for N=2.

Case#1 related to *N=4* is shown in Fig. 34.

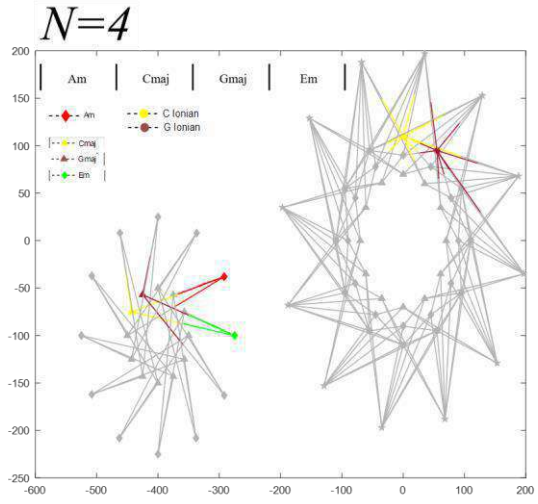

Fig. 34: Case#1 related to N=4.

Case#2 is characterized by the following chord progression:

Table.5: Chord progression related to Case#2

Cmaj7	*Cmaj7*	*Fm7*	*Bb7*
Cmaj7	*Cmaj7*	*Bbm7*	*Eb7*
Abmaj7	*Abmaj7*	*Am7*	*D7*
Dm7	*G7*	*Cmaj7 Eb7*	*Abmaj7G7/5#*

It is possible to graphically represent the chord progression related to Case#2 by adopting different *N* values. In particular, the value related to *N=2* has been employed for the first six bars (Figs. 35, 36), the value related to *N=4* has been employed from the 7th to 10th bar (Fig. 37), the value related to *N=2* has been employed from the 11th to 12th bar (Fig. 38), the value related to *N=3* has been employed from the 13th to 15th bar (Fig. 39), the value related to *N=2* has been employed from the 15th to 16th bar (Figs. 40 and 41). The whole music-transient process related to the chord progression denoted by Case#2 is summarized by Fig. 42 for the different *N* values.

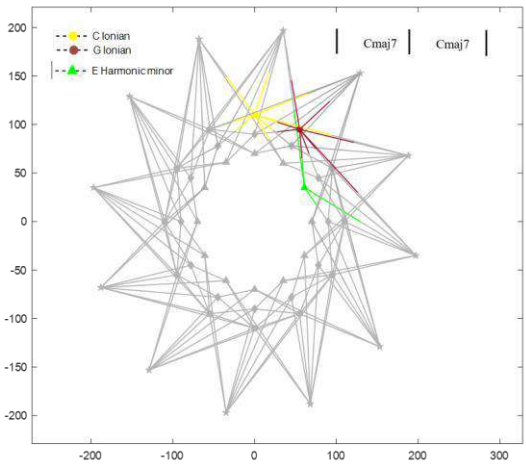

Fig. 35: Case#2 related to N=2: 1st, 2nd, 5th and 6th bars.

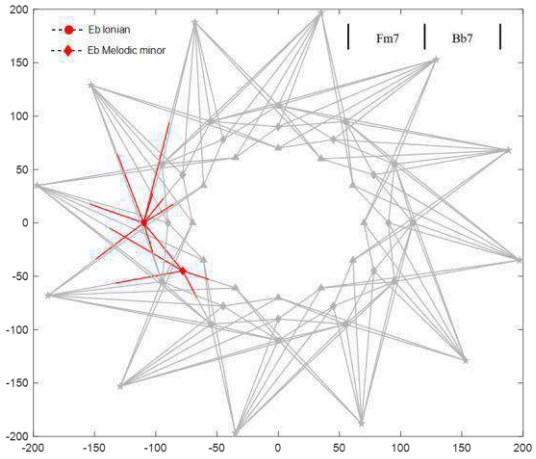

Fig. 36: Case#2 related to N=2: 3rd and 4th bars.

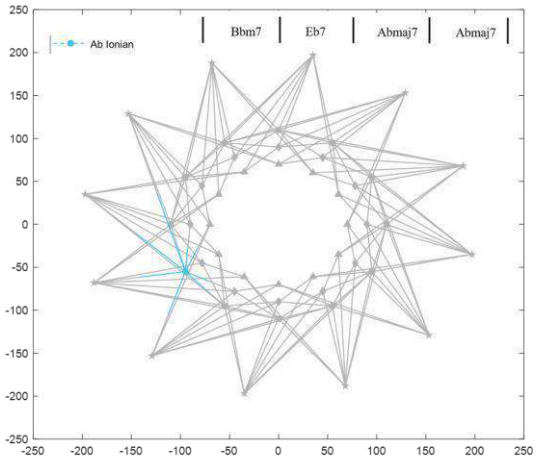

Fig. 37: Case#2 related to N=4: 7th, 8th, 9th and 10th bars.

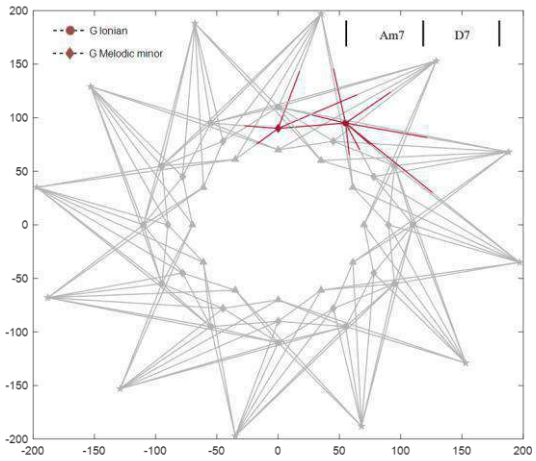

Fig. 38: Case#2 related to N=2: 11th and 12th bars.

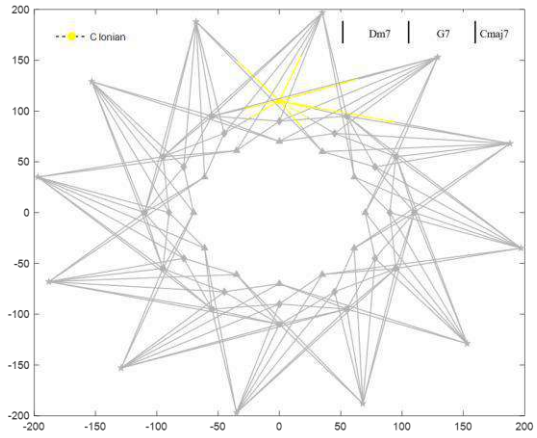

Fig. 39: Case#2 related to N=3: 13th, 14th and 15th bars.

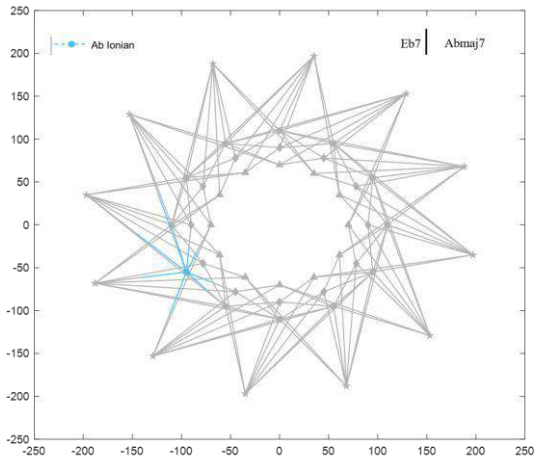

Fig. 40: Case#2 related to N=2: 15th and 16th bars.

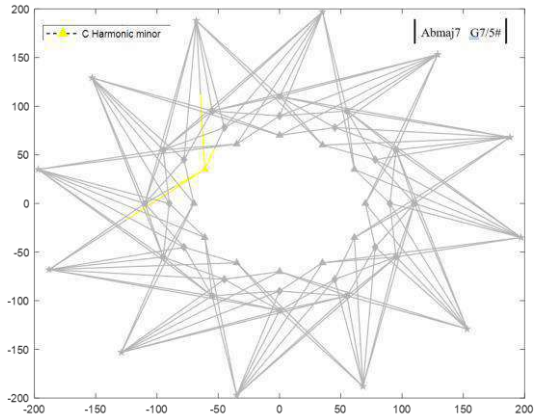

Fig. 41: Case#2 related to N=2: 16th bar.

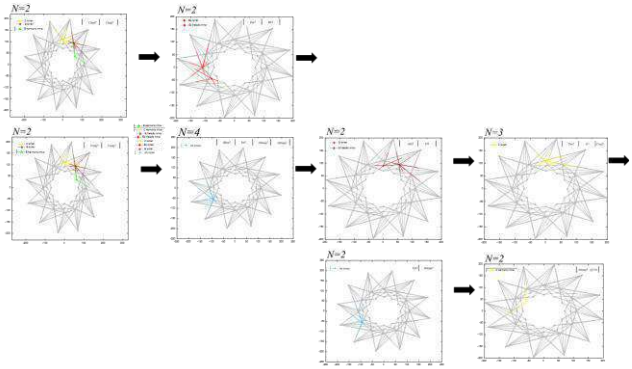

Fig. 42: The flow of sound pathways through the music network related to the chord progression denoted by Case#2 for different N values.

Case#3 is characterized by the following chord progression:

Table.6: Chord progression related to Case#3

Ebmaj7	*Ebmaj7*	*Ebm7*	*Ab7*
Abmaj7	*Abmaj7*	*Abm7*	*Db7*
Ebmaj7	*F#m7 B7*	*Fm7*	*Bb7*
Ebmaj7	*F#m7 B7*	*Fm7*	*Bb7*

It is possible to graphically represent the chord progression related to Case#3 by adopting different *N* values. In particular, the value related to *N=2* has been employed for the first eight bars (Figs. 43 to 46), the value related to *N=1* has been employed for the 9th and 13th bar (Fig. 47), the value related to *N=2* from the 10th to 12th bar and from the 14th to 16th bar (Figs. 48 and 49). The whole music-transient process related to the chord progression denoted by Case#3 is summarized by Fig. 50 for the different *N* values.

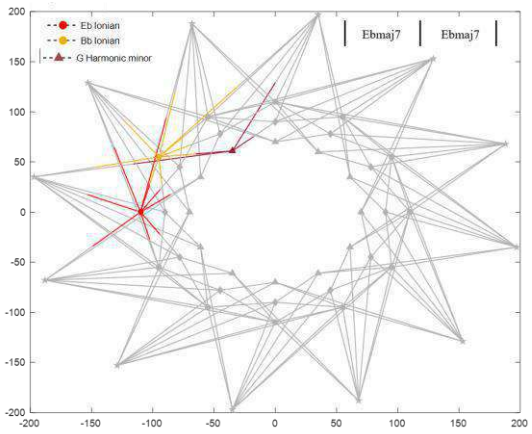

Fig. 43: Case#3 related to N=2: 1st and 2nd bars.

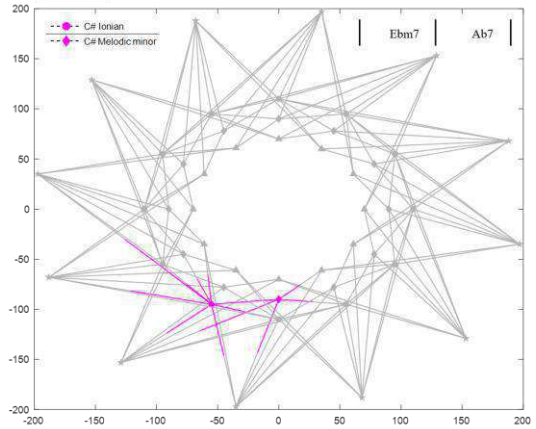

Fig. 44: Case#3 related to N=2: 3rd and 4th bars.

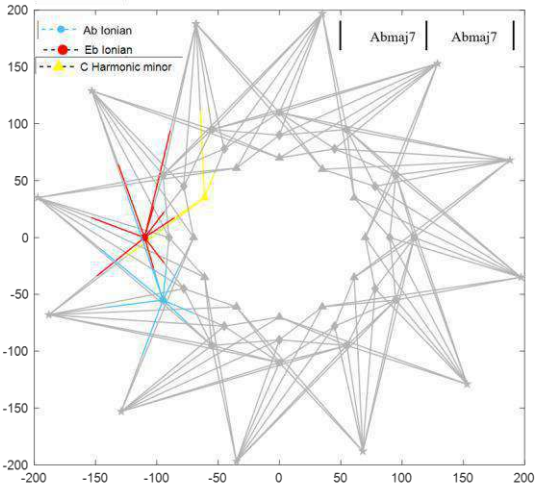

Fig. 45: Case#3 related to N=2: 5th and 6th bars.

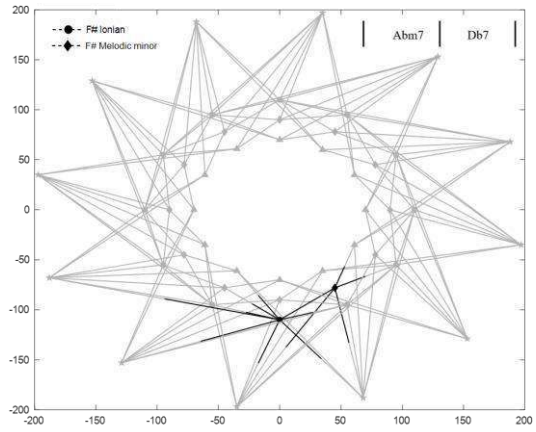

Fig. 46: Case#3 related to N=2: 7th and 8th bars.

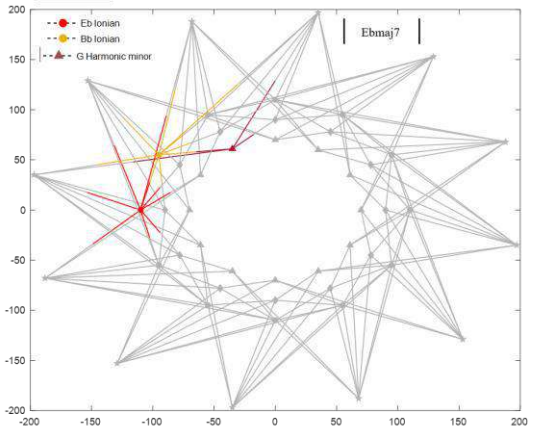

Fig. 47: Case#3 related to N=1: 9th and 13th bars.

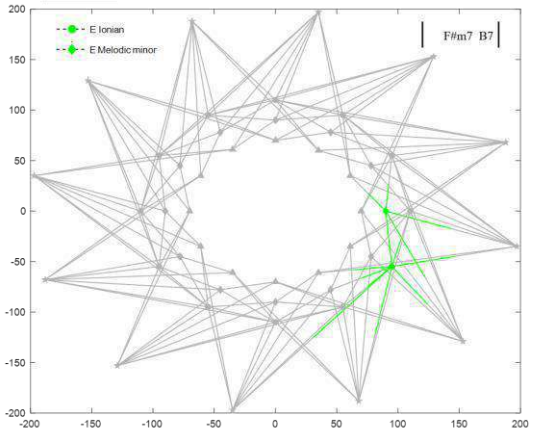

Fig. 48: Case#3 related to N=2: 10th and 14th bars.

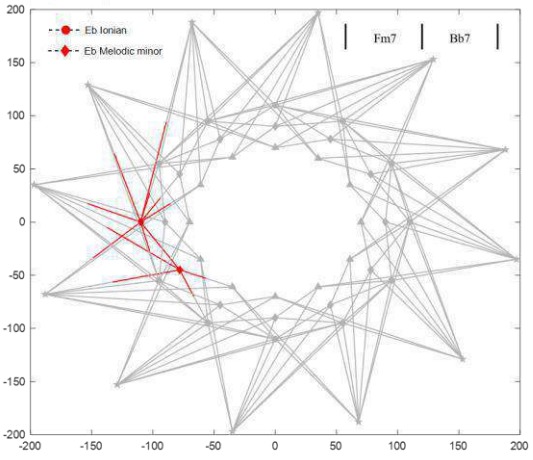

Fig. 49: Case#3 related to N=2: 11th, 12th, 15th and 16th bars.

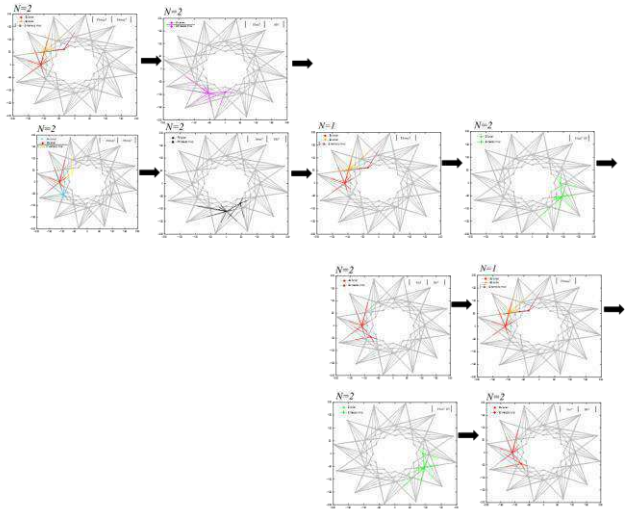

Fig. 50: The flow of sound pathways through the music network related to the chord progression denoted by Case#3 for different N values.

Case#4 is characterized by the following quite ordinary chord progression:

Table.7: Chord progression related to Case#4

Em	*Cmaj*	*Gmaj*	*Dmaj*

It is possible to graphically represent the chord progression related to Case#4 for three different *N* values (*N=1, N=2, N=4*). Case#4 related to *N=1* is shown in Figs. 51 to 54. It has to be specified that the colors adopted for markers and connection lines could be slightly different than those of other cases due to graphic issues.

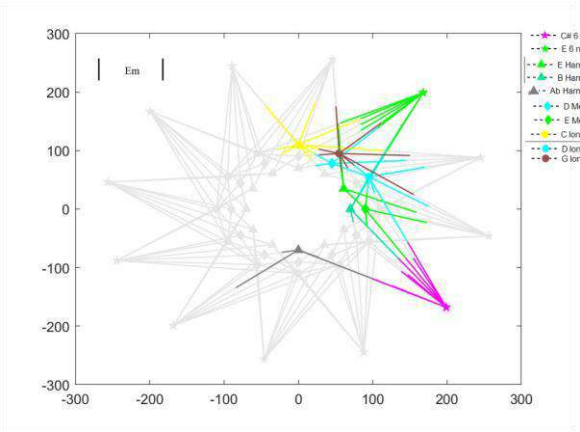

Fig. 51: Case#4 related to N=1, 1st bar.

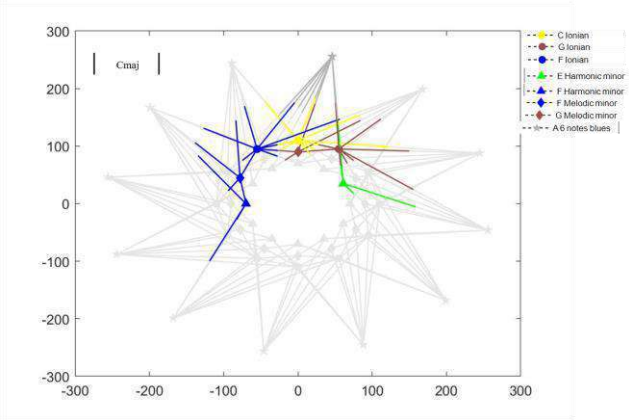

Fig. 52: Case#4 related to N=1, 2nd bar.

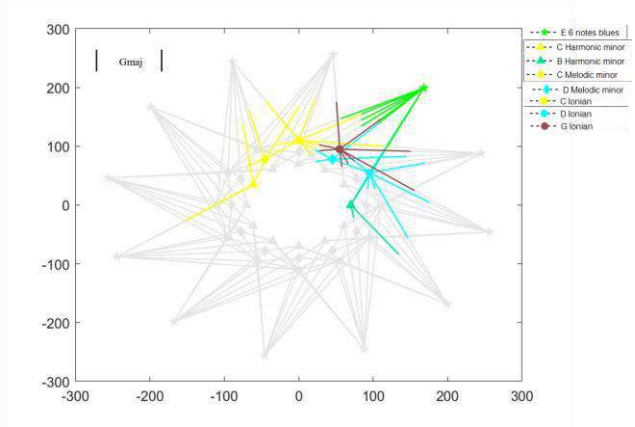

Fig. 53: Case#4 related to N=1, 3rd bar.

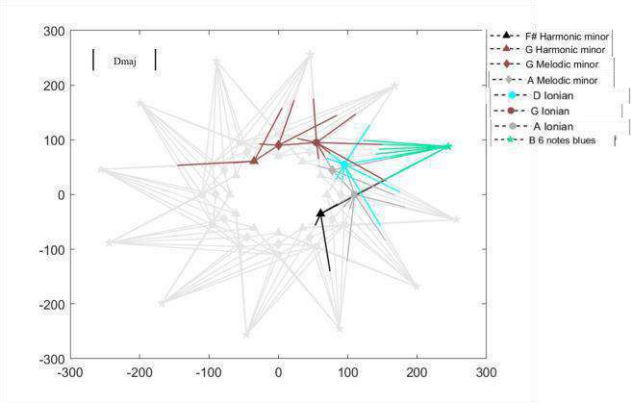

Fig. 54: Case#4 related to N=1, 4th bar.

Fig. 55 summarizes the whole music-transient process related to the chord progression denoted by Case#4 for *N=1*.

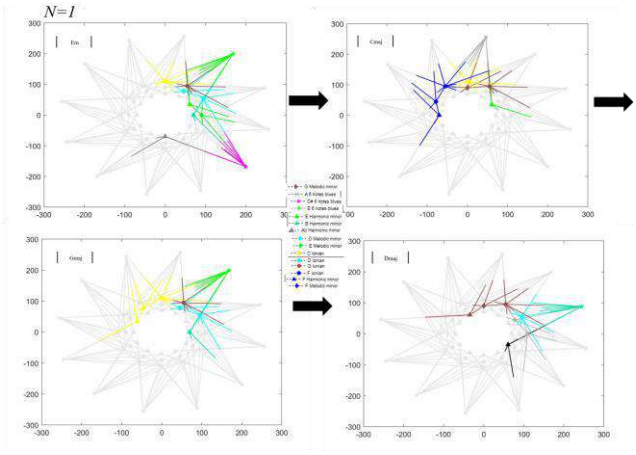

Fig. 55: The flow of sound pathways through the music network related to the chord progression denoted by Case#4 for N=1.

Case#4 related to *N=2* is shown in Figs. 56 and 57.

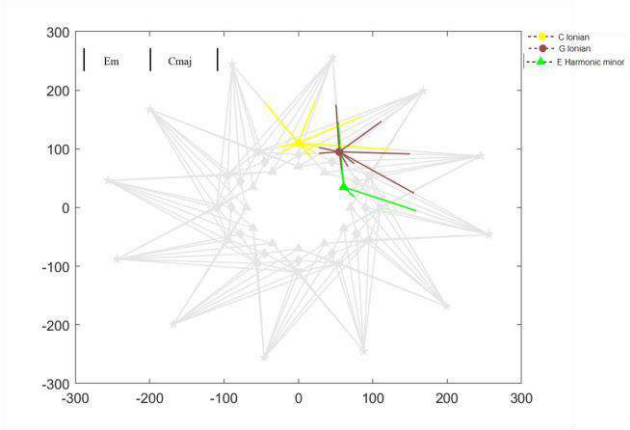

Fig. 56: Case#4 related to N=2, first two bars.

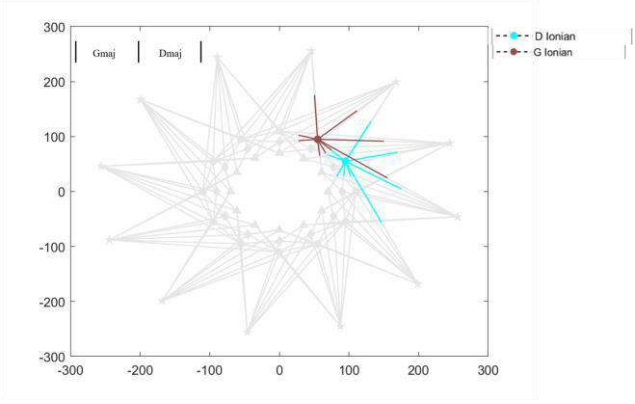

Fig. 57: Case#4 related to N=2, last two bars.

The whole music-transient process related to the chord progression denoted by Case#4 for *N=2* is summarized by Fig. 58.

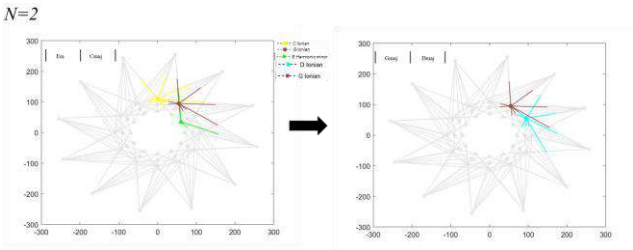

Fig. 58: The flow of sound pathways through the music network related to the chord progression denoted by Case#4 for N=2.

Case#4 related to *N=4* is shown in Fig. 59.

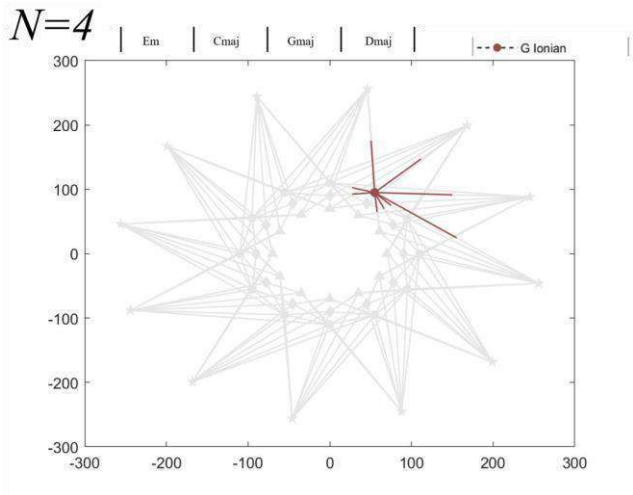

Fig. 59: Case#4 related to N=4.

It is interesting to notice that if the last bar had featured the *Dm* chord instead of *Dmaj*, the analysis related to *N=4* would have yielded a different response despite the first three bars remaining the same, as shown in Fig. 60.

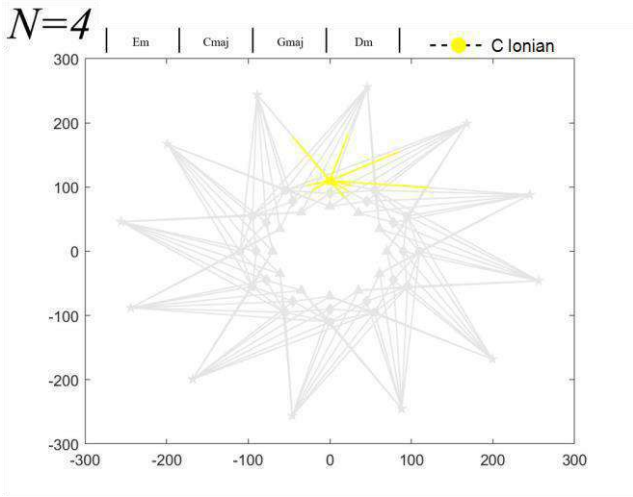

Fig. 60: Case#4 related to N=4 when the Dm chord replaces the Dmaj in the last bar.

In general, the scales related to the *Modes of limited transposition* should be included in the analysis (*12 notes chromatic scale* included), in order to better describe and justify some of the harmonic and melodic passages related to the chord progressions reported in the present paper. In this case, deeper harmonic analyses will be presented hopefully in a subsequent study. This paper has to be intended as a general presentation, an introduction of the main concepts related to the utilization of the music graphs (on how these graphs and the related approach work).

VII. CONCLUSIONS

A specific algorithm has been designed to detect the harmonic and melodic transient passages involving any generic group of notes arbitrarily played in real-time (or digited on a pc-keyboard). An interactive software application tool (via hardware connected to the instrument of each musician) has been realized. The geometrical music graphs are automatically traced by the process as any generic group of notes is played. These graphs constitute a network whose nodes are reciprocally interconnected. Each node symbolically represents a specific music scale or a specific chord (more in general any generic group of notes). The music network is constituted by a set of maps in which the melodic passages and harmonic progressions can be traced and analyzed on the graphs instead of on a pentagram. The shape of these graphs is determined by the interconnections between the nodes which are arbitrarily placed by the user. These graphs have not to be intended for replacing the pentagram but they have to be intended as an auxiliary device to see and analyze the music transient passages through the music geometrical network. In particular, these graphs can be employed for performing the melodic and harmonic analysis (any sort of music investigation) of any kind of tune, to recognize recurring patterns in music, and also to represent and better explain the reasons behind specific melodic and harmonic choices. These graphs can be also intended as an auxiliary device for the visual detection of innovative unexplored harmonic and melodic solutions in the human composition process. More in general, the present system is not related to a specific instrument, representing a synthetic geometrical view of all the potential connections between different groups of frequencies. The number and typology of groups and the shape of the related network depend on the musician's subjective knowledge and taste. The more the musician learns and increases his music-theoretical and practical knowledge, the more the size and shape of the related music graph network can change and grow.

ACKNOWLEDGEMENTS

The Author S.Morchio would like to acknowledge his father Francesco Morchio for his contribution in implementing the algorithm in a software application tool. The Author S.Morchio kindly acknowledges Prof. Steve Hunt for having chosen to employ the music graph related to Fig. 5c by the present Author in the cd cover of his "Connections" album released in February 2021 (https://stevehunt.bandcamp.com/album/connections).

NOMENCLATURE

Notes names:

C = (B#)

C# = Db

D

D# = Eb

E = (Fb)

F = (E#)

F# = Gb

G

G# = Ab

A

A# = Bb

B = (Cb)

Interval names:

1/8= perfect unison/perfect octave

(1#)= (augmented unison)

2b/9b= minor second/minor ninth

2/9= major second/major ninth

2#/9# =augmented second/augmented ninth

3b =minor third

3= major third

(3#) =(augmented third)

(4b/11b) =(diminished fourth/diminished eleventh)

4/11= perfect fourth/perfect eleventh

4#/11# = augmented fourth/augmented eleventh

5b=diminished fifth

5=perfect fifth

5#= augmented fifth

6b/13b =minor sixth/minor thirteenth

6/13= major sixth/major thirteenth

(6#/13#)=(augmented sixth/augmented thirteenth)

(7bb)=(diminished seventh)

7b= minor seventh

7 = major seventh

(7#)= (augmented seventh)

(8b) =(diminished octave)

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Integrity/ Compliance Programs: development of the Structure of the Hotel Network in Foz do Iguaçu - PR.

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Keywords*— *Combating Corruption. Compliance. Corporate governance. Integrity.

***Abstract*—** *The study presents the structure and processes aimed at implementing ethics, integrity and combating corruption and fraud in the organizational environment through integrity/compliance programs. This structure reflects a series of mechanisms that promote business continuity with a focus on concepts linked to the socio-economic sustainability of organizations. Conceptually, the work is supported by the bibliographical review of the concepts elaborated in the academy and main normatives woven in the national and international scopes throughout history. This is an exploratory descriptive research, in which organizations in the hotel industry in the city of Foz do Iguaçu – PR were surveyed about the degree of maturity of the mechanisms contained in these programs in their operations. As a result, it is observed that the theme is already on the corporate governance agenda of these organizations, demonstrating a high degree of engagement with the concepts discussed. It was possible to conclude among the organizations observed that the main business activity in the municipality is already aligning its processes with the best practices explained, however, with some development gaps identified according to the methodology applied.*

I. INTRODUCTION

The development of the concept comes in line with the implementation of the idea of integrity in institutional and organizational relationships, public and private, as well as its effect on society. The term, according to Coimbra and Manzi (2010, p. 2) originates from the English verb to comply and means to comply, execute, obey, observe, satisfy what was imposed on it, that is, the concept is directly linked to the execution of activities which corroborate for regulatory compliance in the execution of its processes, these regulations linked not only to the external regulatory scope, but also to the development of internal control and corporate governance mechanisms for each organization and to promote integrity and combat deviation of conduct within the activities performed.

The article addresses the structure of integrity/compliance programs, their academic foundation and current strategies to achieve it in a perennial and sustainable way.

The structure of these programs also helps to promote ethics as a fundamental element in conducting business, being essential for bringing organizations closer to social interests that are generally distorted. Organizations are one of the main drivers of social development, even if unintentionally and their way of conducting impacts the environment in which they are inserted, the perception of this impact should guide the

necessary changes in administrative paradigms, only profit no longer meets the expectations latent social organizations, but society's perception that business is related to the current form of social organization.

The development of the concept is parallel to the implementation of the idea of integrity and combating corruption in institutional, organizational, public and private relations, and their social effects. These concepts can be observed, for example, in law 12,846/2013, called the anti-corruption law, which contains several integrity mechanisms included in the provisions woven into the standard in reference to the composition and development of the topic at a global level (BRASIL, 2013).

This way compliance can be defined as the function of ensuring the strengthening of defense mechanisms to reduce events that are corrosive to the integrity of the activities carried out by organizations, aiming to promote ethical values, internally and externally.

The adoption of integrity/compliance programs is a topic widely debated around the world, both in the public and private spheres. This structure guides the legislative and academic composition in relation to the best practices to be adopted by corporations and organizations, public and mixed. The structure supports decision making and protects senior management, employees and partners, when all processes developed so far are adopted.

Having a program with the activities contained in it is vital for organizations in the current stage of development of administrative practice, which underlies the relevance of the study to determine which activities are essential to obtain the program and how these activities are being developed in organizations, with a focus in the hotel activity in the region of Foz do Iguaçu – PR.

Also the study proposes to evaluate the dissemination of the practices contained in the program in the organizational environment, researching the degree of maturity and integration of the practices in the hotel chain in Foz do Iguaçu – PR.

II. INTRODUCTION

Integrity programs are in evidence in Public and Private Administration, the development of the subject itself makes this change in organizational thinking evident in recent decades. The relationship between organizations and society is increasingly demanding from organizations solutions for predatory and controversial behavior observed throughout history.

New mechanisms were proposed to bring business activities closer to society's needs and based on the promotion of ethics, integrity and Corporate Social Responsibility. Adhering to the activities contained in integrity programs has become strategic for any type of organization, of any size and nature, due to the numerous benefits generated by the implementation of the structure and activities contained in the program.

The survey was carried out in the Brazilian municipality of Foz do Iguaçu, located in the west of the state of Paraná, with a population of 258,532 dwellers, according to the IBGE 2019 projection, and one of the main tourist attractions in Brazil being internationally recognized for the Iguaçu Falls , Itaipu Hydroelectric Power Plant (second largest hydroelectric plant in the world) and the triple frontier between Argentina, Brazil and Paraguay (MUNICIPAL MUNICIPALITY OF FOZ DO IGUAÇU – PR, 2020).

For the research, only hotels categorized as Luxury by the Municipal Tourism Secretariat of Foz do Iguaçu - PR were used, based on their greater operational complexity. The sample resulted in a group of 7 (seven) hotels in the region, however, due to availability and the disruptive moment attributed to COVID-19, only 6 organizations participated in the survey.

Data collection was performed through an online questionnaire covering fundamental topics of integrity programs. After determining the sample, the researcher went to each of the hotels within the established criteria and presented the project, which sent an email to those responsible with the link to participate in the research. The process was carried out in April and May 2020.

Several entities, private and public, work in the evaluation and integrity practices in Brazil and in the world, with recommendations for the effective implementation of the program, such as the CGU (2018) through the questionnaire "Pro-ethics 2018 - 2019", the Institute Ethos (2019) with its guide on integrity, however, the UN document (2013) entitled “On Anti-Corruption Ethics and Compliance Programs: A Practical Guide” was used as a reference in the elaboration of the methodology and form for this research.

Data analysis was based on the model proposed by the UN (2013) in the document “An Anti-Corruption Ethics and Compliance Programs: A Practical Guide, which determines a series of checks for the activities contained in integrity/compliance programs.

III. RESEARCH RESULTS

According to the scope delimited by the research project, this study intends to evidence the structure destined to the implementation of integrity programs and

to evaluate the degree of maturity of this structure in the region of the municipality of foz do Iguaçu-PR.

For Giovanini (2014, p. 137), the success of the code of conduct is linked to: "communicating it to the entire staff and how senior management must be an example in complying with it, easy for everyone to understand, unambiguous, impartial , fair".

Consequently, according to the analyzed data, it is inferred that the organizations surveyed provide these devices to their employees to strengthen the mechanisms of integrity, with a high degree of cooperation with authorities.

The degree of development of integrity/compliance programs in the hotel network in the region of Foz do Iguaçu – PR.

According to delimited samples, six hotels in the region of Foz do Iguaçu - PR were surveyed through an online questionnaire for data collection and, respecting the criteria of confidentiality, they will be represented as Hotel 1 to Hotel 6. However, it presents a binary system of responses and for data analysis, a scale of development of the researched process was implemented in five levels, which were tabulated with scores from 1 to 5 for the elaboration of the total score for each of the reference topics: 1 point for "Strongly Disagree"; 2 points for "Partially Disagree"; 3 points for "Neutral"; 4 points for "Partially Agree"; and 5 points for Totally Agree.

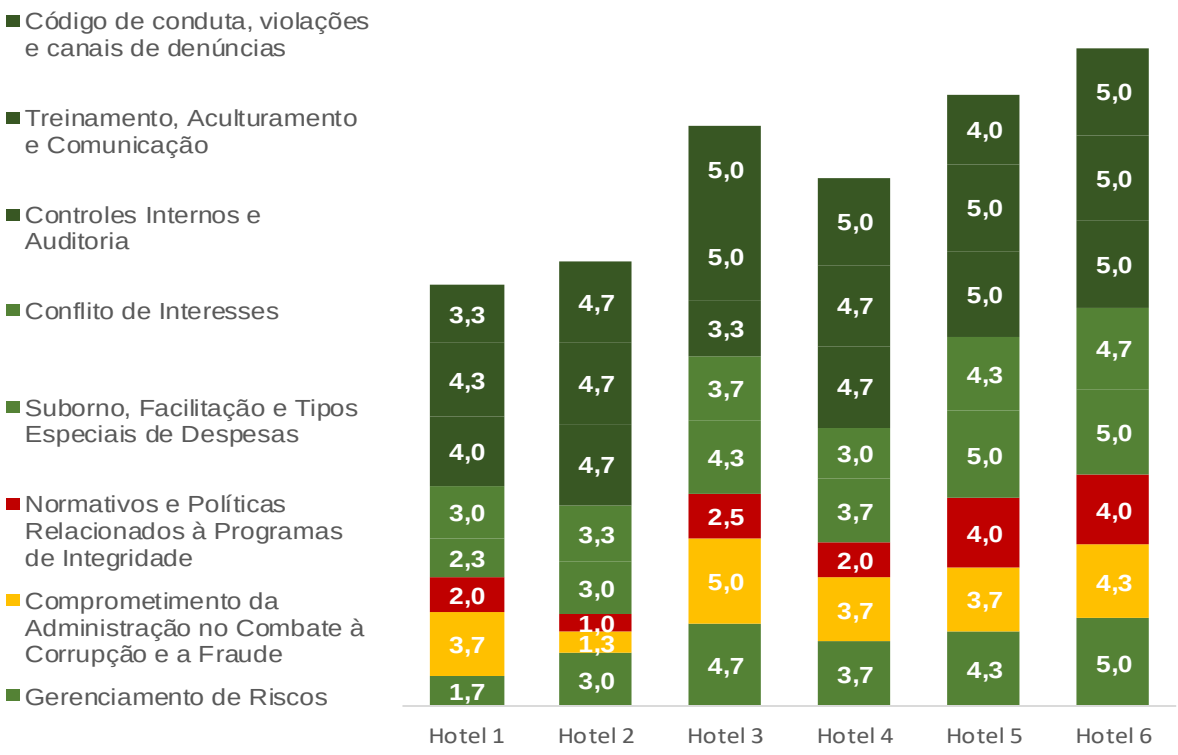
Through the collected data, a high adherence of the surveyed hotels to the activities and processes contained in the integrity/compliance program is observed. Thus, the next table demonstrates the overall ranking of organizations surveyed. The survey was applied to the largest hotels in the region, but the UN guide (2013, p. 104) emphasizes that: "organizations of all sizes must publicly demonstrate their efforts and commitment to fighting corruption and promoting ethics and integrity". Therefore, the next table shows the general classification of organizations surveyed.

Table: General Classification

Dados	Hotel 1	Hotel 2	Hotel 3	Hotel 4	Hotel 5	Hotel 6	Média
Gerenciamento de Riscos	1,7	3,0	4,7	3,7	4,3	5,0	3,7
Comprometimento da Administração no Combate à Corrupção e a Fraude	3,7	1,3	5,0	3,7	3,7	4,3	3,6
Normativos e Políticas Relacionados à Programas de Integridade	2,0	1,0	2,5	2,0	4,0	4,0	2,6
Suborno, Facilitação e Tipos Especiais de Despesas	2,3	3,0	4,3	3,7	5,0	5,0	3,9
Conflito de Interesses	3,0	3,3	3,7	3,0	4,3	4,7	3,7
Controles Internos e Auditoria	4,0	4,7	3,3	4,7	5,0	5,0	4,5
Treinamento, Aculturamento e Comunicação	4,3	4,7	5,0	4,7	5,0	5,0	4,8
Código de conduta, violações e canais de denúncias	3,3	4,7	5,0	5,0	4,0	5,0	4,5
POTUAÇÃO FINAL	**3,0**	**3,2**	**4,2**	**3,8**	**4,4**	**4,8**	**3,9**

Source: Author data.

Gráfico: Composição por tópico

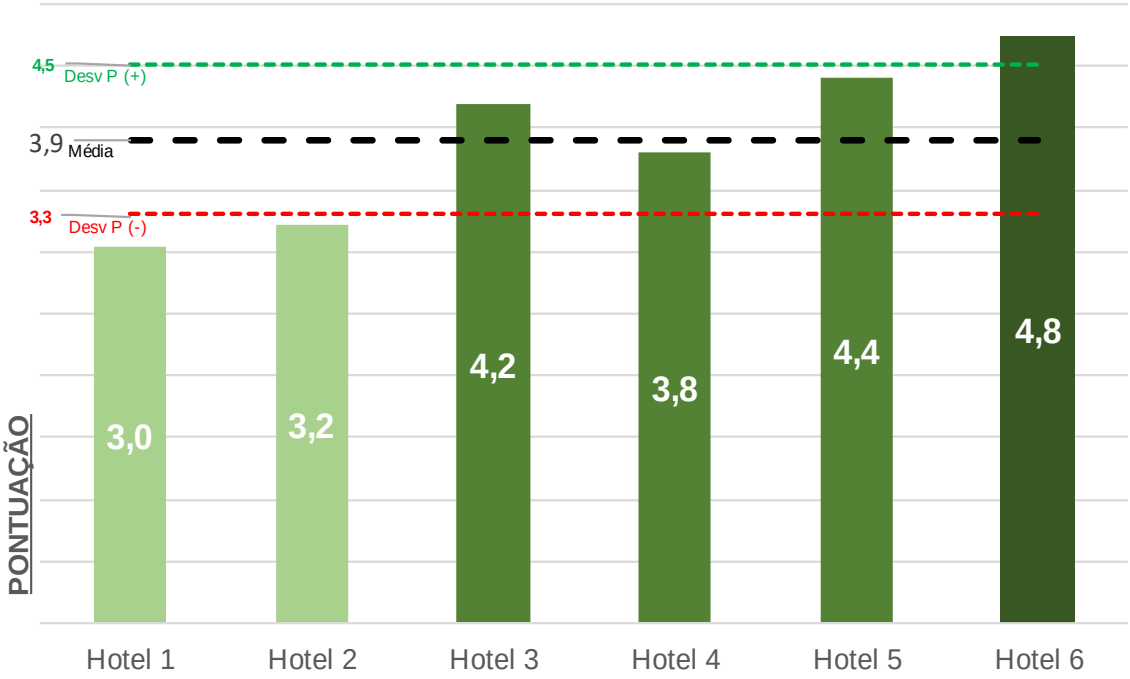


Source: Author data.

The organizations surveyed showed a high degree of maturity regarding the structure intended for integrity programs, however, the performance presented under the normative and policy topic reveals that, even if the structure exists, it is not circumscribed under the characterization of an integrity program in themselves. The UN document lists a series of attributes for the normative elaboration of program policies that must contain, for its best effectiveness:

> - As políticas devem ser formalmente documentadas;
>
> -A linguagem deve ser clara e de fácil entendimento, traduzida para todas as línguas onde exista operação;
>
> - As políticas devem ser visíveis a todas as partes da operação, internos e externos, em todos os níveis e hierárquicos e para todos os *stakeholders; e*
>
> -A políticas devem conter casos reais para facilitar o entendimento dos normativos contidos" (ONU, 2013, p. 35, tradução nossa)

Graph 18: General Classification



Source: Author data.

According to the mean and standard deviation, it is observed that the performance of hotels 1 (one) and 2 (two) are below their peers, that is, the development of activities aimed at the program must be promoted. However, when compared with the numbers obtained by the KPMG document (2019, p. 8), the region presents: "high degree of maturity regarding the activities". It is important to point out that the survey carried out by the Consultancy covers the entire national territory, influencing the performance of the sector, which in the document presents a total score of 2.9 out of a total of 5 (five). Despite being different methodologies, both propose the observation of activities described in the study, revealing a strong positive correction and thus becoming comparable.

IV. CONCLUSION

Integrity/Compliance Programs have become indispensable for organizations in conducting their operations with a view to their own sustainability, therefore, it is an ethical commitment in which production processes will converge to the development of ethics as the core of decisions at all hierarchical levels.

The concept, when rooted in the institutional core, will influence the actions of those involved in institutional processes and in other spheres, promoting the concept and generating social development through spillover, which makes the benefits of the program even more comprehensive, as it will not only bring benefits to the institution, but also to society, being disseminated by the attitude of its employees and administrators.

In parallel, the maturity stage of the program structure in the hotel network of Foz do Iguaçu - PR was raised, one of the main tourist destinations in the country and being a reference in the researched segment, which, according to the research protects its processes through the integrity.

The best practices of integrity programs are increasingly present in the organizational day-to-day, several entities monitor and promote this structure as observed during the survey. The hotel network in Foz do Iguaçu - PR is not below the vanguard of organizational integrity, according to the structure observed in the literature review and the data collected through the research, it is concluded that, despite having gaps related mainly to composition normative and engagement of senior management in this process, the organizational activity in the region has a high degree of maturity in relation to the topic, although not characterized as integrity in itself so far, but rather dispersed in the business units.

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Boundary value problems of fractional differential equations with nonlocal and integral boundary conditions

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***Abstract*—** *The boundary value problems of fractional differential equations involving Caputo derivatives are examined in this article. The ultimate goal of our study is to institute the existence and uniqueness properties for our boundary problems with nonlocal and integral boundary conditions by applying the Banach and the Schaefer's theorems of fixed point. We finally discuss two applicable questions to enhance the comprehension of our outcomes and conclude by summarizing our results and giving vital suggestions for further research works in relation to our study.*

I. INTRODUCTION

The concept of fractional differentials and integrals date as far back as the middle of the nineteenth century by the works of some mathematicians such as Liouville, L'Hospital and Riemann. A century later, engineers and physicists found considerable applications to the concept in their respective fields of interest such as physics, identification of signals and processing of images, aerodynamics, blood flow phenomena and many other relevant fields of study[11,13]. Over the years, numerous concepts of fractional derivatives have been established such as the Riemann-Liouville and the Caputo derivative coupled with an extensive and significant advancements in the analysis of the solutions of FDEs, specifically of higher-order differentials with boundary restrictions.

The importance and applicability of fractional differential equations keep increasing extensively over the years due to its accuracy and objectiveness in describing nonlinear and or natural phenomenon such as stochastic and diffusion models, hydrology processes and finance. Lately, the advancement of fractional derivatives has not only portrayed in-depth research backgrounds but also a vast application to real life situations. The analysis of the multiplicity, uniqueness and existence of solutions and positive solutions of boundary value problems via the application of nonlinear techniques such as the theory of fixed points, the Leray-Schauder theorem, the technique of Upper and Lower solution among others has garnered much attention from researchers[3-13].

Benchohra et al[5], investigated the boundary problems of the FDE below;

$$D_{0+}^{\propto} y(t) = f\big(t, y(t)\big), \quad t \in J = [0, T], \quad \propto \in (1, 2].$$

$$y(0) = g(y), \qquad y(T) = y_T$$

where $D_{0+}^{\propto}$ is a Caputo's differential, $f: [0, T] \times R \to R$ and $g: c(J, R) \to R$ are continuous functions and $y_T \in R$.

Cabada and Wang [6], examined the positive solutions of the FDE below with integral boundary conditions;

$${}^{c}D^{\alpha} u(t) + f\big(t, u(t)\big) = 0, \qquad 0 < t < 1$$

$$u(0) = u^{''}(0) = 0, \qquad u(1) = \lambda \int_0^1 u(s)ds$$

where $\alpha \in (2,3), \lambda \in (0,2), {}^{c}D^{\alpha}$ is a Caputo fractional differential, order α and $f:[0,1]\times[0,\infty] \to [0,\infty)$ is a continuous function.

$$x(0) = y(x), \qquad \int_0^T x(t)dt = m$$

$$x(0) = y(x), \quad x(T) = \int_0^T g(s)x(s)ds$$

in which ${}^{c}D_{0+}^{\propto}$ is a Caputo differential, $f:[0,T]\times R \to R, y: C^2([0,T],R) \to R$ and $g:[0,T] \to R$ are C^2 continuous function and $m \in R$.

Inspired by the aforementioned articles, we examine the solutions of the FDE below involving Caputo derivatives; ;

$${}^{c}D_{0+}^{\gamma}u(t) = g(t,u(t), {}^{c}D_{0+}^{\delta}u(t)) = 0, \ \ t \in [0,\tau], \ \ \gamma \in (n-1,n] \ \ where \ (n \geq 2)$$

subject to the nonlocal and integral boundary conditions;

$$k_0 = \mu(u), \ \int_0^{\tau} u(t)dt = \rho$$

$$k_0 = \mu(u), \quad u(\tau) = U_{\tau} \qquad (1.1)$$

Where ${}^{c}D_{0+}^{\gamma}$ and ${}^{c}D_{0+}^{\delta}$ are the Caputo fractional order differentials of γ and δ respectively, $g:[0,\tau]\times R\times R \to R$ is a continuous function, $\delta \in (0,1)$ for all $\delta, \rho, U_{\tau} \in R$.

Yan et al.[18], investigated the boundary value problems with integral conditions for the fractional differential equation;

$${}^{c}D_{0+}^{\alpha}x(t) = f\big(t,x(t)\big), \quad t \in [0,T], \quad n-1 < \propto \leq 2,$$

As follows, we arrange the rest of the document. We stipulate our definitions and lemmas in section 2 to aid establish our main objectives. In section 3, by using the Banach and Schaefer's theorems of fixed points, we define some requirements for the existence of problem (1.1). Two examples to explain our key findings are discussed at the end.

II. PRELIMINARIES

To commence the section, we stipulate some definitions and notations utilized in our study and proceed to prove our supporting lemmas before stating our key findings.

Definition 2.1([11]) The Caputo fractional differential of order α for a continuous function $f(t)$ is defined by;

$${}^{c}D_{0+}^{\alpha}f(t) = \frac{1}{\Gamma(n-\alpha)}\int_0^t (t-s)^{n-\alpha-1}f^{(n)}(s)ds,$$

where n = $[\alpha]+1$, $[\alpha]$ connotes the integer of $\propto$ and Γ is the gamma function.

Definition 2.2([18]). If $f \in (0,\infty)$ is a continuous function, the Riemann-Liuoville fractional integral of order $\alpha > 0$ is defined as;

$$I_{0+}^{\alpha}f(t) = \frac{1}{\Gamma(\alpha)}\int_0^t \frac{f(s)}{(t-s)^{1-\alpha}}ds,$$

where Γ is the gamma function.

Definition 2.3([19]). The gamma function, $\Gamma(\cdot)$ is defined by,

$$\Gamma(\propto) = \int_0^{\infty} e^{-t}t^{\propto-1}dt,$$

where $[\alpha]$ is the integer of $\propto$ and $\Gamma(\propto+1) = \propto \Gamma(\propto)$.

Lemma 2.1([11]). If $\propto > 0$, the FDE $D_{0+}^{\propto}h(t) = 0$ has the solution $h(t) = k_0 + k_1t + k_2t^2 + \ldots + k_{n-1}t^{n-1}$, $k_i \in R$, $i = 0,1,\ldots,n-1$.

Lemma 2.2 ([19]). If $\propto > 0$, then $I_{0+}^{\propto}D_{0+}^{\propto}h(t) = h(t) + k_0 + k_1t + k_2t^2 + \ldots + k_{n-1}t^{n-1}$ for any $k_i \in R$, $i = 0,1,\ldots,n-1$, $n = [\propto]+1$.

Lemma 2.3. Let $\gamma \in (1,2]$ and $q(t) \in c^2[0,\tau]$. Then a function u satisfies the BVP;

$$\begin{cases} {}^{c}D_{0+}^{\gamma}u(t) = q(s), & t \in [0,\tau] \\ \mu(u) = k_0, & \int_0^{\tau} u(t)dt = \rho \end{cases} \qquad (2.1)$$

Iff u satisfies the fractional integral equation;

$$u(t) = \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}q(s)ds + (1-\frac{2t}{\tau})\mu(u) + \frac{2\rho}{\tau^2}t - \frac{2t}{\tau^2\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^{\gamma}q(s)ds. \quad (2.2)$$

Proof: From lemma 2.2 with the boundary conditions $\mu(u) = k_0$ and $\int_0^\tau u(t)dt = \rho$, then;

$u(t) = I_{0+}^{\gamma}q(t) + k_0 + k_1 t$ where $k_0, k_1 \in R$,

$$u(t) = \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}q(s)ds + k_0 + k_1 t$$

$$\int_0^\tau u(t)dt = \frac{1}{\Gamma(\gamma)}\int_0^\tau\int_0^t (t-s)^{\gamma-1}q(s)ds + \int_0^\tau k_0 dt + \int_0^\tau k_1 t\, dt$$

$$2\rho = \frac{2}{\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^{\gamma}q(s)ds + 2k_0\tau + \tau^2 k_1;$$

$$k_1 = \frac{2\rho}{\tau^2} - \frac{2}{\tau}\mu(u) - \frac{2}{\tau^2\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^{\gamma}q(s)ds$$

Hence;

$$u(t) = \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}q(s)ds + (1-\frac{2t}{\tau})\mu(u) + \frac{2\rho}{\tau^2}t - \frac{2t}{\tau^2\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^{\gamma}q(s)ds.$$

Prove is completed.

Lemma 2.4 Let $\gamma \in (1, 2]$ and $q: [0, \tau] \to R$ be continuous. Then u satisfies the fractional integral equation;

$$u(t) = \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}q(s)ds + (1-\frac{t}{\tau})\mu(u) + \frac{t}{\tau}U_\tau - \frac{t}{\tau\Gamma(\gamma)}\int_0^\tau (\tau-s)^{\gamma-1}q(s)ds \quad (2.3)$$

Iff u satisfies BVP (2.4);

$$\begin{cases} {}^cD_{0+}^{\gamma}u(t) = q(s), \quad t \in [0, \tau] \\ \mu(u) = k_0,\ u(\tau) = U_\tau \end{cases} \quad (2.4)$$

Proof: From lemma 2.2 and the boundary conditions $\mu(u) = k_0,\ u(\tau) = U_\tau$ then;

$u(t) = I_{0+}^{\gamma}q(t) + k_0 + k_1 t$ for some $k_0, k_1 \in R$,

$$u(t) = \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}q(s)ds + k_0 + k_1 t$$

this implies that;

$$u(\tau) = \frac{1}{\Gamma(\gamma)}\int_0^\tau (\tau-s)^{\gamma-1}q(s)ds + k_0 + k_1\tau$$

$$U_\tau = \frac{1}{\Gamma(\gamma)}\int_0^\tau (\tau-s)^{\gamma-1}q(s)ds + \mu(u) + k_1\tau$$

$$k_1 = \frac{U_\tau}{\tau} - \frac{1}{\tau}\mu(u) - \frac{1}{\tau\Gamma(\gamma)}\int_0^\tau (\tau-s)^{\gamma-1}q(s)ds$$

Hence,

$$u(t) = \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}q(s)ds - \frac{t}{\tau\Gamma(\gamma)}\int_0^\tau (\tau-s)^{\gamma-1}q(s)ds + (1-\frac{t}{\tau})\mu(u) + \frac{t}{\tau}U_\tau$$

Prove is completed.

III. MAIN RESULTS

Now we find appropriate to establish our main findings.

Theorem 3.1 Suppose;

($A1$). A non-negative constant L exists and satisfies;

$$|g(t, u_1, v_1) - g(t, u_2, v_2)| \le L(|u_1 - u_2| + |v_1 - v_2|) \quad for\ any\ t \in [0, \tau]\ \forall\ u_i, v_i \in R.$$

(A_2) A non-negative constant L_1 exists and satisfies;

$$|\mu(t, u) - \mu(t, v)| \le L_1|u - v|, \forall\ t \in [0, \tau]\ and\ u, v\ \in R.$$

(A_3) If $\varphi = \max\{(\frac{\tau^\gamma}{\Gamma(\gamma+1)} + \frac{2\tau^{\gamma-1}}{\Gamma(\gamma+2)})2L + L_1, \frac{\tau}{\Gamma(2-\delta)}[(\frac{\tau^{\gamma-1}}{\Gamma(\gamma)} + \frac{2\tau^{\gamma-2}}{\Gamma(\gamma+2)})2L + L_1]\} < 1.$

Then the BVP (2.1) has a unique solution.

Proof: We convert BVP (2.1) to a problem with fixed point by considering the

operator $P : U \to U$, where $U \in C([0, \tau], R)$ defined by;

$$P(u)(t) = \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1} g(s, u(s), {}^cD^\delta_{0+}u(s))ds - \frac{2t}{\tau^2\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^\gamma g(s, u(s), {}^cD^\delta_{0+}u(s))ds + (1-\frac{2t}{\tau})\mu(u) + \frac{2\rho}{\tau^2}t \quad (2.5)$$

Obviously, P has fixed points which satisfies problem (2.1). Now, from (A_1) we show that P has a fixed point and hence maps onto itself.

Let $u_1, u_2 \in u$, then;

$$|P(u_1)(t) - P(u_2)(t)| \le \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}\left|g(s, u_1(s), {}^cD^\delta_{0+}u_1(s)) - g(s, u_1(s), {}^cD^\delta_{0+}u_2(s))\right|ds + \frac{2t}{\tau^2\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^\gamma\left|g(s, u_1(s), {}^cD^\delta_{0+}u_1(s)) - g(s, u_1(s), {}^cD^\delta_{0+}u_2(s))ds\right| + \left|1-\frac{2t}{\tau}\right||\mu(u_1) - \mu(u_2)|. \quad (2.6)$$

From (A_1), it implies that;

$$\begin{aligned}\left|g(s, u_1(s), {}^cD^\delta_{0+}u_1(s)) - g(s, u_1(s), {}^cD^\delta_{0+}u_2(s))\right| &\le L(|u_1(s) - u_2(s)| + \left|{}^cD^\delta_{0+}u_1(s)) - {}^cD^\delta_{0+}u_2(s))\right| \\ &\le L(\|u_1 - u_2\| + \left\|{}^cD^\delta_{0+}u_1 - {}^cD^\delta_{0+}u_2\right\| \\ &\le 2L\|u_1 - u_2\|_* \quad (2.7)\end{aligned}$$

And from (A_2),

$$|\mu(u_1) - \mu(u_2)| \le L_1\|u_1 - u_2\|_* \quad (2.8)$$

Therefore from (2.6),

$$\begin{aligned}|P(u_1)(t) - P(u_2)(t)| &\le \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}ds.\,2L\|u_1 - u_2\|_* + \left|1-\frac{2t}{\tau}\right|.L_1\|u_1 - u_2\|_* \\ &\quad + \frac{2t}{\tau^2\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^\gamma ds.\,2L\|u_1 - u_2\|_* \\ \|P(u_1) - P(u_2)\| &\le \frac{\tau^\gamma}{\gamma\Gamma(\gamma)}.2L\|u_1 - u_2\|_* + L_1\|u_1 - u_2\|_* + \frac{2}{\tau(\gamma+1)\Gamma(\gamma+1)}\tau^\gamma.2L\|u_1 - u_2\|_* \\ &\le (\frac{2L\tau^\gamma}{\Gamma(\gamma+1)} + \frac{4L\tau^{\gamma-1}}{\Gamma(\gamma+2)}).\|u_1 - u_2\|_* + L_1\|u_1 - u_2\|_* \\ &\le [(\frac{\tau^\gamma}{\Gamma(\gamma+1)} + \frac{2\tau^{\gamma-1}}{\Gamma(\gamma+2)})2L + L_1]\|u_1 - u_2\|_*\end{aligned}$$

Again from (2.5);

$$(Pu)'(t) = \frac{1}{\Gamma(\gamma-1)}\int_0^t (t-s)^{\gamma-2} g(s, u(s), {}^cD^\delta_{0+}u(s))ds - \frac{2}{\tau}\mu(u) + \frac{2\rho}{\tau^2} - \frac{2}{\tau^2\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^\gamma g(s, u(s), {}^cD^\delta_{0+}u(s)ds$$

Then;

$$\begin{aligned}\left|(Pu_1)'(t) - (Pu_2)'(t)\right| &\le \frac{1}{\Gamma(\gamma-1)}\int_0^t (t-s)^{\gamma-2}\left|g(s, u_1(s), {}^cD^\delta_{0+}u_1(s)) - g(s, u_2(s), {}^cD^\delta_{0+}u_2(s))\right|ds \\ &\quad + \frac{2}{\tau^2\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^\gamma\left|g(s, u_1(s), {}^cD^\delta_{0+}u_1(s)) - g(s, u_2(s), {}^cD^\delta_{0+}u_2(s))\right|ds \\ &\quad + |\mu(u_1) - \mu(u_2)|\end{aligned}$$

From (2.7) and (2.8),

$$\left|(Pu_1)'(t) - (Pu_2)'(t)\right| \le \frac{t^{\gamma-1}}{\Gamma(\gamma)}.2L\|u_1 - u_2\|_* + L_1\|u_1 - u_2\|_* + \frac{2\tau^{\gamma-2}}{\Gamma(\gamma+2)}.2L\|u_1 - u_2\|_*$$

$$\leq [(\frac{\tau^{\gamma-1}}{\Gamma(\gamma)} + \frac{2\tau^{\gamma-2}}{\Gamma(\gamma+2)})2\mathrm{L} + L_1] \,.\, \|\mathrm{u}_1 - \mathrm{u}_2\|_*$$

But;

$$^{c}D^{\delta}_{0+}(Pu)'(t) = \frac{1}{\Gamma(1-\delta)}\int_0^t (t-s)^{-\delta} ds.\,(Pu)'(t)$$

$$= \frac{1}{\Gamma(1-\delta)} . \frac{\mathrm{t}^{1-\delta}}{1-\delta} (Pu)'(t)$$

$$= \frac{1}{\Gamma(2-\delta)} . (Pu)'(t)$$

Therefore;

$$\left|{}^{c}D^{\delta}_{0+}(Pu_1)'(t) - {}^{c}D^{\delta}_{0+}(Pu_2)'(t)\right| \leq \frac{1}{\Gamma(1-\delta)}\int_0^t (t-s)^{-\delta} ds \left|(Pu_1)'(s) - (Pu_2)'(s)\right|$$

$$\leq \frac{\tau}{\Gamma(2-\delta)}[(\frac{\tau^{\gamma-1}}{\Gamma(\gamma)} + \frac{2\tau^{\gamma-2}}{\Gamma(\gamma+2)})2\mathrm{L} + L_1]\|\mathrm{u}_1 - \mathrm{u}_2\|_*$$

Hence,

$$\|Pu_1 - Pu_2\|_* = max\{\|P(u_1) - P(u_2)\|, \left\|{}^{c}D^{\delta}_{0+}(Pu_1)'(t) - {}^{c}D^{\delta}_{0+}(Pu_2)'(t)\right\|\} \leq \varphi\|\mathrm{u}_1 - \mathrm{u}_2\|_*$$

Hence, P with $\varphi \leq 1$ contracts. Therefore as a result of the contraction principle, we infer that P has a fixed point which is unique and satisfies (2.1). Consequently, the proof is completed.

Theorem 3.2 Suppose $g : [0, \tau] \times \mathrm{R} \times \mathrm{R} \to \mathrm{R}$ and $\mu : \mathrm{C}([0,1], \mathrm{R}) \to \mathrm{R}$ are continuous functions and satisfy;

(B_1) $|g(t,u,v)| \leq k$ for any $\mathrm{t} \in [0, \tau]$ $\forall$ u, v $\in$ R,

(B_2) $|\mu(t,u) - \mu(t,v)| \leq k_1|u - v|$ for any $\mathrm{t} \in [0, \tau]$ $\forall$ u, v $\in$ R.

(B_3) $|\mu(u)| \leq k_*$ $\forall$ $\mu \in C([0,\tau], R)$.

where k and k_* are positive constants, then BVP (2.1) has a solution.

Proof: To ascertain our results, we use the Schaefer's fixed point theorem. We divide the proof into four parts for simplicity and clarity.

Step 1: Firstly, we establish the continuity of P.

Let $u_n \in C([0,\tau], R)$ be a sequence such that $u_n \to u$. Then $\forall\, \mathrm{t} \in [0, \tau]$, we derive;

$$\mathrm{P(u_n)(t) - P(u)(t)} \leq \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}\left|g(s, u_n(s), {}^{c}D^{\delta}_{0+}u_n(s)) - g(s, u(s), {}^{c}D^{\delta}_{0+}u(s))\right| ds$$

$$+ \frac{2}{\tau^2\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^{\gamma}\left|g(s, u_n(s), {}^{c}D^{\delta}_{0+}u_n(s)) - g(s, u(s), {}^{c}D^{\delta}_{0+}u(s))\right| ds$$

$$+ |\mu(u_n) - \mu(u)|$$

From (B_1) and (B_2);

$$\left|g(t, u_n(t), {}^{c}D^{\delta}_{0+}u_n(t)) - g(t, u(t), {}^{c}D^{\delta}_{0+}u(t))\right| \leq \mathrm{k}(\|\mathrm{u_n(s) - u(s)}\| + \left\|{}^{c}D^{\delta}_{0+}u_n(s) - {}^{c}D^{\delta}_{0+}u(s)\right\|)$$

$$\leq \mathrm{k}(\|\mathrm{u_n - u}\| + \left\|{}^{c}D^{\delta}_{0+}u_n - {}^{c}D^{\delta}_{0+}u\right\|)$$

$$\leq 2\mathrm{k}\|\mathrm{u_n - u}\|_*$$

and

$$\|\mu(u_n) - \mu(u)\| \leq k_1\|u_n - u\|$$

Therefore,

$$|P(u_n)(t) - P(u)(t)| \leq \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1} ds.\ 2\mathrm{k}\|\mathrm{u_n - u}\|_* + k_1\|u_n - u\| + \frac{2}{T^2\Gamma(\gamma+1)}\int_0^T (T-s)^{\gamma} ds.2\mathrm{k}\|\mathrm{u_n - u}\|_*$$

also,

$$\left|{}^{c}D^{\delta}_{0+}P(u_n)(t) - {}^{c}D^{\delta}_{0+}P(u)(t)\right| \leq \frac{1}{\Gamma(1-\delta)}\int_0^t (t-s)^{-\delta}|P(u_n)(s) - (Pu)(s)| ds$$

Since the functions g and μ are continuous, it implies that $\|P(u_n) - P(u)\| \to 0$ and $\left\|{}^{c}D^{\delta}_{0+}P(u_n) - {}^{c}D^{\delta}_{0+}P(u)\right\| \to 0$ as $n \to \infty$. Therefore P is continuous.

Step 2: Now we prove the boundedness of P.

By (B_1) *and* (B_3) from (2.5) for any $t \in [0, \tau]$, we derive;

$$|P(u)(t)| \leq \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}\left|g(s,u(s),{}^{c}D^{\delta}_{0+}u(s))\right|ds + 2|\mu(u)| + \frac{2}{\tau}|\rho| + \frac{2}{\tau\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^{\gamma}\left|g(s,u(s),{}^{c}D^{\delta}_{0+}u(s)\right|ds$$

$$\leq \frac{k}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}ds + 2k_* + \frac{2}{\tau}|\rho| + \frac{2k}{\tau\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^{\gamma}ds$$

$$\leq \frac{k}{\gamma\Gamma(\gamma)}.\tau^{\gamma} + \frac{2k}{\tau}.\frac{\tau^{\gamma+1}}{(\gamma+1)\Gamma(\gamma+1)} + 2k_* + \frac{2}{\tau}|\rho|$$

$$\leq \frac{k}{\Gamma(\gamma+1)}.\tau^{\gamma} + \frac{2k}{\Gamma(\gamma+2)}.\tau^{\gamma} + 2k_* + \frac{2}{\tau}|\rho|$$

and,

$$\left|P({}^{c}D^{\delta}_{0+}u(t))\right| = \left|{}^{c}D^{\delta}_{0+}P(u)(s)\right| \leq \frac{1}{\Gamma(1-\delta)}\int_0^t (t-s)^{-\delta}ds.\,|(Pu)(s)|$$

$$\leq \frac{\tau}{\Gamma(2-\delta)}\left[\frac{k}{\Gamma(\gamma+1)}.\tau^{\gamma} + \frac{2k}{\Gamma(\gamma+2)}.\tau^{\gamma} + 2k_* + \frac{2}{\tau}|\rho|\right.$$

Thus, P is evenly bounded.

Step 3: Next we establish that P is completely continuous.

Let $t_1, t_2 \in (0, \tau]$ where $t_1 < t_2$, then;

$$|P(u)(t_2) - P(u)(t_1)| =$$

$$\left|\frac{1}{\Gamma(\gamma)}\int_0^{t_1}[(t_2-s)^{\gamma-1} - (t_1-s)^{\gamma-1}]g(s,u(s),{}^{c}D^{\delta}_{0+}u(s))\,ds + \frac{1}{\Gamma(\gamma)}\int_{t_1}^{t_2}[(t_2-s)^{\gamma-1}g(s,u(s),{}^{c}D^{\delta}_{0+}u(s))\right|ds$$

$$+ \frac{2(t_2-t_1)}{\tau}|\mu(u)| + \frac{2(t_2-t_1)}{\tau^2}|\rho| + \frac{2(t_2-t_1)}{\tau^2\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^{\gamma}\left|g(s,u(s),{}^{c}D^{\delta}_{0+}u(s))\right|ds$$

$$\leq \frac{k}{\Gamma(\gamma)}\int_0^{t_1}[(t_2-s)^{\gamma-1} - (t_1-s)^{\gamma-1}]ds + \frac{k}{\Gamma(\gamma)}\int_{t_1}^{t_2}(t_2-s)^{\gamma-1}ds + \frac{2k_*}{T}(t_2-t_1) + \frac{2|\rho|}{T^2}(t_2-t_1)$$

$$+ \frac{2k}{T^2\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^{\gamma}ds.\,(t_2-t_1)$$

$$\leq \frac{k}{\Gamma(\gamma+1)}[(t_2-t_1)^{\gamma} + t_2^{\gamma} - t_1^{\gamma}] + \frac{k}{\Gamma(\gamma+1)}(t_2-t_1)^{\gamma} + \frac{2k\tau^{\gamma+1}}{\tau^2\Gamma(\gamma+2)}(t_2-t_1) + \frac{2k_*}{\tau}(t_2-t_1) + \frac{2|\rho|}{\tau^2}(t_2-t_1) \qquad (2.9)$$

From (2.9), it can be easily seen that as $t_1 \to t_2$, the RHS tends to zero. Together with the Arzela - Ascoli theorem and the preceding steps, we conclude that P is completely continuous.

Step 4: Finally, we assume P maps onto itself, such that the set $\Phi = \{u \in E: u = \lambda Pu \text{ for any } \lambda \in (0, 1)\}$ is bounded.

Now $\forall\, t \in [0, \tau]$,

$$P(u)(t) = \frac{\lambda}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}g(s,u(s),{}^{c}D^{\delta}_{0+}u(s))ds + \lambda(1-\frac{t}{\tau})\mu(u) + \lambda\frac{2t}{\tau^2}\rho$$

$$- \lambda\frac{2t}{\tau^2\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^{\gamma}.\,g(s,u(s),{}^{c}D^{\delta}_{0+}u(s))ds$$

By (B_1) and (B_3) for any $t \in [0, \tau]$;

$$|P(u)(t)| \leq \frac{k}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}ds + k_* + \frac{2}{\tau}|\rho| + \frac{2k}{\tau\Gamma(\gamma+1)}\int_0^\tau (\tau-s)^{\gamma}ds$$

$$\leq \frac{k}{\Gamma(\gamma+1)}\tau^{\gamma} + \frac{2k}{\Gamma(\gamma+2)}\tau^{\gamma+1} + k_* + \frac{2}{\tau}|\rho|$$

Hence the set Φ is bounded. Therefore P has a fixed point which is a solution to problem(2.1). The end of prove.

At this point, we examine the solutions of BVP (2.4) to ascertain its existence and uniqueness.

Theorem 3.3 Suppose;

(C_1) A non-negative constant L exists and satisfies;

$|g(t,u_1,v_1)-g(t,u_2,v_2)| \le L(|u_1-u_2|+|v_1-v_2|)$ for each t ∈ J and all $u_i, v_i \in R$.

(C_2) A constant $L_1 > 0$ exists and satisfies condition;

$|\mu(u_0)-\mu(u_1)| < L_1|u_0-u_1|$, for any t ∈ J and all $u_0, u_1 \in U$

(C_3) If $\varphi = \max\{(\frac{\tau^\gamma}{\Gamma(\gamma+1)}+\frac{\tau^{\gamma-1}}{\Gamma(\gamma+1)})2L + L_1,\ \frac{\tau}{\Gamma(2-\beta)}[(\frac{\tau^{\gamma-1}}{\Gamma(\gamma)}+\frac{\tau^{\gamma-1}}{\Gamma(\gamma+1)})2L + L_1]\} < 1.$

Then, the BVP (2.4) has a unique solution.

Proof: We convert BVP (2.4) to a problem with fixed point by considering the operator $P: U \to U$ defined by;

$$P(u)(t) = \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1} g(s,u(s),{}^cD_{0+}^{\delta}u(s))ds + (1-\frac{t}{\tau})\mu(u) + \frac{t}{\tau}U_\tau - \frac{t}{\tau\Gamma(\gamma)}\int_0^\tau (\tau-s)^{\gamma-1} g(s,u(s),{}^cD_{0+}^{\delta}u(s))ds \quad (2.10)$$

Now we show that P has a fixed point and hence is a contraction.

Let $u_1, u_2 \in U\ \forall\ t \in [0,\tau]$;

$$|P(u_1)(t)-P(u_2)(t)| \le \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}\left|g(s,u_1(s),{}^cD_{0+}^{\delta}u_1(s)) - g(s,u_2(s),{}^cD_{0+}^{\delta}u_2(s))\right|ds + \frac{t}{\tau\Gamma(\gamma)}\int_0^\tau (\tau-s)^{\gamma-1}\left|g(s,u_1(s),{}^cD_{0+}^{\delta}u_1(s)) - g(s,u_2(s),{}^cD_{0+}^{\delta}u_2(s))\right|ds + |\mu(u_1)-\mu(u_2)|$$

From (C_1) and (C_2);

$$\left|g(t,u_1(t),{}^cD_{0+}^{\delta}u_1(t)) - g(t,u_2(t),{}^cD_{0+}^{\delta}u_2(t))\right| \le L(|u_1(s)-u_2(s)| + \left|{}^cD_{0+}^{\delta}u_1(s) - {}^cD_{0+}^{\delta}u_2(s)\right|) \le L(\|u_1-u_2\| + \left\|{}^cD_{0+}^{\delta}u_1 - {}^cD_{0+}^{\delta}u_2\right\|) \le 2L\|u_1-u_2\|_1 \quad (2.11)$$

And,

$$|\mu(u_1)(t)-\mu(u_2)(t)| \le L_1\|u_1(s)-u_2(s)\| \le L_1\|u_1-u_2\|_1 \quad (2.12)$$

From (2.11) and (2.12),

$$|P(u_1)(t)-P(u_2)(t)| \le \frac{\tau^\gamma}{\Gamma(\gamma+1)}.2L\|u_1-u_2\|_1 + \frac{\tau^{\gamma-1}}{\Gamma(\gamma+1)}.2L\|u_1-u_2\|_1 + L_1\|u_1-u_2\|_1 \le [(\frac{\tau^\gamma}{\Gamma(\gamma+1)}+\frac{\tau^{\gamma-1}}{\Gamma(\gamma+1)})2L + L_1]\|u_1-u_2\|_1$$

Again from (2.10),

$$(Pu)'(t) = \frac{1}{\Gamma(\gamma-1)}\int_0^t (t-s)^{\gamma-2} g(s,u(s),{}^cD_{0+}^{\delta}u(s))ds - \frac{1}{\tau}\mu(u) + \frac{1}{\tau}U_\tau - \frac{1}{\tau\Gamma(\gamma)}\int_0^\tau (\tau-s)^{\gamma-1} g(s,u(s),{}^cD_{0+}^{\delta}u(s))ds$$

Then;

$$\left|(Pu_1)'(t)-(Pu_2)'(t)\right| \le \frac{1}{\Gamma(\gamma-1)}\int_0^t (t-s)^{\gamma-2}\left|g(s,u_1(s),{}^cD_{0+}^{\delta}u_1(s)) - g(s,u_2(s),{}^cD_{0+}^{\delta}u_2(s))\right|ds + \frac{1}{\tau\Gamma(\gamma)}\int_0^\tau (\tau-s)^{\gamma-1}\left|g(s,u_1(s),{}^cD_{0+}^{\delta}u_1(s)) - g(s,u_2(s),{}^cD_{0+}^{\delta}u_2(s))\right|ds + \frac{1}{\tau}|\mu(u_1)-\mu(u_2)|$$

From (2.11) and (2.12),

$$\left\|(Pu_1)' - (Pu_2)'\right\| \leq \frac{\tau^{\gamma-1}}{\Gamma(\gamma)} 2L\|u_1 - u_2\|_1 + L_1\|u_1 - u_2\|_1 + \frac{\tau^{\gamma}}{\Gamma(\gamma+1)} 2L\|u_1 - u_2\|_1$$

$$\leq [(\frac{\tau^{\gamma-1}}{\Gamma(\gamma)} + \frac{\tau^{\gamma}}{\Gamma(\gamma+1)})2L + L_1]\|u_1 - u_2\|_1$$

and

$$\left|{}^{c}D^{\delta}_{0+}(Pu_1)(t) - {}^{c}D^{\delta}_{0+}(Pu_2)(t)\right| \leq \frac{1}{\Gamma(1-\delta)}\int_0^t (t-s)^{-\delta}\left|(Pu_1)'(t) - (Pu_2)'(t)\right| ds$$

$$\leq \frac{\tau}{(2-\delta)}[(\frac{\tau^{\gamma-1}}{\Gamma(\gamma)} + \frac{\tau^{\gamma}}{\Gamma(\gamma+1)})2L + L_1]\|u_1 - u_2\|_1$$

Therefore;

$$\|P(u_1) - P(u_2)\|_1 = max\{\|P(u_1) - P(u_2)\|, \left\|{}^{c}D^{\delta}P(u_1) - {}^{c}D^{\delta}P(u_2)\right\|\} \leq \varphi\|u_1 - u_2\|_1$$

Therefore with $\varphi < 1$, P is said to contract and hence uniquely satisfies the BVP (2.4). Thus, the end of proof..

Theorem 3.4 Suppose $g : [0, \tau] \times R \times R \to R$ and $\mu : C([0, 1], R) \to R$ are continuous functions and satisfy;

(D_1) $|g(t, u, v)| \leq k$ for any $t \in J \; \forall \; u, v \in R$.

(D_2) $|\mu(u)| \leq k_1 \; \forall \; u \in C([0, \tau], R)$.

where k and k_1 are positive constants, then BVP (2.4) has a solution.

Proof: Similarly, we apply the Schaefer's theorem of fixed points in proving our results.

Step 1: We prove that P is continuous. Let the sequence u_n exist in such a way that $u_n \to u \in U$. For any $t \in [0, \tau]$;

$$|P(u_n)(t) - P(u)(t)| \leq \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}\left|g(s, u_n(s), {}^{c}D^{\delta}u_n(s)) - g(s, u(s), {}^{c}D^{\delta}u(s))\right| ds + |\mu(u_n) - \mu(u)|$$

$$+ \frac{1}{\tau\Gamma(\gamma)}\int_0^{\tau} (\tau-s)^{\gamma-1}\left|g(s, u_n(s), {}^{c}D^{\delta}u_n(s)) - g(s, u(s), {}^{c}D^{\delta}u(s))\right| ds$$

From assumptions (D_2) and (D_3);

$$\left|g(s, u_n(s), {}^{c}D^{\delta}u_n(s)) - g(s, u(s), {}^{c}D^{\delta}u(s))\right| \leq 2k\|u_n - u\|_2$$

and

$$|\mu(u_n) - \mu(u)| \leq k_1\|u_n - u\|_2$$

Therefore;

$$|P(u_n)(t) - P(u)(t)| \leq \frac{\tau^{\gamma}}{\Gamma(\gamma+1)} 2k\|u_n - u\|_2 + k_1\|u_n - u\|_2 + \frac{\tau^{\gamma-1}}{\Gamma(\gamma+1)} 2k\|u_n - u\|_2$$

also,

$$\left|{}^{c}D^{\delta}P(u_n)(t) - {}^{c}D^{\delta}P(u)(t)\right| \leq \frac{1}{\Gamma(1-\delta)}\int_0^t (t-s)^{-\delta}\,|P(u_n)(s) - P(u)(s)| ds$$

From the above, we conclude that P is continuous since the functions g and μ are continuous which implies that $\|P(u_n) - P(u)\| \to 0$ and $\left\|{}^{c}D^{\delta}P(u_n)(t) - {}^{c}D^{\delta}P(u)(t)\right\| \to 0$ as n approaches infinity.

Step 2: P transforms bounded sets into another sets bounded in U. A non-negative constant r exists and satisfies $\|P(u)\| \leq r$. Hence, for $t \in [0, \tau]$ we derive;

By (D_1) and (D_2);

$$|P(u)(t)| \leq \frac{1}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1}\left|g(s, u(s), {}^{c}D^{\delta}u(s))\right| ds + |\mu(u)| + |U_{\tau}| + \frac{1}{\Gamma(\gamma)}\int_0^{\tau} (\tau-s)^{\gamma-1}\left|g(s, u(s), {}^{c}D^{\delta}u(s))\right| ds$$

$$\leq \frac{k}{\Gamma(\gamma)}\int_0^t (t-s)^{\gamma-1} ds + k_1 + |U_{\tau}| + \frac{k}{\Gamma(\gamma)}\int_0^{\tau} (\tau-s)^{\gamma-1} ds$$

$$\leq \frac{k}{\Gamma(\gamma+1)}\tau^{\gamma} + \frac{k}{\Gamma(\gamma+1)}\tau^{\gamma} + k_1 + |U_{\tau}|$$

Therefore;

$\|P(u)\| \leq \frac{2\tau^{\gamma}}{\Gamma(\gamma+1)}k + k_1 + |\mathrm{U}_{\tau}| = \mathrm{r}$

Step 3: P maps any bounded sets into an equi-continuous sets in U.

Let $t_1, t_2 \in [0, \tau]$, $t_1 \leq t_2$. Then from (2.10) we have;

$$|P(u)(t_2) - P(u)(t_1)| = \frac{1}{\Gamma(\gamma)}\left|\int_0^{t_1}[(t_2-s)^{\gamma-1} - (t_1-s)^{\gamma-1}]\, g(s,u(s),{}^{c}D^{\delta}u(s))\right| ds$$
$$+ \frac{1}{\Gamma(\gamma)}\left|\int_{t_1}^{t_2}(t-s)^{\gamma-1} g(s,u(s),{}^{c}D^{\delta}u(s))\right| ds + \frac{(t_2-t_1)}{\tau}|\mu(u)|$$
$$+ \frac{(t_2-t_1)}{\tau}|\mathrm{U}_{\tau}| + \frac{(t_2-t_1)}{\tau\Gamma(\gamma)}\int_0^{\tau}(\tau-s)^{\gamma-1}\left|g(s,u(s),{}^{c}D^{\delta}u(s))\right| ds$$
$$\leq \frac{\mathrm{k}}{\Gamma(\gamma)}\int_0^{t_1}[(t_2-s)^{\gamma-1} - (t_1-s)^{\gamma-1}]\, ds + \frac{k}{\Gamma(\gamma)}\int_{t_1}^{t_2}(t-s)^{\gamma-1} ds + \frac{(t_2-t_1)}{\tau}k_1$$
$$+ \frac{(t_2-t_1)}{\tau}|\mathrm{U}_{\tau}| + \frac{k(t_2-t_1)}{\tau\Gamma(\gamma)}\int_0^{\tau}(\tau-s)^{\gamma-1} ds$$
$$\leq \frac{\mathrm{M}}{\Gamma(\gamma+1)}[(\mathrm{t}_2-\mathrm{t}_1)^{\gamma} + \mathrm{t}_2^{\gamma} - \mathrm{t}_1^{\gamma}] + \frac{\mathrm{k}}{\Gamma(\gamma+1)}(\mathrm{t}_2-\mathrm{t}_1)^{\gamma} + \frac{(\mathrm{t}_2-\mathrm{t}_1)}{\tau}\mathrm{k}_1 + \frac{(t_2-t_1)}{\tau}|\mathrm{U}_{\tau}| + \frac{k\tau^{\gamma-1}}{\Gamma(\gamma+1)}(t_2-t_1) \qquad (2.13)$$

As $t_1 \to t_2$, the RHS of (2.13) tends to zero. Therefore P is completely continuous as a consequence of the above steps and the Arzela-Ascoli theorem.

Step 4: Finally, we prove the set $\phi = \{\mathrm{u} \in \mathrm{E};\ \mathrm{u} = \lambda \mathrm{Pu} \text{ for any } \lambda \in (0,1)\}$

Let $\mathrm{u} \in \phi$, then

$\mathrm{u} = \lambda \mathrm{P}(\mathrm{u})\ \forall\ \lambda \in (0,1)$ and $0 \leq \mathrm{t} \leq \tau$,

$$\mathrm{P(u)(t)} = \frac{\lambda}{\Gamma(\gamma)}\int_0^{t}(t-s)^{\gamma-1} g(s,u(s),{}^{c}D^{\delta}u(s)) + \lambda(1-\tfrac{t}{\tau})\mu(u) - \frac{\lambda t}{\tau}U_{\tau} - \frac{\lambda t}{\tau\Gamma(\gamma)}\int_0^{\tau}(\tau-s)^{\gamma-1} g(s,u(s),{}^{c}D^{\delta}u(s)) ds$$

From (D_2) and (D_3);

$$|P(u)(t)| \leq \frac{k}{\Gamma(\gamma)}\int_0^{t}(t-s)^{\gamma-1} ds + k_1 + |U_{\tau}| + \frac{k}{\Gamma(\gamma)}\int_0^{\tau}(\tau-s)^{\gamma-1} ds$$
$$\leq \frac{\mathrm{k}}{\Gamma(\gamma+1)}.\tau^{\gamma} + \frac{\mathrm{k}}{\Gamma(\gamma+1)}.\tau^{\gamma} + k_1 + |U_{\tau}|$$
$$\|P(u)\| \leq \frac{\tau^{\gamma}}{\Gamma(\gamma+1)}.2k + k_1 + |U_{\tau}|$$

This shows that the set ϕ is bounded and hence satisfies problem (2.10).

IV. APPLICATION

At this point, we apply our obtained results to some selected examples.

Example 4.1 Consider the fractional boundary value problem;

${}^{c}D_{0+}^{1.5}u(t) = t + 0.1tu(t) + (0.1t^2){}^{c}D_{0+}^{0.5}u(t); \quad t \in (0,1], \quad \gamma \in (1,2],$

$k_0 = \sum_{i=1}^{n} c_i u(t_i), \quad \int_0^{\tau} u(t)dt = 1$

Where $t_i \in (0,1), \quad c_i, \quad i = 1,2,\ldots,n-1, \quad n$ are non-negative constants with

$\sum_{i=1}^{n} c_i < \frac{1}{2}$. Set $\gamma = 1.5$ $(\mathrm{n} \geq 2)$, $\delta = 0.5$, $\mu(\mathrm{u}) = \sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{c_i u}(t_i)$; $\tau = 1$, $\rho = 1$ and

$g(t,u(t),{}^{c}D_{0+}^{\delta}u(t)) = t + 0.1tu(t) + (0.1t^2){}^{c}D_{0+}^{0.5}u(t).$

Let $\mathrm{t} \in [0,\tau]$ and $u_i, v_i \in R$, where $\mathrm{i} = 1,2$.

Then we have;

$$|g(t,u_1,u_2) - g(t,v_1,v_2)| = |0.1t(u_1) - 0.1t(u_2)| + |0.1t^2(v_1) - 0.1t^2(v_2)|$$
$$\leq 0.1(|\mathrm{u}_1 - \mathrm{u}_2| + |\mathrm{v}_1 - \mathrm{v}_2|)$$

Hence, satisfies condition (A_1) with $L = 0.1$. Also,

$$|\mu(u_1) - \mu(u_2)| = \left|\sum_{i=1}^{n} c_i u_1(t_i) - \sum_{i=1}^{n} c_i u_2(t_i)\right|$$
$$\leq \sum_{i=1}^{n} c_i \|u_1 - u_2\|$$

Hence, (A_1) is satisfied with $L_1 = \sum_{i=1}^{n} c_i < \frac{1}{2}$

Finally, we show that (A_3) holds.

$$\varphi = \left(\frac{\tau^{\gamma}}{\Gamma(\gamma+1)} + \frac{2\tau^{\gamma-1}}{\Gamma(\gamma+2)}\right)2L + L_1 = \left(\frac{1}{\Gamma(2.5)} + \frac{2}{\Gamma(3.5)}\right)2(0.1) + 0.5 \cong 0.771 < 1.$$

and

$$\frac{\tau}{\Gamma(2-\delta)}\left[\left(\frac{\tau^{\gamma-1}}{\Gamma(\gamma)} + \frac{2\tau^{\gamma-2}}{\Gamma(\gamma+2)}\right)2L + L_1 = \frac{1}{\Gamma(1.5)}\left[\left(\frac{1}{\Gamma(1.5)} + \frac{2}{\Gamma(3.5)}\right)\right] 2(0.1) + 0.5 \cong 0.954.\right.$$

(A_3) is satisfied with $\varphi < 1$.

Hence, from theorem 3.1 we conclude that BVP (2.1) has a unique solution.

Example 4.2 Consider the fractional boundary value problem;

$${}^{c}D_{0^+}^{1.5}u(t) = e^{\frac{-1}{2}t} + \frac{e^{\frac{-1}{2}t}u(t)}{10e^{t}(1+u(t))} + \left(\frac{e^{-t^3}}{10e^{t}}\right){}^{c}D_{0^+}^{0.5}u(t)$$

$$u(0) = \sum_{i=1}^{n} c_i u(t_i); \quad u(1) = 0$$

Where $t_i \in (0,1)$, $c_{i,}$ $i = 1,2,\ldots,n-1,n$ are non-negative constants with

$\sum_{i=1}^{n} c_i < \frac{1}{6}$. From BVP (3.2), $\gamma = 1.5$, $\delta = 0.5$, $\tau = 1$, $U_{\tau} = 0$,

$$g(t,u(t),{}^{c}D^{\delta}u(t)) = e^{\frac{-1}{2}t} + \frac{e^{\frac{-1}{2}t}u(t)}{10e^{t}(1+u(t))} + \left(\frac{e^{-t^3}}{10e^{t}}\right){}^{c}D_{0^+}^{0.5}u(t)\,, \quad \mu(u) = \sum_{i=1}^{n} c_i u(t_i);$$

Let $u_i, v_i \in R, i = 1,2$ *and* $t \in [0,1]$. Then;

$$|g(t,u_1,v_1) - g(t,u_2,v_2)| = \left|\frac{e^{-1/2t^2}}{10e^{t}}u_1(t) - \frac{e^{-1/2t^2}}{10e^{t}}u_2(t)\right| + \left|\frac{e^{-1/2t^2}}{10e^{t}}v_1(t) - \frac{e^{-1/2t^2}}{10e^{t}}v_2(t)\right|$$
$$= \frac{1}{10}(|u_1 - u_2| + |v_1 - v_2|)$$

Hence, satisfies condition (C_1) with $L = \frac{1}{10}$.

Also,

$$|\mu(u) - \mu(v)| \leq \sum_{i=1}^{n} c_i |u - v|$$

Now, we verify that (C_3) is satisfied with $\tau = 1$.

$$\left(\frac{\tau^{\gamma}}{\Gamma(\gamma+1)} + \frac{\tau^{\gamma-1}}{\Gamma(\gamma+1)}\right)2L + L_1 = \left(\frac{2}{\Gamma(2.5)}\right) \times 2(0.1) + \frac{1}{6} \cong 0.4675 < 1.$$

and,

$$\frac{\tau}{\Gamma(2-\beta)}\left[\left(\frac{\tau^{\gamma-1}}{\Gamma(\gamma)} + \frac{\tau^{\gamma}}{\Gamma(\gamma+1)}\right)2L + L_1\right] = \frac{1}{\Gamma(1.5)}\left[\left(\frac{1}{\Gamma(1.5)} + \frac{1}{\Gamma(2.5)}\right) \times 2(0.1) + \frac{1}{6}\right] \cong 0.6123 < 1$$

which satisfies (C_3) with $\varphi < 1$ for any $\gamma \in (1,2]$. Hence, we establish that BVP (2.4) has a unique solution.

V. CONCLUSION

This article examines the existence and uniqueness of solutions using the principle of contraction mapping and the Schaefer's fixed point theorem to ascertain our results for fractional differential equations involving Caputo derivatives with nonlocal and integral boundary conditions. Boundary problems for fractional derivatives with multiple boundary conditions or eigenvalue problems may be considered for further research works.

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Bioenergy in South America: Directions and Challenges for Biofuels

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Abstract*—Biofuels have become a global interest for many private and public investors, since, in several European countries, bioenergy is considered a part of the energy matrix. However, South America is entering the same path, promoting, and applying policies to produce liquid and gaseous biofuels, so that they are developed in a more environmentally friendly way, have a social impact, and are economically sustainable. It could represent a strategic opportunity for the development of the entire southern continent's energy matrix, in addition to the fact that biofuels can be an ally in the fight against climate change and stimulate economic development, reducing rural poverty and promoting more integrated and efficient agricultural systems. This work aims to demonstrate the existence of bioenergy in South America, its state of the art in the countries, updated information, production, use of biofuels, and showing the policies applied throughout these years, to provide an information base.*

I. INTRODUCTION

In the middle of the 20th century, the actions adopted against climate change began to be a fundamental focus regarding the environment and energy stability. Various factors influenced the reduction of our natural resources, being that over the last few years, their consumption has increased exponentially. The growth of the population, the industrial expansion, and the massive use of technology began to be a concern worldwide due to the depletion of oil reserves, natural resources and added environmental deterioration, which motivated to seek new ideas in the production of renewable energy, as well as public policies that promote its use [1]. Since then, solar energy, hydro energy, and bioenergy from biofuels have been viewed as viable renewable sources and are better known in South America, demonstrating an exponential increase in the use of new energy sources [2].

Bioenergy presents itself as a feasible route for the future of energy consumption because it involves the use of biological materials for energy purposes, converting them into thermal energy, electricity, and transportation fuels through different processes. Therefore, there are many established bioenergy pathways technically proven, so that the systems are commercially available [2,3].

Latin America has become one of the most propitious and tending regions for agricultural exploitation due to the usable spaces for said activity. In addition, the region has a favorable climate and soils with the necessary properties for it. Considering this context, Latin America is a potential exporter of biofuels [4].

The discussion on biofuels focuses on the techno-scientific aspects of energy sources production, aiming to reform social-political aspects, generating employment and improving economic income, conserving ecosystems, and

reducing environmental pollution, factors that influence decision-making in every country, especially in South America. The scale production of biofuels requires a socio-ecological response that is not economically efficient [5].

Biofuels come from biomass (i.e., sugar cane, wood, agricultural waste, and urban waste), using methods and processes such as hydrolysis, fermentation, gasification, synthesis gas, and rapid pyrolysis to obtain diesel, ethanol, butanol, methanol, dimethyl ether, biogas and other chemical products. Traditionally, biomass is used for cooking and heating. However, in recent years, this has decreased due to efforts to reduce fuel inefficiency and improve access to clean sources, given the negative effects on the local air and other associated impacts [4].

On the other hand, modern bioenergy is making it possible to provide a cleaner and more efficient fuel for the transportation industry. Sustainable energy has become the interest of governments around the world, because, if used correctly, it can be an ally in the fight against hunger and stimulate the economic development of countries, promoting agricultural systems and reducing poverty [5].The progress and development of renewable energy technologies have been achieved thanks to the efficiency of government policies. Thus, these types of actions continue to be an important factor in overcoming economic, technical, and institutional barriers.

The bioeconomy provides competitive advantages and opportunities to achieve sustainable development objectives, the great benefit for South America is its ecosystem, a large part of the economy is subject to agriculture. Considering the information discussed here, this paper aims to present a panoramic view of biofuels in South America, while being aware of the local development problems and the biofuel market, as well as the internal policies and goals established by each country.

II. STATE OF THE ART

The development of the global biofuel markets since the beginning of the 20th century prompted public policies for the production and use of this type of renewable energy, but, before promoting and motivating countries, these policies were established through a combination of events, including the use of biofuels. Therefore, they were established with the goal of helping energy security, reducing the greenhouse effect and reusing agricultural residues [6].

The oil market is an important component when it comes to biofuel, as it is the most widely used non-renewable liquid fuel, due to its competitiveness, which can influence the price of biofuels. The United States of America (USA) is one of the countries that imports oil and understands that one of the main points on the international energy agenda is the economic instability of oil; however, it is one of the first countries to seek and promote investment and research in clean energy technologies and alternative fuel production [7].

The United States Energy Independence and Security Act of 2007 (EISA Act) defined the Renewable Fuels Standard (RFS2) program. This law established mandatory standards until 2022, which dictate that fuels must achieve at least 20% to 50% reduction of the greenhouse effect, as well as the integration of biodiesel and cellulose into the standard fuel production. Additionally, the Environmental Protection Agency (EPA) establishes annual minimum quantities for the four types of biofuels required [5].

The global production of biofuels grew exponentially and is seen as an opportunity for developing and emerging countries, being an alternative to guarantee internal consumption, mitigate the effects of greenhouse gases, as well as satisfy energy demand [8]. First-generation biofuels are made from sugar, starch, and vegetable oil; these materials biologically produce ethanol, propanol, and butanol by the action of sugar, starches or cellulose, although there is a conjecture that they cannot produce enough biofuel without threatening food supply and biodiversity. On the other hand, second-generation biofuels are produced from non-food crops, including food crop wastes. Things such as agricultural residues, wood sawdust, and used oil are inedible products of non-food crops [9]. The third generation focuses on more experimental processes where the products are extracted from algae. However, it has not been carried out on a commercial scale.

The potential of biofuels depends on the demand for fossil fuels that are required in transport (gasoline, CNG, LPG, and diesel), in addition to the technological possibility of the engines when admitting mixtures with such fuels [10].

The European Union, in a political framework, established the cooperation of biofuels between countries in the 2009 Renewable Energy Directive (RED), which decrees those renewable fuels, including liquids, must be increased to 10% of the total used as transportation fuel by 2020, which requires fuel producers to gradually reduce environmental pollution [11].

In 2019, the global production of liquid biofuels had a raise of 5% to 161 billion liters, which is equivalent to 4 EJ [12]. This is due to the increase of investments in renewable energy over the years. The Table 1 below shows the leading countries in renewable energy production and capacity.

Table 1: Leading countries in renewable energy by production and capacity

	1	2	3	4
Hydroelectric capacity	Brazil	China	Lao[1]	Bhutan
Solar water heating capacity	China	Turkey	India	Brazil
Ethanol production	United States	Brazil	China	India
Biodiesel production	Indonesia	United States	Brazil	Germany

The leading producer is the United States, with a 41% share, despite the production drops in both ethanol and biodiesel. The producer with 26% was Brazil and, further back, Indonesia with 4.5% followed by China, 2.9%, and Germany, 2.8%. It is worth highlighting the participation of Brazil as the only country in South America that competes in the leadership of renewable energy investment.

Bioethanol is the most widely used liquid biofuel from corn, cane sugar, and other crops. Moreover, biodiesel is also commonly produced from vegetable oils and fats, including waste such as used cooking oil [13]. Both bioethanol and biodiesel form large groups of liquid biofuels nowadays.

By the end of 2019, at least 70 countries had conventional biofuel policies, while at least 9 countries already had some form of advanced biofuels or policy incentive programs before this year, and at least 24 countries had the goal of advancing biofuels, in addition to setting a collective objective of 70% renewable electricity by 2030 [10,14].

In Brazil, Sweden, and the United States, millions of vehicles on the road accept a blend of up to 85% of ethanol/gasoline [15]. Flexible fuel vehicles run on gasohol mixed with gasoline and anhydrous ethanol with E100 hydrated ethanol.

The use of biogas to generate electricity and heat increased at the end of 2019, some 132,000 biodigesters are in operation around the world [16]. In China, there are more than 100,000 units, followed by Europe, with around 18,000, and the United States, with 2,200 sites in all 50 states producing biogas [17].

[1] Laos PDR, LAOS People's Democratic Republic.

The production of biofuels in South America is led by Brazil, Argentina, and Colombia, according to a study published by the Economic Commission for Latin America and the Caribbean (ECLAC) [5]. The Fig. 1 shows the biofuels available in each country from bioethanol, biodiesel, and biogas.

Fig 1: Biofuels in South America

In most of South America, there is a great acceptance of biofuels, although some countries are still exploring the subject, while others have been developing it for years, which is the case of Brazil, a country that developed technology, research, and internal policies to obtain an alternative liquid fuel, and it turned out to be the example for neighboring countries [18].

The regulations and decrees in recent years are important because the political, environmental, and social interest that are committed to the fight against climate change is observed. Table 2 shows the most important regulations in each country.

Table 2: Biofuel laws and regulations in South America

Country	Laws and Normatives

Argentina	Resolution 554/10	Ratifies Addendum to the Biodiesel Supply Agreement for its mixture with fossil fuels in national territory.
	Biofuel Law 26,093	Approves project to obtain bioethanol from corn and sorghum in the country.
Bolivia	Law 3207	Biofuel Incentives, September 2005, which establishes a series of incentives for the incorporation of biodiesel in the country's production as an additive in the use of fuel in the national territory.
	Law 1098	Regulatory framework that allows the production, storage, transport, marketing and mixing of additives of vegetable origin, in order to gradually replace the import of additive inputs and diesel oil, safeguarding food and energy security with sovereignty.
Brazil	Law Nº 737 de 1938	Imposed almost at the beginning of the 20th century, this law made the addiction of alcohol to gasoline mandatory.
	Law Nº 8.723 de 1993	The obligatory nature of the mixture of anhydrous alcohol and gasoline.
	Law 11.097 de 2005, que	Introduces biodiesel into the Brazilian energy matrix, reforms laws 9478 of 1997; 9847 of 1999 and 10636 of 2002.
	Law 11.116 de 2005	Establishes the special registry of producer or importer of biodiesel in the federal revenue secretariat of the finance ministry; modifies laws 10451 of 2002 and partially law 11,097 of 2005
Colombia	Law 939 del 2004	Stimulates the production and commercialization of biofuels for use in diesel engines.
	Decree 2629, f 2007	Expands the mandatory mix of biofuels to 10% as of 2010 and establishes that new vehicles must be capable of consuming a mix of at least 20%.
Chile	Law 20.257	Introduces modified actions to the General Law of Electric Services regarding the generation of energy with non-conventional renewable energy sources.
	Law 5.238-08	Bill that creates the National Fund for Research and Development of Biofuels.
Ecuador	The Executive Decree 2332, December 2nd, 2004, through which was created.	The Biofuels Consultative Council of the Presidency of the Republic creates, with this decree, the National Biofuels Council with the mission of: "defining and approving plans, programs and projects related to the production, management and commercialization of biofuels", according to Article 3, as well as the responsibility of: "establishing policies and preferential support mechanisms for the agricultural and agro-industrial sectors, especially small producers, and will regulate the price of the biofuel in question"
Paraguay	Law Nº 2.748	Promotion of Biofuels, which declares its production, the raw materials for its manufacture, and its use throughout the national territory of national interest.
	The Paraguayan Norm (La Norma Paraguaya) NP 16.018.05	It was prepared by the Technical Committee for Standardization (CTN) 16 - Fuels, formed by representatives of public institutions, private companies, consumer associations, and universities, in order to establish the requirements and test methods for pure Biodiesel (B100) that It is used in Diesel engines.
Peru	Law N° 1.002, 2008	Law for the Promotion, Investment and Generation of Electricity with the Use of Renewable Energies.
	Law N° 28054, August 7th, 2003	It establishes the general framework to promote the development of the biofuels market on the basis of free competition and free access to economic activity.

Uruguay	Law 17.567, October 1st, 2002	Declares the national interest in the production throughout the country, of alternative, renewable fuels and replace them with petroleum derivatives, made with national material of animal or vegetable origin.
	Law 18.195, November 2007	The regulation of the production, commercialization and use of agro-fuels corresponding to the categories that are defined. Its main articles are: - Promotion of the production of agro-fuels with national raw materials. - incorporation goals
Venezuela	-	-

In the rest of the world, the development of biofuel markets is comparatively smaller, depending on political support and price trends, which generates a mixed perspective in different countries. Table 3 shows the world production of liquid biofuels for the years 2018 and 2019.

Table 3: World production of the main biofuels in recent years

Fuel	2018/ billion liters	2019/ billion liters
Bioethanol production (annual)	111	112
FAME Biodiesel Production (annual)	41	47
HVO Biodiesel Production (annual)	6	6,5

Bioethanol represented around 59% of biofuel production in terms of energy, FAME biodiesel 35%, and hydrotreated oils (HVO) / Hydroprocessed fatty acids (HEFA) 6%. Other biofuels included biomethane and a range of advanced biofuels [19].

A. Bioethanol production in South America

Biofuel production in Brazil, for example, arose almost from the automotive industry in the 19th century. Since the 1930s, bioethanol has become a common component of gasoline and since 1975 it has been blended with gasoline [19]. According to the ANP (2019), approximately 45% of the energy and 18% of the two fuels consumed in Brazil come from renewable energy sources. In 2018, Brazil produced approximately 33 million liters of bioethanol, used as the only fuel in Flex vehicles (hydrated) and mixed with gasoline (anhydrous) [20].

The constant variations in the oil market caused technological advances in the automotive sector during the 2000s, because of the Flex-fuel engines, which changed the dynamics of the market, the support of the state drove the growth of investment in the production of bioethanol. The latest policies to maintain the price of gasoline and the elevation of the anhydrous mixture of common gasoline from 25% to 27% in 2015 represent a relief for domestic markets, as the increase in gasoline will determine the consumption of biofuels. Brazil is expected to raise its ethanol production and consumption in the coming years, due to the RenovaBio program, which proposes the reduction of the intensity of emissions from the transportation sector [21].

Bioethanol in Colombia is the product of public policies for rural, environmental, and energy development that have been working in recent years, which contributes to the generation of new jobs and the diversification of the energy sources. Thanks to government policies and private sector investment worth 900 million dollars in 7 distilleries, Colombia is the third-largest bioethanol-producing country in Latin America after Brazil and Argentina [22]. Since 2005, the use of liquid biofuels has been implemented to reduce gasoline emissions with the mixture of 10% fuel alcohol and 90% gasoline of fossil origin in the south of the country (E10 oxygenated gasoline) [23–25].

Peru, for its part, produces ethanol from different types of honey through yeast fermentation, in addition to mixing gasoline to increase octane and reduce greenhouse gas emissions, Peru still does not extract ethanol from sugar cane However, there is extensive experience in the production of pharmaceutical alcohol, rectified alcohol, rum, and huarapo. Currently, there are projects to serve the national (Petroperú) and international market (the United States and Japan) [26]. Some agro-industrial companies on the coast have been implemented to supply ethanol to the international market due to the demand for the product.

Argentina, in turn, obtains bioethanol through the biomass fermentation process, which can be mixed with naphtha in variable quantities in its pure state as an alternative or in the manufacture of methyl tert-butyl ether. Currently, the production is from molasses, a by-product of sugar, sugar cane juice with 72% and 28% of cereals, mainly corn [27]. In 2018, the installed capacity was 950 thousand tons per year, almost 64% was saved in greenhouse effect emissions, the highest concentration of bioethanol production plants is due to the northeast of Argentina [28].

In Paraguay, corn and sorghum are used as raw material for the production of bioethanol, both, for anhydrous alcohol (99.5 GL) and hydrated alcohol (96 GL).

Furthermore, as a by-product of the industrial process of crude corn oil and dry distillation, residues are obtained, and soluble substances are used as an animal feed base [29].

While Uruguay produces bioethanol from sweet sorghum, sugar beet, sugar cane, and from starches such as sorghum grain, corn, wheat, barley, cassava, the National Administration of Fuels, Alcohol and Portland (ANCAP), a Uruguayan public company in charge of the exploitation and management of the national alcohol and fuel monopoly, receives anhydrous ethanol from the ALUR SA production plant in Paysandú, a company responsible for the production of bioethanol, biodiesel, animal feed, energy, and sugar, in addition to being in charge of the distribution and mixes with gasoline in the percentages mandated by law [26,30].

In Ecuador, gasoline contains a derivative of sugar cane (ethanol) called, by the country, Ecopais mixed by Petroecuador, with a composition of 95% pre-mixed gasoline and 5% bioethanol. However, they intend to advance with the Inen-935 normative, which establishes gasoline for combustion engines [26,31].

Chile does not produce ethanol commercially yet. However, research centers and universities carry out various investigations to make the process viable. In addition, the lignocellulosic consortium BIOENERCEL S.A. seeks to take advantage of forest biomass to produce bioethanol [32,33].

Bolivia produces first-generation bioethanol from sugarcane bagasse to produce fuel with 60% ethanol, of which other types of alcohol can be obtained, in addition to sorghum with a minimal contribution [34]. In 2017, the ANH (National Hydrocarbons Agency), through the hydrocarbons ministry, approved Law 1098, where it commits to using a mixture of anhydrous ethanol and gasoline of 8 to 12% in 2020 [33].

B. Biodiesel production in South America

In Brazil, biodiesel production has increased by 11% in 2019, reaching 5,900 million liters [35]. It is the second biggest producer of biodiesel in the world, according to data from the ANP 2018 [36]. Industries in the country respond positively to the increase in mandatory blends, being that, in 2014, it was a 6% blend, and, in 2018, it reached 10%, increasing production by 56.4%. The brazilian production of biodiesel happens mostly in the South and Center West regions of the country, and it is mainly constituted of multinational companies that act in various segments of the agro-industrial business, from production to marketing [37,38].

Biodiesel in Colombia is produced from vegetable oils of palm, sunflower, soybean, and rapeseed, among others, besides fats and tallow of animal origin. There are 12 companies that supply 67 palm nuclei located in the Central, Eastern, and Southwestern areas of the country [10]. In addition, Colombia is one of the first countries to export biodiesel. In June 2020, it exported 4 million liters to Germany from the Manuelita plant located in the department of Meta, complying with the biofuel quality standards of EN14214, which describes the requirements and test methods for DMARDs [26,39].

Peru takes a step forward in the production of biodiesel by obtaining an alliance with PETROPERU and the Amazon region of palm growers, where they commit to offering crude palm oil, according to their condition and the standards required for the production of B100, which will have the technological support of the Heaven Petroleum Operators (HPO) company, regarding the raw material production process and the production of low sulfur fuel [40].

According to the Foundation for the Promotion of Exports of Palm Oil and its Derivatives of National Origin (Fedepal), Ecuador produces biodiesel from palm oil and its derivatives, due to the surplus production of this vegetable. Ecuador's Decree 3103 establishes that diesel must be mixed with vegetable biofuels, from 5% to 10% [41].

Argentina's production is based exclusively in soybean cultivation as raw material with the transesterification method, a chemical process that combines oil with alcohol. Since 2007, it has emerged as a sector with better performance, strengthening the productive development of the country. In the following years, there was an increase in its production of Biodiesel, with 803,640 m3 in 2015 and, in 2016, with 910,891 m^3. Besides these years, a change in the reference values could be noted; for example, in 2017,it reached 1,105,107 m^3 and, in 2019, 2,147,270 m^3 were produced 26. However, in 2020, the production decreased to 1,120,759 m^3, almost half of what was previously registered, is due to various factors, but mainly because of the tragedy of the COVID-19 virus.

Uruguay obtains biodiesel from soybean, rapeseed-canola, sunflower, turnip, camelina, brassica (also known as Ethiopian or white mustard), spurge or castor oils, with soybean and rapeseed-canola being the most used. The company in charge of manufacturing is ALUR S.A., which receives trucks from the Arena plant or by pipeline from the Capurro plant, both use conventional technology (homogeneous basic transesterification). The company is certified by the international body of the European

standard International Sustainability and Carbon Certification (ISCC) [19,20].

The biodiesel production in Chile is very low, according to the records by the Chilean College of Agronomists, which indicate that it does not exceed 150 thousand liters per month, its installed capacity for production is less than 3 million liters per year [42].

Bolivia is committed to the production of biodiesel from soybeans since 2019. In an agreement with private and public companies, a pilot plant of the Tropical Agricultural Research Center (CIAT) was installed to obtain biofuel from crude soybean oil, and they experiment with Cusi, macoror, pinion, and sunflower to generate technical information and knowledge about these processes [43,44].

C. Biogas production in South America

The expansion of biogas in several countries for electricity generation includes places such as the continent of Africa, India, Latin America, and the Middle East [45] Mexico produces open biogas through poultry waste in the state of Jalisco. The first biogas plant in Brazil uses pig manure in addition to the waste from 18 large pens to run 240 kW motor generators [46].

One of the leading countries in biogas production is Brazil, which began with the oil crisis in 1979, but, as of 1982, the Energy Mobilization Program - PME was launched, which encourages the installation of biodigesters in rural areas. The federal RenovaBio program was instituted to be a National Biofuels policy as annual national decarbonization goals for the fuel sector, encouraging its manufacture, which resulted in future policies that support the generation of renewable energy with biogas and biomethane [17].

Colombia, in recent years, has developed small projects regarding the use of biogas through biodigesters. There are two plants that generate 3MW from biogas for their own consumption and, according to the data collected, Colombia has 62 small plans [47].

Argentina, however, has grown enormously in relation to its technological development, increasing the number of digester plants, improving the quality and diversity of raw materials, as well as the number of service providers. In 2020, the ministry of sustainable development promoted and bought biodigesters that will be installed in different institutions, such as agricultural technical schools. The project finances the incorporation of specialists in the field of energy and biogas [48].

Since the decree of incentives for renewable energies in Peru, the installation of biodigesters at the national level has increased, but there is a lack of coordination to optimize their development.

Ecuador began to produce biogas from urban solid waste. This project is executed through the agreement of the Metropolitan Public Company for Comprehensive Solid Waste Management (EMGIRS EP) and the company GasGreen S.A., as a strategic alliance to benefit the environment [31,49].

Chile developed biogas projects at different scales for different energy uses. Until 2015, they generated a total of 43 MW that came from waste from dairy farms, landfills, and sewage sludge. There are also biogas projects led by the food and agricultural industry with the aim of generating electrical or thermal energy to replace fossil fuels [50].

In Bolivia, there are agreements with cooperation and organizations that promote research and development in biodigesters to alleviate extreme poverty in some parts of the country. Bolivia offers great energy potential due to its ecological diversity, considering that it is a developing country. Since these agreements started in 2007, 750 biodigesters were installed until 2012, sponsored by the Endev-Bolivia program, in a German technical cooperation. Bolivia shows a middle ground because many biodigester installation ventures are from entrepreneurs and environmental policies or international cooperation [31,51].

Paraguay has promising perspectives for the use of biogas, several studies make this energy sector viable [52]. On the other hand, Venezuela has not yet formalized the start of direct projects with biogas and neither has any incentive for the use of biomass and waste.

III. METHODOLOGY

Fig. 2 shows the methodology followed by the article.

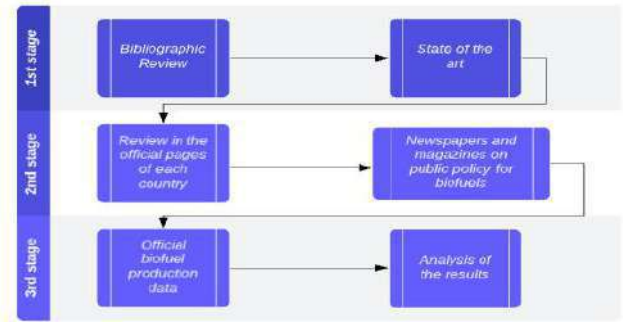

Fig. 2: Methodology used

The methodology used is divided into three stages: the bibliographic review, specific data review, and data evaluation and discussion. In the first stage, a bibliographic review on biofuels focused on the world and

South America is carried out, based on published articles and magazines, as well as the state-of-the-art technology. The second stage consists of the review of specific data in each South American country according to official pages, newspapers, and information found on the web. In the third stage, the data found is evaluated, conducting a discussion of the information found through online searches (Google Scholar).

IV. DISCUSSION

Many of the South American countries have implemented public policies for the development of liquid and gaseous biofuels, allowing agriculture in each region, which favors many countries, since the biodiversity in South America makes the development of biofuels from biomass possible.

Moreover, the promotion of new regulations for the use of clean energy helps the development of each country; consequently, many countries have had an increase in energy production, in addition to a larger number of jobs and a clear economic boost in each region. However, some countries, such as Chile and Venezuela are the last to start biofuel projects, regulations, and laws. These measures, despite not developing rapidly, already are an important step in the development of a new sustainable vision.

It should be noted that there are three predominant countries in the production of biofuels, which are Brazil, Argentina, and Colombia. These countries that have, year after year, increased their production in the three types of fuels already mentioned, and this is mostly due to the relationship of the government with investments in the private sector [53]. Brazil is the predominant country in this scenario of production and consumption of biofuels, as a result of its institutional base, solid policies, investment incentives, projects, research and their acceptance by the country, which contributes to overcoming challenges with the participation of biofuels [2].Table 4 shows the most used fuels in South American countries, in addition to biofuels.

Table 4: Fuels used by each country

Country	Fuels	Biofuels
Argentina	Natural Gas Oil Coal Wood	Bioethanol Biodiesel Biogas Biomass
Bolivia	Natural Gas Diesel Gasoline	Bioetanol Biodiesel Biomasa
Brazil	Natural Gas Petroleum Coal Uranium	Firewood and charcoal Bioethanol Biodiesel Biogas Biomass
Colombia	Kerosene and jet Gasoline Gas Fuel Oil Charcoal Diesel	Bioethanol Biodiesel Biogas Biomass
Chile	Natural Gas Oil and Coal Derivatives	Bioethanol Biodiesel Biogas Biomass
Ecuador	Natural Gas Petroleum and Coal Derivatives	Bioethanol Biodiesel Biogas Biomass
Paraguay	Firewood Coal Diesel Gasoline	Bioethanol Biodiesel Biogas Biomass
Perú	Gas Natural Petróleo y Derivados Carbón	Bioethanol Biodiesel Biogas Biomass
Uruguay	Oil and Charcoal Derivatives	Bioethanol Biodiesel Biogas Biomass
Venezuela	Oil Natural Gas	-

Ethanol in South America has shown an exponential growth in recent years, increasing its production significantly as well as its technology; in the case of Bolivia, Peru, Uruguay, and Ecuador, the most used raw material in most countries was sugarcane of sugar as first-generation bioethanol. Regarding Bioethanol, the other countries are on the path of growth, as is the situation in Uruguay, Bolivia, Paraguay, Peru, and Chile, which, in recent years, have opted to research the biofuel conversion processes, and investments with private companies to generate biodiesel plants [5,9].

Biogas is a little-explored topic in all of South America. However, Brazil takes the lead in terms of research and investment, and Colombia promoted this biofuel with the private sector. On the other hand, Argentina obtained the collaboration of the government in the purchase of equipment.

The other countries have not yet developed projects in relation to this biofuel, being that most of them were linked to international cooperation funds and executed from NGOs, and, therefore, were small projects. Despite being a new market, it already has a promising future regarding the ways that the agricultural sector can treat waste, solving an environmental problem, and generate energy. However, the main factor that determines the success of the projects is the social implementation strategy, for the rural area biogas can contribute considerably to the quality of life, as it is a fuel that can be used to generate electricity, heating, and cooking utensils. Most small or large-scale projects are based on low-cost Slug biodigesters [54].

Table 5 shows the production of biofuels in South America. This information can be found in official pages of each country, and some data is from important newspapers in the region.

Table 5: Biofuel production in South America

Country	Biofuels	Production	Unity
Argentina	Bioethanol (2019)	1.06	Million liters
	Biodiesel (2019)	2.14	Million tons
	Biogas		
Bolivia	Bioethanol (2018)	80	Million liters
	Biodiesel (2018)	3	Million tons
	Biogas	-	-
Brazil	Bioethanol (2019)	35,6	Billion liters
	Biodiesel (2019)	5,9	Billion liters
	Biogas		
Colombia	Bioethanol (2017)	366,75	Million liters
	Biodiesel (2018)	406.12	Thousand Tonnes
	Biogas	-	-
Chile	Bioethanol		
	Biodiesel		
	Biogas		
Ecuador	Bioethanol (2016)	113.5	Million liters
	Biodiesel	-	
	Biogas	-	
Paraguay	Bioethanol (2010)	121.86	Million liters
	Biodiesel (2010)	5.80	Million liters
	Biogas	-	
Peru	Bioethanol (2018)	182	Million liters
	Biodiesel (2018)	154	Million liters
	Biogas		
Uruguay	Bioethanol (2018)	1.79	Million liters
	Biodiesel	5.22	Million liters
	Biogas		
Venezuela	Bioethanol	-	-
	Biodiesel	-	-
	Biogas	-	-

Some data were not found, since many of the countries are venturing into the production of liquid biofuels, because they do not have an established registry. However, there are several data regarding the progress that each country has.

V. CONCLUSIONS

The environmental repercussions have started a global race in search of new alternatives to maintain the ecological balance. Thus, biofuels appear as an alternative to fuels.

European countries undertook the development of new alternatives to replace fossil fuels, investing and promoting public policies with the exchange of technology, which helps to increase the production of bioethanol, biodiesel, and biogas.

Biofuels offer opportunities to meet the environmental, economic, and social challenges in South America. However, to get to this point, there are important steps that must be taken, considering the exchanges that governments must make.

Despite negative impacts or associated risks, there are more opportunities in rural development growth that governments can explore. Although biofuels are emerging in South America and some countries are in the full development and implementation phase, as the case of Chile and Venezuela, most of them already have industries and a consolidated legal framework for bioethanol and as is shown in Table 4, several countries have significant biofuel production capacity. It must be considered that government policies are key for industrial development and have played an important role in the development of South America, where there was the implementation of public policies on the requirement of mixing alcohol with gasoline ranging from 1 to 10% in several countries.

Furthermore, it is important to consider that energy needs must be followed, and the objectives should be cautious reasonable when regarding the development of the implementation. Most of the countries mix their common gasoline with bioethanol or biodiesel in a percentage of 1-10%, the impulse of the established regulations of each country generated a change in the use of biofuels. In this way of finding the best alternatives, Brazil far surpasses several countries as it has managed to use a B100 car powered exclusively by biofuel.

Boosting and promoting technology transfer and adaptation between countries is a good start for significant development for biofuels.

In the last 10 years, the countries in South America have begun to invest in technologies for their production. Additionally, one of the causes that these projects are carried out is thanks to the national government policies of each country, which fostered the agricultural sector and private companies to invest in new practices, facilitating a business that is not only beneficial for each region but also for the locality, generating employment and income.

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Risk Management Applied to Organizational Strategy – A Case Study Applied to a Continuous Billet Forming Machine

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Keywords *— **Continuous casting, hazop, operational risks, risk analysis, risk management.***

Abstract *— Risk management involves a set of structured methods in order to face adverse risks in a planned and systemic way. In general, risk management adds value to the processes and their practices are being consolidated by organizations, no longer an issue only addressed by insurance companies and financial institutions. Nowadays, with the growing evolution of the different aspects that make up an organization, the systemic approach of these factors is considered as the path to reduce and mitigate risks to acceptable levels, raising the equipment safety to admissible parameters. This monograph presents a study of operational risk management through a method called What if, which can be applied as a guiding guide in the identification, analysis and management of risks. Bringing as a result a clear and objective communication about the necessary actions to make them risks acceptable to the organization.*

I. INTRODUCTION

With the growing search for technology and product innovation to be increasingly competitive in the market, so that it acts effectively always aiming at reducing costs and making the business viable, it is clear that the equipment that operates in this journey needs care so that it does not damage and generate costs, which may reflect in the unviability of the business.

Thus, this monograph presents a study of operational risk management applied in a steel mill that manufactures special steels for the automotive industry and, by means of internal technical studies, it was determined that the continuous casting equipment of the melt shop presents a higher operational risk, more precisely in the spinning tower, requiring a more elaborate study on the risk management of the equipment.

According to [1], when risks arise from the uncertainty of the operation itself, they are classified as operational risks, these when caused by external factors that have a significant impact, such as natural disasters, financial system bankruptcies and terrorist attacks, become very important and serious.

According to [2], risks are divided into endogenous risks that originate from the company itself and exogenous risks that are from the supply chain.

[3], stated six types of risks related to software development: organizational adaptability, skill mix, management structure and strategy, software system design, user participation and training, and technical planning and integration.

According to [4], other groups, which are also called risks are team, organizational environment, system requirements, planning and control, users, and complexity. It is also common to classify the risks according to their priority making it possible to act effectively.

One of the strategies, according to [1], is to use a probability and impact matrix to classify risks in high, medium, and low importance.

1.1 Research Contextualization

The current market requires companies to use other management tools to base their strategic planning, such as Balance Score Card - BSC, among others. This work proposes to make decisions based on the organization's risks. It can deal with operational risks, as well as create a governance that allows the evaluation of market risks, sales, logistics, etc. To this end, tools and methods that classify these risks in the organization will be suggested, to be used as information to build the strategic planning.

In this scenario, Operational Risk Management (ORM) has an important role that places it as a determining factor for companies. The implementation of this system will bring to the knowledge of top management the risks that can cause greater loss, according to studies and research that can evaluate, making it possible to eliminate or mitigate them.

1.2 Research Question

How can one map the risks of a continuous casting machine? Can the risk analysis approach be applied to a continuous caster? In today's scenario, are managers aware of these risks which are usually only found at the operational level?

II. THEORETICAL BACKGROUND

2.1 Risk

According to the Nomas Brasileiras/ISO International Organization for Standardization - NBR / ISO 31000 standard [5], risk is defined as the impact of uncertainty on the objectives that an organization faces due to the influence of internal and external factors. Although risk is usually related to circumstances that cause harm to people or assets, this definition means that risk can also appear in the planning process.

According to [3], the goal of using risk management in the process is to reduce uncertainty, define measures to prevent occurrence, and determine the measures that should be taken when risks cannot be avoided, i.e., mitigate, reduce the impact, and reduce the consequences of risk.

It can be said that risk is the impact of uncertainty on objectives. According to [2], this effect is a deviation from expectations - positive and/or negative, objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product, and process).

According to [4], uncertainty refers to the state of lack of information about the event, its understanding, its knowledge, its outcome or probability, even if it is a partial state.

Risk is the deviation from a specified reference value and its associated uncertainty. These impacts may be related to safety, health, sustainability, personnel, organization, operations, market, or finance.

According to [4], as the name implies, risk refers to unpleasant or undesirable things that can happen being dangerous or uncertain events. Its occurrence does not depend on the will of the parties involved.

According to [6], risk is always related to what may happen in the future. We can use risk analysis tools to analyze and manage risks in a rational way. The goal is to provide a reference for decision making in order to achieve future well-being. And according to the [7], a risk is an uncertain event or condition that, if it occurs, will have an impact on at least one project goal, which are: scope, schedule, cost, and quality.

According to [4], risk comes from uncertainty that have been identified and analyzed and mitigated, making it possible to plan a response to the supposed event. There are risks that cannot be actively managed, to do this, the project team must develop a contingency plan or consider lessons learned from previous projects. NBR/ISO 31000 [5], defines how organizations of all types and sizes face internal and external influences and factors that make them uncertain if and when they will achieve their objectives. The impact of this uncertainty on organizational objectives is called risk.

2.1.1 Risk Management

According to [8], the main objectives for the company's survival and competition in the market are: to reduce costs, product quality, increase production, protect the environment, extend the life of equipment, and work safety.

According to [4], the goal of maintenance is to keep the equipment in the operating condition specified by the design. The proactive approach has become part of everyday maintenance.

In this way, the strategic nature of maintenance is clearly seen. For [9], competitive strategy means adopting a number of different activities to provide customers with unique value. A company can only outperform its competitors if it can maintain its differences. The difference comes from both the choice of activity and the way the activity is performed.

2.1.2 Risk Analysis

Risk analysis involves the appreciation of the causes and sources of risk, their consequences and the probability that these consequences may occur, this analysis is always continuous and must be constantly updated and evaluated.

According to [10] qualitative risk analysis is performed using risk-impact or probability-impact probability matrices being a method for assessing risks, ranking risks according to the probability and impact values determined in meetings with experts and brainstorming.

Although there are various methods for risk analysis, the following common elements are considered necessary to qualify the process as risk analysis:

- Risk identification;

- Relation of the risk to its consequence;

- Analysis of risk exposure;

- Risk characterization.

According to [5], risk analysis can provide data for decisions that require choices, and choices involve different types and levels of risk. And according to [7], the goal of risk management is to increase the possibility and impact of positive events and reduce the impact that can generate negative events in the project.

The risk assessment process, according to NBR/ISO 31000 [5], is composed of risk identification, risk analysis, and risk assessment.

Risk identification is the first element. The purpose of this element is to generate a comprehensive list of risks based on events that will alter the predicted situation, in order to determine what may happen in different events.

According to the NBR/ISO 31000 standard [5], these events can create, increase, avoid, reduce, accelerate, or delay the achievement of goals. All possible causes and scenarios should be considered. These events and scenarios should show the possible consequences of each event.

According to [5], risk analysis allows you to understand the risks. The second element is the decision about the risk requirements that need to be addressed and the most appropriate strategies and methods to deal with the risks. In this phase, you will analyze the risks, their consequences and probabilities. This can be done by modeling the outcome of the event, inferring from experimental research, or available data.

Consequence analysis points out the type of impact that may occur from a particular deviation or situation.

The impact may have minor consequences but higher probability, or major consequences but lower probability, or some intermediate outcomes. It is appropriate to focus on the risks that can produce high impacts, these risks are usually of greater concern to managers.

According to [5], risk assessment aims to assist decision making based on the results of risk analysis. This element takes into consideration the risks of the need for treatment and the priority of treatment implementation.

According to [1], any decision made based on identified risks involves two distinct elements: objective facts and subjective views on the impact of the decision. In some cases, a risk assessment may lead to a decision not to address the risk.

2.1.3 Risk Analysis Tools

2.1.3.1 Cause and Effect Analysis

According to [11], cause and effect diagrams (also known as Ishikawa or fishbone diagrams) are very useful for identifying causes of risks. They can be system or process flow charts, which show how various elements of a system interrelate and the cause and effect mechanism or as influences diagrams which are a graphical representation of a problem, which shows causal influences the 6Ms: machine, measure, labor, method and environment; the ordering of events in time and other relationships between variables and outcomes.

The risk identification process generates information, which according to [11], will be used in the evaluation process and other processes. They include lists of identified risks, which will serve as the basis for prioritized risk lists. Risk triggers are very useful in the action plan process input and other processes.

2.1.3.2 What if

The What if method according to [12], proposes general and qualitative analysis, for having an application of simple execution, makes it possible to avoid omitting risks in projects, procedures and standards and still verify behaviors and personal empowerment in work environments.

[13] translates the term What if as the "analysis of hypothetical variations" and points out that the method can help decision makers to simulate the behavior of a complex piece of equipment before any critical decision using technical and historical data to reduce the risk of any unexpected results.

To begin with, the multidisciplinary team must be formed and provided with the following information:

a) Process diagrams (P&ID's);

b) Equipment technical data, project and process parameters;

c) Construction materials;

d) Relief and ventilation systems;

e) Inventories of dangerous substances;

f) Local legislation applicable and compatible with the current situation;

g) International Standards applicable and compatible with the current situation;

h) Previous risk analysis with its recommendations;

i) Material risks (material list, interaction matrix);

j) Process Incident Reports (summary);

k) Maintenance History;

l) Records of Changes that have occurred;

m) Maintenance and Operational Procedures.

In periodic meetings, with a pre-established agenda, the multidisciplinary team will meet to start the work. In possession of the listed information, the team leader will make a brief presentation of the segment to be studied, the multidisciplinary team will make a field visit to recognize the study segment. Then they return to the room to start the What if.

Its definition is a qualitative risk analysis that allows, by asking questions, the identification of hazards and risks in the process, allowing us to perform a global analysis of a facility or process. It can be used at all points in the facility's life cycle.

The method suggests separating the processes into blocks, to ask the "What if?" questions in a delimited manner. Next, identify the hazards in each block by asking the "What If?" question, looking at all the information in the process, and guided mainly by the following items:

a) Multi-disciplinary group concerns (Brainstorming);

b) Process Events;

c) Equipment Failures;

d) Relevant changes in the process or its parameters.

And then, it will be necessary to send evidence of the study's conclusion, for this, the Process Safety Analysis documentary should be stored.

This method is often used in first analyses, more comprehensive analyses where you get the most critical scenarios to use other methods. While the 'SWIFT/What if' technique was originally designed for the study of chemical and petrochemical facility hazards, the technique is now widely applied to systems, facility items, procedures, and organizations in general. In particular, it is used to examine the consequences of changes and the risks thus changed or created.

In a second step the questions should be analyzed. If they are answered and do not represent a relevant hazardous condition they are discarded, they are said to be "overcome". If they do represent a relevant hazardous condition, this hazardous condition must be identified and listed in the Production Risks Analyses – PRA spreadsheet; these are the "validated" questions. The dangerous condition is referenced by the number and the What if question.

Once all questions have been answered, the resulting hazardous conditions will be listed, and for each hazardous condition, current causes, consequences, and protections must be listed.

Next, the level of risk is assessed for each hazardous condition identified. The analysis should use the criteria of the Risk Rating Matrix (see Fig. 2). Always put in more detail for future leadership decisions, the criteria, with a little more detail in the description, of the whys.

2.1.3.3 HAZOP (Hazard and Operability Studies)

The Hazard and Operability Studies (HAZOP) method is one of the most widely applied methods and was developed by Imperial Chemical Industries (ICI) in the 1960s [14]. This method uses keywords to study deviations from the design intent of equipment and processes and to determine the causes and consequences of the deviations. Its main objective is during process operation. The HAZOP method is mainly used when implementing a new process or modifying an existing process during the design phase. The ideal method for HAZOP is to conduct surveys prior to the detailing and construction phases of the project, so as to avoid having to change the details or installation when the HAZOP results are determined. Well-known. HAZOP development combines the indisputable advantages of personal experience and skills, as well as teamwork.

According to [15], the HAZOP process is a qualitative technique that uses key words to question how the design intent or operating conditions cannot be achieved at each stage of the design, process, procedure, or system. Usually conducted by a multidisciplinary team in a series of meetings.

Guiding words lead the study group's thinking to fix attention on the most significant system risks. These can be customized for a system, but the most usual are: none, plus, minus, as well as, part of, reverse/opposite, except, and compatibility. Next, the concepts that help in the analysis and are vitally important to understand are defined.

Nodes are determined which are a part of the process delimited to be studied, usually a node is defined by the

practicality of the study, since the same substance is carried or used, the same variables are used, or it is simple to establish the edges. The process of node selection should be performed according to the P&ID's. Deviations are considered to be situations where the process parameter extrapolates the reference value. The sequence of the study is shown in Fig. 1.

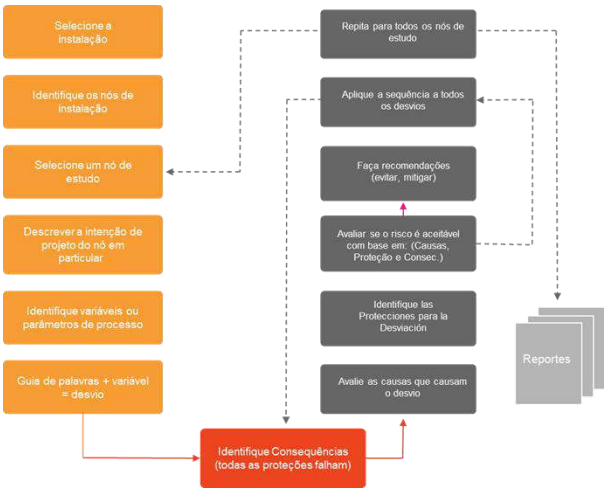

Fig. 1: Hazop sequencing

Source: Authors (2021)

This method is often used in the detailed design phase and should be used when, after the what if method, no solution has been found for the identified risk. It is a more in-depth method indicated only for the most complex and serious risks.

2.1.3.4 Probability and Impact Matrix

The identified risks go through an Analysis and Evaluation process. In this step the risk is estimated (quantified) and its functional dimension is understood. This risk estimation or quantification is a function of the consequence and probability of an event occurring and is based on the risk matrix in Fig. 2:

		Probabilidade de Ocorrência do Risco				
		(1) MUITO BAIXA	(2) BAIXA	(3) MÉDIA	(4) ALTA	(5) MUITO ALTA
Impacto do Risco	(5) CATASTRÓFICO	15	19	22	24	25
	(4) CRÍTICO	10	14	18	21	23
	(3) SÉRIO	6	5	13	17	20
	(2) MODERADO	3	5	8	12	16
	(1) BRANDO	1	2	4	7	11

Fig. 2: 5x5 Risk classification matrix

Source: Authors (2021)

Grau de Risco	Nível de Risco
GR1	20 – 25
GR2	16 – 19
GR3	7 – 15
GR4	1 – 6

Fig. 3: Risk level of the probability x impact matrix
Source: Authors (2021)

The consequence (impact) can be estimated taking into account the potential severity that considers: the nature or size of what is at risk: people, financial, environment, quality, image, legal requirement.

The severity, in the case of people referring to damage or injury to health: mild, severe and death, and the extent of the risk: one person, several people and/or equipment.

The probability of occurrence or the materialization of the risk is a function of the frequency of exposure or occurrence: need for exposure, nature of exposure, frequency of exposure, statistical data or history of events can be used. The possibility of avoiding the materialization of the risk should also be considered: if it is slow to occur, if it can be predictable, if it can occur in a sequential manner, if it occurs due to complaints, etc.

It is necessary that the entire risk analysis and assessment process be documented, showing the basis for the correct classification as to consequence and

probability. Examples: calculation report, reports, reports, modification management, evidence of occurrences, etc., in order not to under or overestimate a certain risk. The risk can be analyzed focusing on each of the impact dimensions, it will have the dimension of the highest risk level evaluated. For this work the financial dimension will be evaluated.

CRITÉRIOS PARA ANÁLISE DE PROBABILIDADE DE MATERIALIZAÇÃO DO RISCO		
NÍVEL	**DECRIÇÃO**	**DETALHAMENTO**
5	MUITO ALTA	Recorrente em operações similares Já ocorreu mais de uma vez. Estatisticamente (por histórico) é esperado que ocorra. A ocorrência é iminente ou é esperada que ocorra em curto prazo. Não existem controles confiáveis
4	ALTA	É provável que ocorra em alguns anos ou com o passar dos anos. Já ocorreu na empresa e não houve ação corretiva efetiva. Uma única causa é suficiente para efetivar o risco, considerando os controles existentes; Controle é fraco e não confiável/não auditado; Há condições agravantes de probabilidade que favorecem a ocorrência.
3	MÉDIA	É provável que ocorra na vida útil do negócio, mas pode ocorrer se houver deterioração ou falta de algum controle. Eventualmente acontece no setor. Equivalente a "ALTA", mas depende de uma 2ª causa para poder ocorrer. Não têm condições agravantes de probabilidade. Até uma redundância de controle.
2	BAIXA	É improvável que ocorra na vida útil do negócio. Já ocorreu no setor mundial, mas é raro. Depende de várias causas para ocorrer, tem várias proteções e redundâncias de modos de falhas diferentes.
1	MUITO BAIXA	Conceitualmente possível, mas extremamente remoto que ocorra na vida útil do negócio. Praticamente impossível de acontecer. Já ocorreu ou não no setor mundial, mas é muito remota essa possibilidade

Fig. 4: Criteria for risk materialization probability analysis

Source: Authors (2021)

In Fig. 4 the criteria relative to the failure frequency are established, with these criteria we classify the risk from very high, which would be the most critical, to very low. Even those classified as very low are treated due to the impact that this failure may generate.

CRITÉRIOS PARA ANÁLISE DE IMPACTO DO RISCO							
GRAU DE IMPACTO	**ESCALA**	**VETORES DE IMPACTO**					
		Segurança e Saúde	**Meio Ambiente**	**Aspectos Legais/Regulatórios**	**Imagem**	**Qualidade**	**Financeira Usina**
5	Catastófico	Acidentes ou doenças que geram lesões que incapacitem **permanentemente** e/ou causem **fatalidade** em **mais de uma pessoa**.	**Fora** da unidade:Impacto ambiental cujos os efeitos são irreversíveis ou reversíveis entre **5 e 10 anos**. **Dentro** da unidade: impacto ambiental cujos efeitos são irreversíveis ou reversíveis em mais de **10 anos**.	**Interdição de colaboradores** e/ou perda de licença gerando **aumento na rigidez** legal e regulatória.	Matérias na imprensa nacional ou internacional negativas com o nome da empresa na manchete. E/ou com **grande impacto** na credibilidade perante a todos os grupos de stakeholders.	Material fora de especificação enviado a cliente que **comprometerá aplicabilidade** do produto podendo causar **impactos a segurança** e/ou saúde.	Impacto financeiro maior que MUS$ 15 ou 30% do EBITDA mensal da planta.
4	Crítico	Acidentes ou doenças que geram lesões que incapacitem **permanentemente** e/ou causem **fatalidade** em **uma pessoa**.	**Fora** da unidade:Impacto ambiental cujos os efeitos são reversíveis entre **1e 5 anos.** **Dentro** da unidade: impacto ambiental cujos efeitos são reversíveis entre **5 e 10 anos.**	Ações de classe e/ou **perda de licença** sem possibilidade de remanejamento de produção	Matérias na imprensa nacional ou internacional negativas com o nome da empresa. E/ou com **impacto mensurável** na credibilidade perante os stakeholders.	Material fora de especificação enviado a cliente que **comprometerá aplicabilidade** do produto podendo causar **impactos no desempenho do produto.**	Impacto financeiro maior que MUS$ 10 ou entre 25% e 30% do EBITDA mensal da planta.
3	Sério	Acidentes ou doenças que geram lesões **permanentes não incapacitantes**.	**Fora** da unidade:Impacto ambiental cujos os efeitos são reversíveis entre **0 e 1 anos.** **Dentro** da unidade: impacto ambiental cujos efeitos são reversíveis entre **1 e 5 anos.**	**Perda temporária** de licença (interdição) associada a compromisso formalizado e/ou **perda de licença** com possibilidade de remanejamento de produção	Matérias na imprensa nacional com a empresa citada em contexto negativo. Presença no ambiente digital de menções negativas relacionadas à marca.	Falha não detectada na Unidade com potencial de comprometer o desempenho do produto ou performance em mais de um cliente	Impacto financeiro entre MUS$ 1 e MUS$ 10 ou entre 5 e 25% do EBITDA mensal da planta.
2	Moderado	Acidentes ou doenças que geram lesões **não permanentes/incapacitantes com afastamento (CPT).**	**Dentro** da unidade:impacto ambiental cujos efeitos são reversíveis entre **30 dias a 1 ano.**	**Autuação** em qualquer esfera **sem risco de interdição.**	Matérias na **imprensa local** com citação da empresa em contexto negativo.	Falha não detectada na Unidade com potencial de comprometer o desempenho do produto ou performance em um cliente	Impacto financeiro menor que MUS$ 1 ou entre 2,5% e 5% do EBITDA mensal da planta.
1	Brando	Acidentes ou doenças que geram lesões **não permanentes/incapacitantes, sem afastamento (SPT).**	Impacto ambiental cujos efeitos são reversíveis com danos de solução menor que **30 dias.**	Processos ou sanções apenas em **esfera Cível.**	Publicidade negativa apenas para o **público interno** sem comprometimento da confiança no Grupo.	Falha que compromete o desempenho do produto ou performance detectada na Unidade.	Impacto financeiro menor que MUS$ 1 ou entre 2,5% e 5% do EBITDA mensal da planta.

Fig. 5: Criteria for the evaluation of risk impacts

Source: Authors (2021)

2.1.3.5 FMEA (Failure Modes and Effects Analysis)

FMEA is a technique used to define, identify, and eliminate known failures or deviations in systems, designs, processes, and/or equipment before they reach the customer [16].

Failure Mode and Effect Analysis is a reliability technique with the primary objective of anticipating known or potential failure modes in a product or process (equipment, systems, or components) and identifying actions that can eliminate or reduce the chance of these failures occurring. It is an analytical method based on the

team's experience, which helps in the identification and prioritization of failures.

To assist in the analysis, information such as performance standards, equipment availability, repair cost, loss profile, environmental and safety risk assessment, failure history, reference documentation, and the operational context can be collected.

FMEA can be used to:

- Anticipate product defects or equipment failures, rather than detect and correct after the occurrence, thus having cost and/or operational risk reduction;

- Assist in the selection of design alternatives for assurance of function;

- Identify the modes and effects of human error;

- Provide basis for test planning and maintenance of physical systems;

- Improve design;

- Provide information for analysis techniques such as fault tree analysis;

- Establish benchmarks for similar equipment or systems;

- Improve or standardize the knowledge of the entire team regarding important aspects of quality and reliability of the process or product.

2.2 Continuous Casting Machine

According to [19], since the 1960s, the continuous casting casting of steel with liquid steel in a single device is the most important technological advancement in metallurgical processes, because it could replace traditional castings performed through ingot moulds, which is very important.

According to [18], the conventional process is considered disadvantageous due to its elevating cost, because, it requires additional equipment such as furnaces, roughing, rippers, ingot maintenance, intermediate transportation (overhead cranes, etc.) to obtain steel sheets.

According to [19], continuous casting eliminates the cost of the aforementioned equipment, reducing time and cost and improving steel quality. The importance of solidification in the metallurgical process of continuous ingot treatment, such as crystal structure, distribution of non-metallic inclusions, micro and macro segregation, and mechanical properties, is closely related to the steel solidification phenomena.

According to [19], the main function of continuous casting is to continuously transform liquid steel into solid. This is the most effective way to solidify large amounts of metal in a simpler form for subsequent rolling [20]. According to [19], as early as 1856, Henry Bessemer proposed a method of continuous solidification, but it was not until the 1930s and 1940s that continuous casting became a common method of producing nonferrous metals and then became a common method of producing steel in the 1960s. Compared with non-ferrous steel, the lower thermal conductivity of steel and the high temperature of casting lead to some problems in steel foundries.

[19], goes on to inform that in the mid-1980s, continuous casting increased significantly, surpassing the conventional ingot solidification route, and became the main method used in steel production. Currently, a large volume of the world's steel with its most diverse chemical composition and shape, uses continuous casting as its solidification method.

According to [21], the continuous casting process aims to solidify the liquid steel that comes from the secondary refining. The ladle, besides having the function of adjusting the chemical composition of the steel, transports it to the distributor, which in turn has as one of its functions to feed the mold continuously.

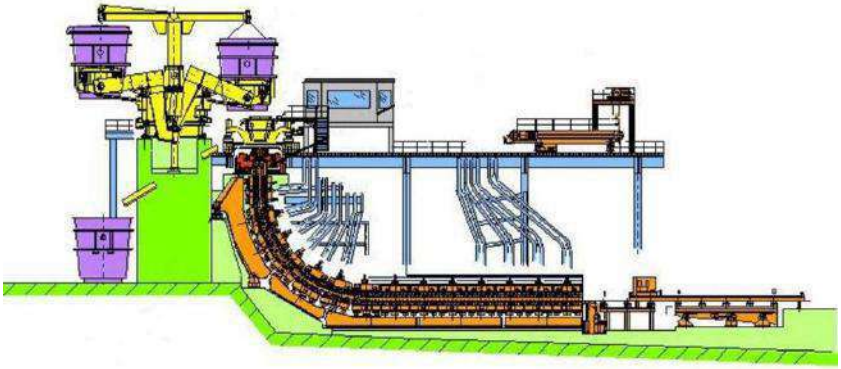

Fig. 6: Continuous casting machine

Source: [22]

The cooling of the steel begins in the copper mold, which in turn is water-cooled. Thus a solidified shell is formed that must have a minimum thickness to withstand the ferrostatic pressure. The mold must oscillate in a way that prevents the steel from sticking to the mold wall. To reduce the friction between the mold wall and the solidified shell, lubricating oil or flux powder is added. The solidified shell is extracted by the extraction machine in conjunction with the rollers and guides that are located after the mold at a rate equal to the casting speed.

At the exit of the mold begins the region of showers (sprays), responsible for the greatest removal of latent heat from the ingot by heat transfer by radiation, conduction in the cooled rollers and evaporation of water from the sprays that bathes the surface of the billet.

Spraying on the surface of the billet can be with air and water or water only. With air and water you get a more uniform application due to the smaller droplet size compared to a water-only spray.

In secondary cooling, the spray zones do not have the same length and, furthermore, the number of zones varies from steel mill to steel mill. It is worth mentioning that one of the internal problems arising from secondary cooling is the midway crack that originates due to too high reheating between the spray zones, as will be seen later.

The last stage of the continuous casting process takes place in the free radiation region. In this phase the ingot is cooled only by natural convection and by heat radiation from the ingot surface to the external environment, while the solidification of all existing liquid up to the oxyfuel area takes place.

III. METHODOLOGICAL PROCEDURES

3.1 Scenario

The company under study is a multinational steel company that operates in the field of special alloyed steels for the mechanical construction industry, mainly for auto parts. It has units in this segment in the states of São Paulo and Rio Grande do Sul. In the unit under study, this company is composed of three large production areas: Steelmaking, Rolling Mills and Mechanical Transformation. This study will address the risks of the Continuous Casting machine, which is part of the Steel Making process.

As more than 60% of the production of liquid steel produced in the Steel Making Plant goes through the Continuous Casting, we chose to work on the risks involved in this machine.

3.2 Equipment studied

Continuous Casting is the process by which the liquid metal is solidified into a semi-finished product in the form of billet, block or slab. In the case of the machine studied, the billets are square billets of 185 unidade de medida linear milimetros – mm and 155mm. The machine has 6 shafts where the billets are formed and cut to the length required by the customer.

The process is through an oscillating mold, where the mold oscillates up and down with variable speed, allowing a continuous extraction of the shaft with very low friction with the side walls of the mold.

3.3 Method

The application of any risk analysis method should be done considering the strategic planning of the mill and the area.

Resources for risk assessment should be prioritized for the most critical areas. The area leadership should accompany and support the teams involved in the analysis, in order to guarantee that all information, conditions and resources are available in a timely manner, according to the steps described in Fig. 7:

Fig. 7: Operational risk management flow

Source: Authors (2021)

The identification step is a process of search, recognition and detailed identification of risks for this study, as previously described, the rotating tower was selected, a subset of the continuous casting machine

which for better understanding can be seen below in Fig. 8.

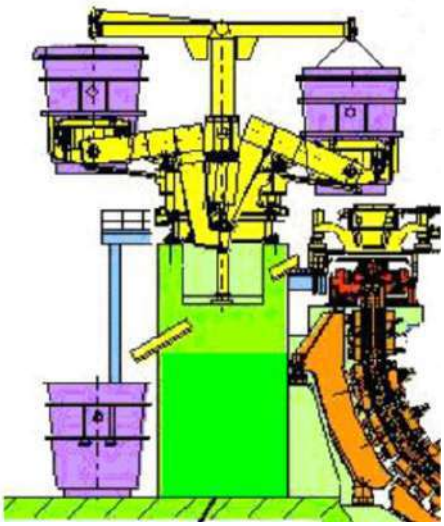

Fig. 8: Representation of a continuous casting tower

Source: [22]

The rotating tower receives the liquid steel pan, released by the electric oven, sustaining it on the distributor. The empty pan is released to the preparation area through a 180º rotation, allowing the quick change of pans and continuing the process.

3.3.1 Evaluation

With the data calculated and the analyses performed, the risks are prioritized through the classification in the 5x5 Matrix in Fig. 2 that relates Impact and Likelihood. First the classification of the Impact is made, considering the value calculated EBITDA – Earn Before Income, Taxation, Depreciation and Amortization of the plant.

After the impact evaluation, the probability of each risk is evaluated based on the parameters in Fig. 4. This evaluation is qualitative and based on the 'know how' of the work team. Hence the importance of the involvement of a multidisciplinary and experienced team. After the classification and prioritization of the risks, they will be studied more deeply and facts and data will be included to support the determination of impact and probability defined in this step.

In possession of this information, the risks are positioned in the 5x5 Matrix in Fig. 2, to obtain the risk grade, and from the classification obtained, the risks are named according to the grade indicated in Fig. 3.

In this way the identified, analyzed, and evaluated risks were prioritized and one can move on to the next step of risk treatment.

The risks classified as Grade - GR1 belong to the Plant Executive Manager, are considered unacceptable, and there should be an action plan with routine checks to verify and bring the risk within acceptable standards.

The risks classified as Grade - GR2 are owned by the maintenance manager of the area where the risk is located and are considered unacceptable, but under control, there must be a monitoring of actions to ensure that this risk does not increase and an action plan to bring it to acceptable standards.

The other risks are owned by the area maintenance coordinator and are considered acceptable, but all their controls and mitigation actions are monitored by the area manager.

3.3.2 Risk Treatment

In this stage the controls will be defined in order to prioritize their implementation. The controls that already exist are also identified, and if they have monitoring of their execution, to ensure that the risk mitigation happens. The respective controls must be defined with the objective of modifying the risks, always seeking to place the risk within the acceptance level.

The implementation of actions to treat risks is not necessarily unique or appropriate for all circumstances. Options for addressing risks may involve one or more of the following approaches:

- Avoid the risk (decision not to initiate the activity that gives rise to the risk);

- Remove the source of risk;

- Change the likelihood;

- Change the consequences;

- Share the risk (e.g. through contracts, purchase of insurance);

- Retain the risk by reasoned decision.

Controls for a given set of risks will generally be broken down into procedures and practices of a technical or managerial nature, and may fall into the following categories:

- Operations Management: operational procedures, best practices related to how to operate processes;

- Maintenance Management: policies and plans related to asset integrity maintenance (e.g. preventive and predictive maintenance plans; inspections and tests; reliability programs; failure analysis, etc.);

- People Management: training of professionals in positions considered critical in relation to risks related to operations;

- Change Management: processes for the management of permanent and temporary changes necessary for the continuity and improvement of operations;

- Emergency Management: set of procedures related to risk scenarios foreseen in the process of Identification, Analysis and Evaluation of Risks;

- Investment Management: risk management process for new installations as well as their impacts on existing processes.

3.3.3 Monitoring

Monitoring has the objective of verification, supervision, critical observation or identification of the situation, performed continuously, in order to identify changes in the level of performance required or expected.

All actions, existing controls are imputed in a system (Power BI or Risk Management Software), so that they are monitored and known to all levels of the organization. Check meetings are held so that the process is always under control and evolving.

The risks are re-evaluated with frequency according to the Risk Grade. Those classified as GR1 are reassessed annually, GR2 every two years, and the others every five years.

The monitoring of the risk management process uses the following indicators:

- Amount of GR1 risks mitigated;

- % of overdue actions;

- % of Reassessment delayed.

IV. RESULTS

4.1 Risk Identification

The what if step resulted in the following Fig. 9:

ANÁLISE DE RISCOS VALIDADOS E RECOMENDAÇÕES - TORRE GIRATORIA DO LINGOTAMENTO CONTÍNUO

PERGUNTA ORIGINAL	RISCO	CAUSAS	CONSEQUÊNCIAS	MEDIDAS CONTROLE	RECOMENDAÇÕES
E SE O REDUTOR DO GIRO DO ROLAMENTO QUEBRAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A) FALHA DE LUBRIFICAÇÃO B) FALHA DA FIXAÇÃO/ VIBRAÇÃO EXCESSIVA	PARADA 7 DIAS PARA RECUPERAÇÃO E TROCA DO REDUTOR	PLANO DE PREVENTIVA/INSPEÇÃO MECANICA (ELETRICA) E PREDITIVA MENSAL	TER UM REDUTOR RESERVA VERIFICAR VIABILIDADE DE CRIAR REVISÃO BASE TEMPO POR NÃO TER MUITAS FORMAS DE MONITORAMENTO BASE CONDIÇÃO.
E SE O ROLAMENTO DO GIRO FALHAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A)FALHA DE LUBRIFICAÇÃO B)FOLGA EXCESSIVA C)FALHA NO PRISIONEIRO DE FIXAÇÃO D)QUEBRA DOS DENTES DO ROLAMENTO	PARADA DE 7 DIAS PARA TROCA DO ROLAMENTO INFERIOR OU SUPERIOR	MEDIÇÃO DE FOLGA DO ROLAMENTO PLANO DE LUBRIFICAÇÃO PLANO DE INSPEÇÃO DO SISTEMA DO GIRO	SISTEMATIZAR PLANO PARA MEDIÇÃO DA FOLGA
E SE A JUNTA ROTATIVA FALHAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A)VAZAMENTOS DE OLEO EM MANGUEIRAS E TUBULAÇÕES B)DANO NAS VEDAÇÕES INTERNAS C)TRAVAMENTO DO ROLAMENTO DO GIRO DA JUNTA	PARADA DE ATÉ 2 DIAS PARA TROCA DA JUNTA ROTATIVA	2 JUNTAS RESERVAS MANGUEIRAS RESERVAS PLANO DE MANUTENÇÃO	REVISAR PLANO DE MANUTENÇÃO GARANTIR VEDAÇÃO ESPECIFICADA UTILIZADA NO REPARO.
E SE O PINHÃO DO REDUTOR FALHAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A)DESGASTE/QUEBRA DOS DENTES B)FALHA DE LUBRIFICAÇÃO	PARADA DE 7 DIAS PARA USINAGEM DE UM NOVO PINHÃO E INSTALAÇÃO.	PLANO DE PREVENTIVA DO SISTEMA DO GIRO.	MEDIÇÃO DE DESGASTE DE DENTES. INSPEÇÃO POR LIQUIDO PENETRANTE ESTUDAR INSTALAÇÃO DE LUBRIFICANTE SOLIDO NO ENGRENAMENTO PINHÃO X COROA DO ROLAMENTO
E SE O MOTOR PNEUMATICO DO GIRO QUEBRAR.	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A)FALHA NO PISTÃO INTERNO B)QUEBRA DO DISCO DE EMBREAGEM C)FALHA DA VALVULA PNEUMATICA	PARADA DE PELO MENOS 8H PARA TROCA DO CONJUNTO.	PLANO PREVENTIVA/INSPEÇÃO MECANICA/ELETRICA MENSAL TEM COMPONENTES RESERVA	NÃO HÁ
E SE O MOTOR ELETRICO DO GIRO QUEBRAR.	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A)BAIXA ISOLAÇÃO B)FALTA DE FASE C)TRAVAMENTO DO ROLAMENTO	PARADA DE PELO MENOS 8H PARA SUBSTITUIÇÃO DO MOTOR	PLANO DE MANUTENÇÃO ELETRICA MOTOR RESERVA	MANUTENÇÃO PREDITIVA

Fig. 9: 'Checklist' filling 'What if'

Source: Authors (2021)

To evaluate the impact, the average production capacity of the continuous casting was considered as 76 tons per hour (t/h) and the gross margin as 550 reais per ton (R$/t). The items that would be necessary to recompose the function of each equipment were also budgeted with the suppliers. The values for each risk are shown in Fig. 10:

ANÁLISE DE RISCOS VALIDADOS E RECOMENDAÇÕES - TORRE GIRATORIA DO LINGOTAMENTO CONTÍNUO							
ITEM	PERGUNTA ORIGINAL	RISCO	CAUSAS	CONSEQUÊNCIAS	Lucro Cessante	Custo de Recomposição	Custo Total do Impacto
1	E SE O REDUTOR DO GIRO DO ROLAMENTO QUEBRAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A) FALHA DE LUBRIFICAÇÃO B) FALHA DA FIXAÇÃO/ VIBRAÇÃO EXCESSIVA	PARADA 7 DIAS PARA RECUPERAÇÃO E TROCA DO REDUTOR	7 (dias) x 24 (h) x 76 (t/h) x 550 (R$/t) = **R$ 6.987.750,00**	Compra do redutor: R$ 450.000,00	R$7.437.750,00
2	E SE O ROLAMENTO DO GIRO FALHAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A)FALHA DE LUBRIFICAÇÃO B)FOLGA EXCESSIVA C)FALHA NO PRISIONEIRO DE FIXAÇÃO D)QUEBRA DOS DENTES DO ROLAMENTO	PARADA DE 7 DIAS PARA TROCA DO ROLAMENTO INFERIOR OU SUPERIOR	7 (dias) x 24 (h) x 76 (t/h) x 550 (R$/t) = **R$ 6.987.750,00**	Compra do rolamento: R$1,2 milhões Instalação: R$400.000,00	R$8.587.750,00
3	E SE A JUNTA ROTATIVA FALHAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A)VAZAMENTOS DE OLEO EM MANGUEIRAS E TUBULAÇÕES B)DANO NAS VEDAÇÕES INTERNAS C)TRAVAMENTO DO ROLAMENTO DO GIRO DA JUNTA	PARADA DE ATÉ 2 DIAS PARA TROCA DA JUNTA ROTATIVA	2 (dias) x 24 (h) x 76 (t/h) x 550 (R$/t) = **R$ 1.996.500,00**	MÃO DE OBRA INTERNA	R$1.996.500,00
4	E SE O PINHÃO DO REDUTOR FALHAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A)DESGASTE/QUEBRA DOS DENTES B)FALHA DE LUBRIFICAÇÃO	PARADA DE 7 DIAS PARA USINAGEM DE UM NOVO PINHÃO E INSTALAÇÃO.	7 (dias) x 24 (h) x 76 (t/h) x 550 (R$/t) = **R$ 6.987.750,00**	Usinagem do pinhão: R$ 230.000,00	R$7.217.750,00
5	E SE O MOTOR PNEUMATICO DO GIRO QUEBRAR.	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A)FALHA NO PISTÃO INTERNO B)QUEBRA DO DISCO DE EMBREAGEM C)FALHA DA VALVULA PNEUMATICA	PARADA DE PELO MENOS 8H PARA TROCA DO CONJUNTO.	8 (h) x 76 (t/h) x 550 (R$/t) = **R$ 332.750,00**	MÃO DE OBRA INTERNA	R$332.750,00
6	E SE O MOTOR ELETRICO DO GIRO QUEBRAR.	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A)BAIXA ISOLAÇÃO B)FALTA DE FASE C)TRAVAMENTO DO ROLAMENTO	PARADA DE PELO MENOS 8H PARA SUBSTITUIÇÃO DO MOTOR	8 (h) x 76 (t/h) x 550 (R$/t) = **R$ 332.750,00**	MÃO DE OBRA INTERNA	R$332.750,00

Fig. 10: What if checklist with financial impact

Source: Authors (2021)

4.2 Risk classification

For the impact evaluation the EBITDA was considered to be R$15,500,000.00, thus positioning the risks in the impact table of Fig. 11 was as follows:

IMPACTO	ESCALA	Segurança e Saúde	Meio Ambiente	Aspectos Legais/Regulatórios	Imagem	Qualidade	Financeira Usina
5	Catrastófico	Acidentes ou doenças que geram lesões que incapacitem **permanentemente** e/ou causem **fatalidade** em **mais de uma pessoa**.	**Fora** da unidade:Impacto ambiental cujos os efeitos são Irreversíveis ou reversíveis entre **5 e 10 anos**. **Dentro** da unidade: Impacto ambiental cujos efeitos são irreversíveis ou reversíveis em mais de **10 anos**.	**Interdição de colaboradores** e/ou perda de licença gerando **aumento na rigidez** legal e regulatória.	Matérias na imprensa nacional ou internacional negativas com o nome da empresa na manchete. E/ou com **grande impacto** na credibilidade perante a todos os grupos de stakeholders.	Material fora de especificação enviado a cliente que **comprometerá aplicabilidade** do produto podendo causar **impactos a segurança** e/ou saúde.	Impacto financeiro maior que MUS$ 15 ou 30% do EBITDA mensal da planta.
4	Crítico	Acidentes ou doenças que geram lesões que incapacitem **permanentemente** e/ou causem **fatalidade** em **uma pessoa**.	**Fora** da unidade:Impacto ambiental cujos os efeitos são reversíveis entre **1e 5 anos**. **Dentro** da unidade: Impacto ambiental cujos efeitos são reversíveis entre **5 e 10 anos**.	Ações de classe e/ou **perda de licença** sem possibilidade de remanejamento de produção	Matérias na imprensa nacional ou internacional negativas com o nome da empresa. E/ou com **impacto mensurável** na credibilidade perante os stakeholders.	Material fora de especificação enviado a cliente que **comprometerá aplicabilidade** do produto podendo causar **impactos no desempenho do produto**.	Impacto financeiro maior que MUS$ 10 ou entre 25% e 30% do EBITDA mensal da planta.
3	Sério	Acidentes ou doenças que geram lesões **permanentes não incapacitantes**.	**Fora** da unidade:Impacto ambiental cujos os efeitos são reversíveis entre **0 e 1 anos**. **Dentro** da unidade: Impacto ambiental cujos efeitos são reversíveis entre **1 e 5 anos**.	**Perda temporária** de licença (interdição) associada a compromisso formalizado e/ou **perda da licença** com possibilidade de remanejamento de produção	Matérias na imprensa nacional com a empresa citada em contexto negativo. Presença no ambiente digital de menções negativas relacionadas à marca.	Falha não detectada na Unidade com potencial de comprometer o desempenho do produto ou performance em mais de um cliente	Impacto financeiro entre MUS$ 1 e MUS$ 10 ou entre 5 e 25% do EBITDA mensal da planta.
2	Moderado	Acidentes ou doenças que geram lesões **não permanentes/incapacitantes com afastamento (CPT)**.	**Dentro** da unidade:Impacto ambiental cujos efeitos são reversíveis entre **30 dias a 1 ano**.	**Autuação** em qualquer esfera **sem risco de interdição**.	Matérias na **imprensa local** com citação da empresa em contexto negativo.	Falha não detectada na Unidade com potencial de comprometer o desempenho do produto ou performance em um cliente	Impacto financeiro menor que MUS$ 1 ou entre 2,5% e 5% do EBITDA mensal da planta.
1	Brando	Acidentes ou doenças que geram lesões **não permanentes/incapacitantes, sem afastamento (SPT)**.	Impacto ambiental cujos efeitos são reversíveis com danos de solução menor que **30 dias**.	Processos ou sanções apenas em **esfera Cível**.	Publicidade negativa apenas para o **público interno** sem comprometimento da confiança no Grupo.	Falha que compromete o desempenho do produto ou performance detectada na Unidade.	Impacto financeiro menor que MUS$ 1 ou entre 2,5% e 5% do EBITDA mensal da planta.

Fig. 11: Criteria for risk impact analysis

Source: Authors (2021)

The second criterion related to the EBITDA percentage was considered, as it would be the most critical case. After the impact evaluation, the probability of each risk was evaluated, positioning them according to Fig. 12.

CRITÉRIOS PARA ANÁLISE DE PROBABILIDADE DE MATERIALIZAÇÃO DO RISCO		
NÍVEL	DECRIÇÃO	DETALHAMENTO
5	MUITO ALTA	Recorrente em operações similares Já ocorreu mais de uma vez. Estatisticamente (por histórico) é esperado que ocorra. A ocorrência é iminente ou é esperada que ocorra em curto prazo. Não existem controles confiáveis
4	ALTA	É provável que ocorra em alguns anos ou com o passar dos anos. Já ocorreu na empresa e não houve ação corretiva efetiva. Uma única causa (vide referências) é suficiente para efetivar o risco, considerando os controles existentes; Controle é fraco e não confiável/não auditado; Há condições agravantes de probabilidade que favorecem a ocorrência.
3	MÉDIA	É provável que ocorra na vida útil do negócio, mas pode ocorrer se houver deterioração ou falta de algum controle. Eventualmente acontece no setor. Equivalente a "ALTA", mas depende de uma 2ª causa para poder ocorrer. Não têm condições agravantes de probabilidade. Há uma redundância de controle.
2	BAIXA	É improvável que ocorra na vida útil do negócio. Já ocorreu no setor mundial, mas é raro. Depende de várias causas para ocorrer, tem várias proteções e redundâncias de modos de falhas diferentes.
1	MUITO BAIXA	Conceitualmente possível, mas extremamente remoto que ocorra na vida útil do negócio. Praticamente impossível de acontecer. Já ocorreu ou não no setor mundial, mas é muito remota essa possibilidade

Fig. 12: Criteria for probability analysis

Source: Authors (2021)

We then have the following condition for each assessed risk:

- Risk 1 - Catastrophic impact and high probability;
- Risk 2 - Catastrophic impact and medium probability;
- Risk 3 - Serious impact and medium probability;
- Risk 4 - Catastrophic impact and low probability;
- Risk 5 - Soft impact and low probability;
- Risk 6 - Soft impact and low probability.

With this information, the risks are positioned in the 5x5 Matrix in Fig. 13, to obtain the degree of risk.

		Probabilidade de Ocorrência do Risco				
		(1) MUITO BAIXA	(2) BAIXA	(3) MÉDIA	(4) ALTA	(5) MUITO ALTA
Impacto do Risco	(5) CATASTRÓFICO	15	19	22	24	25
	(4) CRÍTICO	10	14	18	21	23
	(3) SÉRIO	6	9	13	17	20
	(2) MODERADO	3	5	8	12	16
	(1) BRANDO	1	2	4	7	11

Fig. 13: Positioning of risks in the impact x Likelihood matrix

Source: Authors (2021)

From the positioning of the risks in Fig. 13 and the relationship in Fig. 3 we have the following result. The turntable has two Grade 1 risks (GR1), one Grade 2 risk (GR2), one Grade 3 risk (GR3) and two Grade 4 risks (GR4).

4.3 Existing controls and mitigation/elimination actions

For this step, the highest risk was prioritized in order to detail the actions that are implemented for this risk. Thus, Fig. 14 shows the existing controls for the risk "What if the tower's slewing bearing reducer fails".

CONTROLES EXISTENTES								
Item	Descrição da ação ou controle	Status atual da ação	Impacto da ação na mitigação do Risco	Responsável e Datas		Gerenciamento da Ação		
1	Plano de preventiva de lubrificação para verificação do nível de óleo e completar se necessário. Verificar existencia de vazamentos e substituir mangueiras e conexões	Ação executada trimestralmente.	Impacto na probabilidade do risco sendo um dos controles para evitar a falha por falta de lubrificação.	Status da Ação: Executada Registrada por: Gestor de GRO Responsável: Padrinho Prazo: Concluída		Prioridade: Alta % Reduçao da probabilidade: 5% % Redução do Impacto: 0%	É monitorada? SIM Qual frequência? 3M Quem monitora? Programador Número do Plano 159192 Data ultima execução: 12/03/2021	
2	Plano de inspeção mecânica para verificação da fixação, folgas ou ruido anormal	Ação executada mensalmente.	Impacto na probabilidade do risco sendo um dos controles para evitar a falha por vibração	Status da Ação: Executada Registrada por: Gestor de GRO Responsável: Padrinho Prazo: Concluída		Prioridade: Alta % Reduçao da probabilidade: 5% % Redução do Impacto: 0%	É monitorada? SIM Qual frequência? 1M Quem monitora? Programador Número do Plano 159191 Data ultima execução: 12/02/2021	
3	Plano de preditiva para análise do óleo	Ação executada trimestralmente.	Impacto na probabilidade do risco sendo um dos controles para evitar a falha por lubrificação.	Status da Ação: Executada Registrada por: Gestor de GRO Responsável: Padrinho Prazo: Concluída		Prioridade: Alta % Reduçao da probabilidade: 5% % Redução do Impacto: 0%	É monitorada? SIM Qual frequência? 3M Quem monitora? Programador Número do Plano 270396 Data ultima execução: 15/01/2021	

Fig. 14: Existing Controls

Source: Authors (2021)

In Fig. 15, it is possible to observe the maintenance policies established to mitigate the risk, but they do not guarantee that the failure will occur again, they are not considered robust controls because they depend on human action for execution.

Therefore, the risk remained classified as high probability.

The recommendations for this risk are also listed, as can be seen in the 'what if' in Fig. 9, actions that still need to be taken, either to mitigate or eliminate the risk.

AÇÕES DE MITIGAÇÃO/ELIMINAÇÃO DO RISCO								
Item	Descrição da ação ou controle	Status atual da ação	Impacto da ação na mitigação do Risco	Responsável e Datas		Gerenciamento da Ação		
1	Aquisição de um redutor reserva.	Redutor especificado e orçado no mercado. Aguardando liberação de recurso	Redução do tempo de parada de 7 dias para 18 horas. Reduzindo o impacto de R$7mi para R$750mil	Status da Ação: Em andamento Registrada por: Gestor de GRO Responsável: Padrinho Prazo: 30/12/2021 % de Conclusão: 30%		Prioridade: Alta % Reduçao da probabilidade: 0% % Redução do Impacto: 89%	Custo Implantação: R$ 450.000,00 Benefício Financeiro (Se houver) 0	
2	Criar plano de manutenção para troca programada base tempo.	Não iniciada	Garantir condição de funcionamento do redutor, executando as verificações necessárias conforme o plano de manutenção.	Status da Ação: Não iniciada Registrada por: Gestor de GRO Responsável: Padrinho Prazo: 30/06/2022 % de Conclusão: 0%		Prioridade: Média % Reduçao da probabilidade: 1 % Redução do Impacto: 0%	Custo Implantação: R$ - Benefício Financeiro (Se houver) Calcular	

Fig. 15: Risk mitigation and/or elimination actions

Source: Authors (2021)

For the case evaluated, performing the action of acquiring a spare part will bring the risk to acceptable parameters. Reassessing the financial impact of this risk in Fig. 11, the impact would be classified as moderate and the probability would remain high:

Impacto do Risco	Probabilidade de Ocorrência do Risco				
	(1) MUITO BAIXA	(2) BAIXA	(3) MÉDIA	(4) ALTA	(5) MUITO ALTA
(5) CATASTRÓFICO	15	19	22	24	25
(4) CRÍTICO	10	14	18	21	23
(3) SÉRIO	6	9	13	17	20
(2) MODERADO	3	5	8	12	16
(1) BRANDO	1	2	4	7	11

Fig. 16: Reassessment of risk

Source: Authors (2021)

The risk would be classified as a GR3 according to Fig. 3 and considered acceptable by the organization, with the controls shown in Fig. 15 being maintained and the scheduled exchanges being performed as shown in Fig. 16.

4. 4 Communication and Documentation

In possession of all the necessary information, the specialist in the area prepares a One Page that contains all the information for decision making by the company's top management, whether it is the purchase of the necessary item, or to assume living with the risk and thus ensure that the controls are executed so that it does not occur during the period.

The One Pages are presented to the managers, involving all interested parties in the dialogue about the general Risk situation and the measures taken by those responsible. Its objective is to know and validate all the stages of the risk management process.

For the risk studied, as an example in this work, we have in Fig. 17 the 'One Page' with the main information, which will also have a detailed study based on facts and data to ensure the credibility of the values and information presented.

Área:	1-ACIARIA	Nome do Risco:	QUEBRA DO REDUTOR DO GIRO DA TORRE	Freq. de Revisão:	ANUAL	GR INICIAL	GR ATUAL	GR ALVO	Núm Falha
Equipamento:	LINGOTAMENTO CONTÍNUO	Owner:	COORDENADOR DA ÁREA	Data da Revisão:	mar/22	GR1	GR1	GR3	xxxxx
Subconjunto:	TORRE GIRATÓRIA	Aprovado por:	GERENTE DA PLANTA	Responsável:	ESPECIALISTA DA ÁREA				

DESCRIÇÃO COMPLETA DO RISCO	CENÁRIO / HISTÓRICO
QUEBRA DO REDUTOR DO GIRO, PODENDO PARAR O PROCESSO DO LINGOTAMENTO CONTÍNUO POR 7 DIAS RISCO DE DESABASTECIMENTO DA CADEIA AUTOMOTIVA	EQUIPAMENTO DE EXTREMA IMPORTÂNCIA PARA O PROCESSO, SENDO RESPONSÁVEL POR 60% DE TODO AÇO PRODUZIDO NA ACIARIA E QUE ABASTECE OS DOIS LAMINADORES DA EMPRESA. LINHA DE PRODUTO DESTINADA AOS FABRICANTES DE AUTOPEÇAS SENDO CLIENTES MUITO CRÍTICOS PARA O NEGÓCIO. EQUIPAMENTO DE 1975, BASTANTE ROBUSTO, MAS QUE NECESSITA DE CONTROLES DEVIDO A VIDA ELEVADA. NÃO HÁ HISTÓRICO DE FALHAS NO SUBCONJUNTO ESTUDADO E/OU REFORMA RELEVANTE.
FOTO DO RISCO	CONSEQUÊNCIAS
	PARADA DO PROCESSO POR 7 DIAS PARA RECUPERAÇÃO E TROCA DO EQUIPAMENTO. GERANDO UM IMPACTO FINANCEIRO DE R$ 6.987.750,00
	CONTROLES EXISTENTES
	ROTINAS DE MANUTENÇÃO PREVENTIVA E PREDITIVAS PARA ATUAR NA REDUÇÃO DA PROBABILIDADE DA FALHA

	PRINCIPAIS AÇÕES DE MITIGAÇÃO/ELIMINAÇÃO DO RISCO	IMPACTO NO RISCO	CUSTO DE IMPLANTAÇÃO
1	AQUISIÇÃO DE REDUTOR RESERVA	REDUÇÃO DO IMPACTO DE R$7MI PARA 750mil, REDUZINDO O GRAU DO RISCO PARA GR3	R$ 450.000,00
2			
3			
5			

Fig. 17: One Page

Source: Authors (2021)

The 'One Page' shown in Fig. 17 becomes the cover page of this study that will help the specialist in the presentation to answer questions from top management. All the risks are archived, forming a book used for the preparation of the company's strategic planning, budgets, and investment plans.

V. CONCLUSION

The present work had as a proposal to present a systematic of identification, analysis and evaluation of the risks of a company, in order to inform the top management in a simple and objective way, about the operational risks contained and that are under their responsibility, showing the controls that are within the possibilities of the area to perform and informing the financial needs or proposing solutions to mitigate or eliminate these risks. The exposed objectives were validated and achieved.

For a manager it is complex to know and manage all the operational risks that the organization has. Without their knowledge, there is no possibility of creating or evaluating controls that can prevent the occurrence of disasters or unwanted events. For this reason, this work will serve as a guide for professionals to use in the most diverse equipment.

The work could have covered a larger and diverse amount of equipment, which would have brought a greater confirmation of its applicability.

For future studies, it is suggested to evaluate the other dimensions considered in the impact matrix, thus having a comprehensive portfolio, which will provide subsidies for the control of all the organization's processes. The use of other methods for more complex risks and also the use of machine learning software that can help both in the automation of the classification matrix and in the estimation of probability.

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Phyllanthus (*Phyllanthus multiflorus Willd.*) Fruit as Natural pH Indicator

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***Abstract*—** *A substance property as an acid or a base is determined in terms of quantity of pH. It makes use of various tools ranging from simple litmus paper to the sophisticated benchtop pH meter. Natural indicators on the other hand are utilized as an alternative to synthetic acid-base indicators. This paper relates to the preparation of natural indicator from Phyllanthus fruit containing anthocyanin, and the establishment of its effectiveness. The experimental method of this study is composed of the preparation of raw materials, standardization of solutions, calibration, testing for effectiveness, and development of a color chart. The developed pH indicator consists of Phyllanthus fruit, water, and ethanol. The process of producing the pH indicator comprises of the following steps: collecting; washing; weighing; crushing; mixing with water; boiling the mixture; filtering; cooling down; mixing with ethanol; soaking; and drying. The calibration of the indicator involves different solutions with pH 0 to 14 to come up with a color chart. This serves as a reference in the effectiveness test. Treatment 2 of the indicator produced a distinctive color that is comparable to the existing pH measurement tool. This finding indicates that the pH indicator from Phyllanthus fruit consisting of a 1:1 ratio of fruit to water, and a 1:1.5 ratio of the mixture to ethanol can be a cheaper alternative tool in measuring pH that can be used in laboratory testing, as instructional material, and in the household.*

I. INTRODUCTION

In science, a substance property as an acid or a base is one of the main concepts being discussed. The acidity and basicity of solutions are determined in terms of quantity of pH. The “power of hydrogen” is a scale ranging from 0 to 14, with lower numbers than pH 7 representing higher acidity while numbers higher than pH 7 indicate basic solutions [1]. Chemistry titrations, water quality testing, testing of proper composition of biotechnology, food products preservation, and tasting are few of the various activities that need the measurement of acidity and alkalinity of a substance. It makes use of various tools ranging from simple litmus paper to the sophisticated benchtop pH meter. The litmus paper is effective at indicating the acidity or basicity of a substance by changing its color due to chemical reaction when exposed to acid as it turns red, or a base as it turns blue, but cannot report an exact pH value. It works the same with pH test strips but the packages come with a color-coded scale as a reference when paper turns a certain color. A typical pH meter on the other hand can be made of a moving coil or a digital meter, and either one or two probes. It works by dipping the two electrodes into a solution and by ion-exchange it creates a different degree of hydrogen ion activity showing a pH measurement [2]. The sophisticated pH meter from the group of benchtop pH meters, wireless

pH transmitters, and portable pH meter offers great accuracy and convenience but is costly.

Natural indicators on the other hand are utilized as an alternative to synthetic acid-base indicators. These indicators are dyes and pigments that are isolated from groups of plants, fungi, and algae. Plant pigments such as flavonoids with common types including anthocyanins, aurones, chalcones, flavonoids, and proanthocyanidins are commonly produced in many colors in flowers and plants such as red cabbage, berries, eggplant, turmeric, curry powder, cherries, tomato, and citrus fruits. Different studies revealed that various plants such *as* antirrhinum, cotton tree, marigold, dahlia, sunflower, China rose, beach morning glory, santan, fern tree, white mulberry, and pomegranate show good acid-base indicator activity against various synthetic pH indicators [3].

Phyllanthus is a common weed in the Philippines that is synonymous with *Phyllanthus reticulatus* [4]. It is a small spreading shrub with rough bark from brown to grey and bears a depressed-globose bluish-black berry when ripe usually with dark purplish pulp [5]. There are more than 510 known organic substances isolated from Phyllanthus, the majority of which are flavonoids, tannins, lignins, and triterpenoids [6]. Thus, this paper relates to the development of pH indicator from Phyllanthus fruit extract and the establishment of its effectiveness.

II. LITERATURE REVIEW

pH Measurement

The term pH means power of hydrogen or hydrogen ion exponent was first used by the Danish biochemist Søren Peter Lauritz Sørensen in 1909. It is a measure of the acidity and alkalinity of a substance. Specific pH value gives the same relative point of reference and is defined in terms of the hydrogen ion activity which equals the negative logarithm of the hydrogen ion activity [7]. The activity is referred to the effective concentration of the hydrogen ion in the solution. Litmus paper is the most common pH indicator used in the laboratory. It is a paper that has been treated with natural dyes obtained from lichens *Roccella tinctoria* [8] and is usually sold in strips. Red litmus paper will turn red in acid and blue in basic substances. The pH paper strip is used in the same way as the litmus paper but comes with a color-coded reference indicating the pH level when the paper turns a certain color. This is due to the presence of flavin. Flavin is an anthocyanin that is water-soluble and turns red in acidic solution, greenish in basic solution while purple in neutral solution [9]. Another accurate pH measurement tool consists of three parts: a pH measuring electrode which is a hydrogen ion sensitive glass bulb, a reference electrode, and a high input impedance meter that displays the results directly. Modern technology offers sophisticated means of measuring pH from the group of wireless, handheld, portable, and benchtop pH meters which are commercially available at a high cost. Wireless pH meter used to remotely monitor pH with that easily streams data to a mobile device. The portable pH meter combines advanced digital processing technology and software design.

Measuring pH has significant importance in food quality and production which is used to produce products with consistent well-defined properties, efficiently produce products at optimal cost, avoid causing health problems to consumers, and meet regulatory requirements. pH is important in agriculture, biological process, and corrosion research [10]. In agriculture, determining the pH of the soil aids in the identification of the type of fertilizer to be used and the types of crops to sow. In the biological process, pH can adjust the medium in fermentation, enzyme hydrolysis, sterilization, etc. In corrosion research, measuring the pH of seawater is also a determining factor on the material to be used for building ships and submarines.

Natural Indicator

Major plant pigments include chlorophyll, carotenoid, carotene, xanthophyll, astaxanthin, flavonoid, aurone, chalcone, proanthocyanidin, betalain, betacyanin, betaxanthin, flavanol, acylated flavonoid, anthocyanin, glycosylated acylated anthocyanin, quinine, imine, polymethine, naphthoquinone, anthraquinonoid, indigoid, dihydropyran, diarylethene, and carotene are compounds responsible for the color property of parts of the plants.

The use of natural indicators can be an alternative for synthetic indicators due to the presence of these colored pigments that change in color with a variation of pH used in acid-base titrations to show sharp endpoints such as with *Combretum indicum* ethanolic extract found to be nearly closed with equivalence point by standard indicators for four types of titrations equivalence using methyl red, methyl orange, phenolphthalein, and mixed indicator [11].

The utilization of natural indicators is not only limited to chemistry experiments but it can be developed to formulate a pH test kit. Extracts from butterfly pea flower, roselle red flower, and dragon fruit peel can be used for effluent measurement and provide similar results produced by commercial pH test kit [12]. Also, the utilization of natural indicators serves a significant role in the food industry. Anthocyanin in dragon fruit skin (*Hylocereus costaricensis)* can be utilized as an indicator of the presence of formalin and borax in food [13]. The same with *Hibiscus esculentus* that is a better substitute for methyl orange and *Telfairia occidentalis* to phenolphthalein in research analyses [14]. *Tagetes erecta,*

Impatiens balsamina, *Tecoma stans*, white rose, and hybrid tea rose were found to give positive results at neutralization and are comparable with methyl orange and phenolphthalein [15]. *Quisqualis indica L.*, *Pentas lanceolate*, *Melastoma malabathricum L*, and *Impatiens acaulis* ethanolic extract also proved to be very close with an equivalence point obtained by standard phenolphthalein [16]. Kamias (*Averrhoa bilimbi L.*) flower extract was found to be highly acceptable as a substitute to pH indicating mean [17]. *Hibiscus rosa sinensis* flower sap's methanolic and aqueous extract shows very little variation in acid-base titration [18].

Phyllanthus

Phyllanthus multiflorus Willd is commonly known as a black-honey shrub that grows up to about 3m tall. The stems are hairy when young and the leaves are simple, alternate, and stipulate. The stipules are lanceolate and minute with petiole up to about 5mm long. The blade is elliptic, 1-5cm x 0.7 – 3cm, membranous, base obtuse, apex acute, and with 5-7 pairs of secondary nerves. The inflorescences are axillary fascicles. The calyx includes 5-minute sepals. The androecium includes 5 stamens. The ovary develops 3 bifid styles. The fruits are globose berries and about 5mm in diameter, dark purplish, and contain numerous minute seeds. Phyllanthus in Bangladesh and West Bengal is used to clean teeth and treat malaria. Extracts of the plant exhibited anti-diabetic, anti-inflammatory, analgesic, and anti-plasmodial activities [19]. The fruit, whole plant, and root of Phyllanthus contain gallic acid, ellagic acid, 1- *o*- galloyl-β-d-glucose, 3,6-di-*o*-galloyl-d-glucose, chebulagic acid, quercetin, chebulinic acid, corilagin, and isotrictiniin [20], niranthin, nirtetralin, hinokinin, and geraniin compounds [21], roseoside, and byzantionoside B [22].

III. METHODOLOGY

Experimental Method

The method is composed of the preparation of raw materials, standardization of solutions, calibration of Phyllanthus fruit ethanolic extract, testing for effectiveness, and development of color chart. The preparation of raw materials includes the steps of: collecting ripe Phyllanthus fruit which is bluish-black in color; washing; weighing; measuring of distilled water; crushing of Phyllanthus fruit; mixing with water; boiling the mixture; filtering the mixture; cooling down the filtrate; mixing the filtrate to ethanol- a mixture of sugar cane, wheat, and barley; soaking the filter paper strips; and drying. Calibrating and testing the effectiveness of the indicator comprises the following steps: dipping of an individual strip of paper in each solution; developing a color chart; and comparison to other pH measuring tools.

For standardization of solutions, different solutions measured with pH 1 to 14 were calibrated using the portable pH meter as shown in Table 1.

Table 1. pH Level of Different Solutions.

Solutions	pH
Hydrochloric acid	1
Acetic acid	2
Carbonic acid	3
Tomato juice	4
Black Coffee	5
Milk	6
Distilled water	7
Seawater	8
Sodium bicarbonate	9
Milk of magnesia	10
Dishwashing Liquid	11
Ammonia solution	12
Sodium hypochlorite	13
Sodium Hydroxide	14

Composition

Treatments in three different formulations as shown in Table 2 are composed of selectively hand-picked ripe Phyllanthus fruit which is bluish-black in color, distilled water, and carefully milled and fermented ethanol which is a mixture of sugar cane plant, wheat, and barley.

Table 2. Treatments of the Composition of Natural pH Indicator.

Composition	Treatment 1	Treatment 2	Treatment 3
Phyllanthus fruit	33%	29%	22%
distilled water	17%	29%	45%
Ethanol	50%	42%	33%

IV. RESULTS

Development of Color Chart

The best formulation of the study that produced distinctive colors for pH 1-14 is Treatment 2 comprises 29% Phyllanthus fruit, 29% water, and 42% ethanol as shown in Table 3, pH 1 resulted in color red; pH 2 dark red; pH 3 light red; pH 4 pink; pH 5 light brown; pH 6 light pink; pH 7 no reaction; pH 8 violet; pH 9 yellow-

green; pH 10 green; pH 11 dark green; pH 12 light green; pH 13 blue; and pH 14 light blue. It shows that the color reaction of Treatment 1 and Treatment 3 is indistinguishable. For Treatment 1, pH 5 and 6 are light pink; pH 8 and 9 are violet; and pH 10-12 are green. For Treatment 3, pH 1 and 2 are dark red; pH 3 and 4 are pink; and pH 5 and 6 are light pink.

Table 3. Color Reactions at Different Formulations.

Solutions	Color Reaction		
pH Level	Treatment 1	Treatment 2	Treatment 3
1	Red	Red	Dark Red
2	Dark Red	Dark Red	Dark Red
3	Light Red	Light Red	Pink
4	Pink	Pink	Pink
5	Light Pink	Light Brown	Light Pink
6	Light Pink	Light Pink	Light Pink
7	No reaction	No reaction	No reaction
8	Violet	Violet	Violet
9	Violet	Yellow Green	Yellow Green
10	Green	Green	Green
11	Green	Dark Green	Dark Green
12	Green	Light Green	Dark Green
13	Light Blue	Blue	Blue
14	Light Blue	Light Blue	Light Blue

Comparison of Results

Results of comparison of different pH measurement tools as shown in Table 4 revealed that the developed pH indicator is comparable with the existing pH measuring tools. It works the same with the popular line of compound pH indicators as it offers distinctive colors for each pH level.

Shelf-life Analysis

The developed pH indicator was stored in a room temperature and tested once every month for 5 months. The indicator can stay for a period of 4 months in the case of the present study. Results revealed that the storing of the developed indicator did not affect its effectiveness.

V. CONCLUSION

Natural pH indicators have been developed as an alternative to existing pH measurement tools. This study shows that Phyllanthus fruit can be used as a natural indicator. It can also be concluded that the developed product is comparable with the existing pH measurement tools such as pH meter and pH paper strips due to its distinctive color reaction in different pH levels. Most importantly, this study can be a reference to other research related to natural indicators.

Table 4. Comparison of Results of Different pH Measuring Tools.

Solutions	Color Reaction				
	Litmus paper		Paper strips	Phyllanthus indicator	Portable pH meter
	Red	Blue			
Hydrochloric acid	Red	Red	Dark Red	Red	1
Acetic acid	Red	Red	Red	Dark Red	2
Carbonic acid	Red	Red	Orange	Light Red	3
Tomato juice	Red	Red	Light Orange	Pink	4
Black Coffee	Red	Red	Yellow Orange	Light Brown	5
Milk	Red	Red	Light Brown	Light Pink	6
Distilled water	Red	Blue	Dark Yellow	No reaction	7

Seawater	Blue	Blue	Yellow Green	Violet	8
Sodium bicarbonate	Blue	Blue	Green	Yellow Green	9
Milk of magnesia	Blue	Blue	Dark Green	Green	10
Dishwashing Liquid	Blue	Blue	Dark Blue	Dark Green	11
Ammonia solution	Blue	Blue	Blue Violet	Light Green	12
Sodium hypochlorite	Blue	Blue	Blue Green	Blue	13
Sodium Hydroxide	Blue	Blue	Yellow	Light Blue	14

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Medical and Pharmaceutical Assistance in a Basic Health Unit in the Municipality of Mountain/ES during the Covid-19 Pandemic

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***Keywords*— Pharmaceutical care, Pandemic, COVID-19, primary care.**

***Abstract*—** *This study aimed to understand the role of pharmaceutical assistance in a basic health unit in Montanha/ES within the scope of the COVID-19 pandemic. The research was developed through an exploratory research, qualitative and descriptive in nature, having as a sample professionals working in Pharmaceutical Assistance (FA) in a Basic Health Unit in Mountain/ES. The results indicated that participants felt that providing care during the pandemic was challenging but rewarding. It was necessary to develop new skills related to PA, primary care and health care. Other skills mentioned by participants include remote communication, time management, resilience and the ability to work under pressure. It is concluded that pharmacists have adapted their existing functions and implemented innovations to existing work practices in order to face the challenges presented by COVID-19. Thus, it is clear that they faced the pandemic to the best of their abilities to ensure that Pharmaceutical Assistance services were uninterrupted as much as possible in times of critical need. misinformation during the COVID-19 pandemic, including the development of reliable and reliable pandemic-specific information resources for the general public.*

I. INTRODUCTION

COVID-19 is caused by the Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV-2) and has been recognized as a global pandemic. Since the first case was reported in Wuhan province, China, in December 2019, the virus has spread rapidly around the world, with a devastating impact on virtually every aspect of daily life (FREITAS; NAPIMOGA; DONALISIO, 2020).

As written by Palácio and Takenami (2020) in September 2020, COVID-19 had already infected more than 28 million people worldwide and resulted in more than 900,000 deaths. High infection and death rates have been reported globally in many European countries, having experienced some of the highest mortality rates in the world, including Italy, France and the UK.

In Brazil, health services across the country were severely affected by COVID-19, where access to hospitals and primary care was restricted (eg non-urgent elective surgeries, routine health checks and medication analyses) to ensure that adequate resources were available to deal with patients with COVID-19.

For many individuals with questions or health concerns related to COVID-19, pharmacists can be the first point of contact for reliable information and advice through pharmaceutical assistance (FA). In this sense, this study *starts* from the following question: *what is the role*

played by pharmaceutical assistance during the COVID-19 pandemic?

The hypothesis is that as health professionals, pharmacists can play a fundamental role during the pandemic, acting directly with the community, continuing to care for patients with chronic diseases and providing pharmaceutical assistance to patients in COVID-19. In addition, they can provide reliable information to prevent, detect, treat and control coronavirus infections. As a result, several challenges have emerged and innovative strategies are being adopted by pharmacists to overcome them.

To answer the question, this study aimed to understand the role of pharmaceutical assistance in a basic health unit in Montanha/ES within the scope of the COVID-19 pandemic. Specifically, the research also aimed at (i) knowing the attributions of pharmaceutical assistance, as well as the challenges and possibilities of its performance in confronting COVID-19; (ii) explore how PA services have adapted, responded to the pandemic and; (iii) reflect on the process of transformation of the pharmaceutical profession in a scenario of changes caused by the pandemic.

The research is justified in the fact that pharmacy is a very dynamic profession and the role of the pharmacist is improving with the expansion of the scope of services and the introduction of new subspecialties over time. Moving from drug dispensers to results-oriented, patient-focused care providers; pharmacists will have more responsibility and commitment to improve their knowledge and practices.

It is also relevant as it seeks to ensure evidence-based responses to future public health crises. This will help identify and share good practices, determine barriers and enablers to service delivery, as well as any lessons that can be incorporated into pharmacist training. In this context, it is expected that through the development of this study, the academic community, as well as society, will be able to understand that PA can contribute to the demands of health care during the pandemic.

II. THEORETICAL FRAMEWORK

2.1 THE WORLDWIDE PANDEMIC OF COVID-19

The new coronavirus was termed as severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2, 2019-nCoV) because of its high homology (~80%) with SARS-CoV. zoonotic associated with the seafood market in Wuhan, China. It was later recognized that person-to-person transmission played an important role in the subsequent outbreak (SILVA *et al*, 2021).

In December 2019, the disease caused by this virus was called COVID-19 and a pandemic was declared by the World Health Organization (WHO). Since then, it has impacted a large number of people around the world, being reported in approximately 200 countries and territories (PALÁCIO E TAKENAMI, 2020).

As written by Fernandes (2020), the SARS-CoV-2 virus mainly affects the respiratory system, although other organ systems are also involved. Symptoms related to lower respiratory tract infection, including fever, headache, dry cough, and dyspnoea, were reported in the initial case series from Wuhan, China.

Furthermore, according to Silva *et al*, (2020) some patients can progress to serious diseases, such as pneumonia, acute respiratory distress syndrome, multiple organ dysfunction and even death. It is widely recognized that the respiratory symptoms of COVID-19 are extremely heterogeneous. A growing number of patients with serious illnesses continued to succumb around the world. Epidemiological studies have shown that mortality is higher in the elderly population and the incidence is much lower in children.

There are no proven effective treatments against COVID-19 and widespread efforts are being devoted to developing a safe vaccine. Thus, the population must follow recommendations to reduce the transmission of SARS-CoV-2, including social distancing, use of masks and strict hand hygiene (BEZEERA *et al*, 2020).

While millions of people are in their homes to reduce the risk of transmitting the infection, health professionals are on the front line against COVID-19. These professionals are committed to ensuring that the population has access to health services and to minimizing the adverse impacts of the pandemic (MEDEIROS, 2020).

Following public health measures to suppress the spread of the virus (eg social distancing, use of face masks), restrictions have now been eased to some extent in many countries (FERNANDES, 2020). However, according to Daumas *et al*, (2020) an additional challenge for health services is to deal with the lack of information, as well as guidance without scientific evidence.

For Ferreira and Andricopulo (2021, p. 13)

> The search for simple solutions without scientific proof seems to have no limits. Without confirmed efficacy, a "covid-19 kit" containing azithromycin, ivermectin and chloroquine or hydroxychloroquine has been

> distributed in some states for the prevention or treatment of people with early symptoms of the disease.

Current medical management is largely favorable, with no targeted therapy available. Several drugs, including lopinavir-ritonavir, remdesivir, hydroxychloroquine and azithromycin, have been tested in clinical trials, but none of them has proven to be definitive therapy yet (MELO *et al*, 2021).

2.2 THE RELATIONSHIP OF PRIMARY CARE AND PHARMACEUTICAL ASSISTANCE

With regard to primary care, the Brazilian model uses 'mannealing', a process of assigning patients to a primary health care team, as a central strategy for providing quality care (GIOVANELLA, 2018).

In the study by Pereira and Barcellos (2004), it is described that every individual within the Family Health Center (PSF) is assigned to a Family Health Strategy (ESF) team, which is responsible for providing services to up to 1,000 families. located in a specific geographic area. This geographic method helped to avoid gaps in population coverage and overlap between ESFs. Continuity of care is also achieved, as each ESF serves each patient over time.

Family health teams include a physician, nurse, and four to six community health workers to address needs that range from community to facility and from prevention and surveillance to medical treatment. In coordination with the ESF's basic clinical team, separate primary health care support teams provide additional care to populations (ESCOREL *et al* , 2007). These support teams may include nutritionists, social workers, psychologists, obstetricians and gynecologists and pharmacists.

The Family Health Program, with the ESFs at its heart, is widely considered a successful and cost-effective reform. This multidisciplinary ESF model improved accessibility, coverage and continuity of care for Brazilians. A bibliographic study by Arantes *et al* , (2016) pointed out that the wide range of services offered by the team promotes prevention and well-being and resulted in a dramatic change in the way Brazilians interact with the primary care system. health.

Community health agents (CHA) play critical roles as key members of the ESFs. According to Faria and Paiva (2020), agents focus on primary and secondary prevention, including the promotion of a healthy lifestyle and health education, and screening programs for early detection of hypertension, diabetes and other prevalent conditions. CHWs also serve as a first point of access to services, connecting patients to needed preventive and curative treatment.

Despite its challenges in achieving scale in urban areas, the model has been effective in addressing health disparities, with the most dramatic improvements seen in the poorest municipalities (VIANA & DALPOZ, 2005). Overall, the PSF has led to substantial improvements in service coverage and health outcomes over the past 20 years, including Pharmaceutical Care. According to Araújo *et al*, (2008, p. 613):

> pharmaceutical care is a large area composed of at least two distinct but complementary sub-areas, that is, one related to drug management technology (guarantee of access) and the other related to drug use technology (correct use of the drug), and pharmaceutical care can be considered as a specialty of the technology of drug use and private to the pharmacist.

Therefore, in the scope of primary care, pharmaceutical care represents a patient-centered approach, in which pharmacists, in collaboration with other health professionals, are responsible for the drug therapy of patients. Patient care produces better results when a comprehensive approach is used, which encompasses all relevant health professionals (GELBCKE; MATTOS; SALLUM, 2012).

It is noteworthy that Law No. 8080/90 attaches special importance to pharmacotherapeutic procedures and activities that involve or are directly linked to pharmaceutical services (ANDRADE; PONTES; MARTINS JUNIOR, 2000).

This involves a drug supply cycle at each constituent stage: selection, scheduling, acquisition, storage, distribution and a dispensing based on the concepts of drug safety and therapeutic efficacy; usage monitoring and evaluation; provision and dissemination of drug information; and the continuing education of health professionals, patients and the community to ensure the rational use of medications (BRASIL, 2002).

In Brazil, health professionals maintain a fragmented view of services related to medications, because, although the purchase, storage and dispensing are controlled, the pharmacist is excluded from other important stages of the PA cycle, something that does not characterize a job. teamwork (MARIN *et al*, 2003).

It is important to consider that, according to Franco (2007), a team is a group of individuals who work together to produce products or provide services for which they are mutually responsible. The team's shared goals are manifested by the mutual and cordial interaction of team members, and the roles of each professional on the team are mutually interdependent and accountable to enable the achievement of established goals.

Thus, as a team, the pharmacist working with the AF ensures that each of the patient's medications is evaluated to determine if it is appropriate, effective, safe and if the patient is able to take the medications as expected. The service can be provided in different service environments; pharmacies, primary, secondary and tertiary care (ARAÚJO *et al*, 2008).

In a historical perspective,

> in the first 10 years of the sus, af was characterized by the transition between the extinction of the ceme and the validity of the pnm. in this initial trajectory, the basic pharmacy program was reprinted, marked by the sending of medicine kits to small municipalities [...] between 1998 and 2007, principles coherent with the sus were identified, with a focus on the organization of af based on decentralization and in the search for resources to access medicines (BERMUDEZ *et al*, 2018, p. 1939).

It is noted that the implementation of pharmaceutical care at different levels of health care has been taking place for several decades. Many works were completed by pharmacists at this time, even before the first descriptions. However, according to Vieira and Zucchi (2013), even if reliable data have pointed out that PA can lead to progress in health and therapy outcomes with good cost-benefit ratio, and positive impact on health-related quality of life outcomes , implementation was not as fast as might be expected.

Lack of time and attitudes/opinions of other professionals, clinical education, communication skills and remuneration were reported as barriers to implementation. In this regard, little communication between pharmacists and physicians on clinical issues is reported, although pharmacists are taking on a greater role as primary care providers to patients (COSTA *et al*, 2017).

One of the challenges of PA is related to the fact that this shift in focus also implies that the pharmacy curriculum must be adapted in order to provide pharmacists with new knowledge and skills (ALMEIDA; MENDES; DALPIZZOL, 2014). Furthermore,

> [...] changes in pharmaceutical education, proposed by the 2002 DCNs, have already been discussed and recommended internationally since 1997, both by the World Health Organization (WHO) and by the International Federation of Pharmacists (FIP). However, Brazil has peculiarities that hinder the implementation of an adequate curriculum for the training of pharmacists, including the complexity of the organization of the SUS and the breadth of the professional scope (SOUSA; BASTO; BOGO, 2013, p. 132).

However, since the introduction of PA into the pharmaceutical education curriculum, there has been debate about its definition. Probably, differences in health systems between different countries are responsible for this, as well as problems related to resources, education requirements and skills development (COSTA *et al*, 2017).

Patient care produces better results when a comprehensive approach is used, including all relevant health professionals (LIMA *et al*, 2018). This is because the best and most profitable results for the patient are achieved by professionals who collaborate at work, learning, mapping a prognosis and generating new ideas.

It is in this context that the research by Araújo *et al*, (2017) reports that a multidisciplinary team, each team member implements a specialized part of a care plan and the main objective of multidisciplinary teams is to group a series of views on the care of people and make optimal use of the knowledge and skills of many professionals and sectors.

2.4 THE ROLE OF THE PHARMACIST DURING THE PANDEMIC

The pharmacist profession has played an important role in the frontline health response to COVID-19. According to Amorim *et al*, (2021) pharmacists

performed a number of roles and activities in response to the pandemic, which include providing public health advice, information and education on personal and environmental hygiene, and making appropriate referrals in suspected cases of COVID-19 .

Specifically in primary care, primary care pharmacists have also taken on a variety of roles and activities covering disease prevention and infection control, providing patient care and supporting other health professionals, as well as obtaining and ensuring adequate supplies of medications. (TRITANY AND TRITANY, 2020).

As the most accessible health workers during the pandemic, pharmacists have shown that they can deftly assist in the public health response to COVID-19, maintaining continuity of health services and taking on additional responsibilities to help relieve pressure in other areas of the service. health, such as general practice (PASSOS; CASTOLDI; SOLER, 2021).

According to Fuzari *et al*, (2021) they have become an information center on coronavirus infection, both for having a direct role in combating misinformation and for helping patients to select healthy behaviors.

Specific emerging issues also arise with media exposure, such as the provision of evidence-based information about the safety of ibuprofen and certain antihypertensives along with the COVID-19 threat. The role of pharmacists during the COVID-19 pandemic in dispelling inaccurate health information, for example, the dissemination of evidence-based regulatory safety information on hydroxychloroquine was exemplary (SILVA AND ARAÚJO, 2020).

Although the COVID-19 crisis resulted in considerable difficulties for many in the wider community, it also showed how PA can be integrated as a bridge between health care and broader community services, as the contribution of PA Pharmacy can ensure continuity of drug supply and early identification and treatment of adherence barriers and other medication-related problems (RUBERT *et al*, 2020).

In addition to the pharmacy staff, several of its vulnerable patient groups, those most in need of continuum of care, are facing additional risks associated with the COVID-19 pandemic. Elderly people, under the instruction of social isolation, depend on delivery services and may miss opportunities to discuss problems related to medication (FUZARI *et al*, 2021).

However, virtual and telephone consultations have become common, especially for vulnerable patients. In the study by Almeida *et al* , (2021) the process of adapting teleconsultations in the pharmaceutical care clinic of the pharmacy school of the Federal University of Paraíba is described, in which pharmacists implemented systems to dispense medication in advance to minimize waiting times and duplicate queries. In case-by-case examples, such as palliative care and for vulnerable patients, medication-related needs were managed in advance. All these actions are intended to reduce non-essential medical and pharmaceutical consultations, maintaining continuity of care and facilitating social distance whenever possible.

It is also important to consider that in vaccination, pharmacists are key players. According to the opinion of the Ordem dos Farmacêuticos (2020), decades of experience of these professionals in vaccine studies have shown that, with increased accessibility, pharmacists have helped to improve immunization rates, updating patients on vaccinations and reaching those who, otherwise, they would not have the opportunity to be vaccinated.

For Farinha and Rijo (2020), although the scope and nature of their clinical functions and activities vary across environments and jurisdictions, the focus of pharmacists is to provide effective pharmaceutical care to improve patients' health outcomes and quality of life.

Thus, the COVID-19 pandemic is placing extraordinary and sustained demands on health systems and care needs persist, in which pharmacists have had to adapt and adopt professional role changes amid a dynamic health system architecture, all on top of already scarce resources (PASSOS *et al*, 2011).

III. METHODOLOGY

This study was developed through an exploratory, qualitative and descriptive research. Qualitative data were sought to obtain a deeper and richer understanding of the factors related to the COVID-19 pandemic that impact changes in knowledge, attitudes, behavior and competence of the pharmacist working in PA.

The study population comprises the city of Montanha/ES, having as a sample professionals working in Pharmaceutical Assistance in a Basic Health Unit. All potential participants were informed about the study. Confidentiality and anonymity were ensured, and data were collected by signing the Informed Consent Form - Informed Consent Form (Appendix 1). Data were collected from April 26 to 29, 2021 through semi-structured interviews.

The study included pharmacists who regularly exercised in PA in the UBS in Montanha/ES. Professionals who work in functions other than PA, or professionals

outside the city of Montanha/ES, as well as participants who refused and/or did not sign the consent form were excluded from the study.

Data were analyzed using an inductive qualitative approach through content analysis with the aim of helping to understand the meaning of complex data through the development of discussion of the areas of expertise. Bibliographic research provided a systematic and objective means of making valid inferences from theoretical models to describe specific phenomena pointed out by the research. Confirmability was established by the objectivity and neutrality with which the data were treated.

IV. RESULTS AND DISCUSSION

Qualitative data were obtained from 03 pharmacists of a Basic Health Unit in the city of Montanha/ES, representing a range of clinical contexts, specialties and experiences in response to aspects of protection, preparation and planning during the ongoing pandemic. The sample data are organized in table 1.

Table 1 - Sample characteristics

Identification	Age	Formation	Time experience
EGSP	45	Degree in Pharmacy/Postgraduate in Public Health.	1 year and 2 months
TPD	33	Degree in Pharmacy/Postgraduate Degree in ESF.	2 years
ASS	37	Degree in Pharmacy/Postgraduate degree in Clinical Pharmacy with Pharmaceutical Care.	3 years and 4 months

In data collection, a series of prevention and mitigation measures for the continuity of PA services in the units where they were surveyed were described. This included adopting social distance, increasing hand hygiene and hygiene practices. Facilities have been reorganized to ensure limited staff and patients in clinical and office spaces, as well as waiting areas.

In that unit, patients received protective masks when entering clinical facilities. Participants noted that sanitizing chemicals, wet wipes, and personal protective equipment (PPE) were not in adequate stock at the start of the pandemic. In addition, they reported being unsure about how to effectively use PPE, which in several cases was attributed to a perception of lack of training.

"The personal protective equipment was not enough and not always adequate. They weren't of sufficient quality either... We didn't know how to use personal protective equipment" (ASS).

The description of being actively involved in the direct education of patients and members of the public about social distancing, the correct use of PPE and the prevention of the dissemination of COVID-19 was unanimous. This included verbal counseling, provision of information through social media and the development of educational material. The provision of advice on analgesic use in COVID-19 was frequently mentioned. Some participants, however, described the challenges they faced in educating the public.

"They thought we were overreacting. And some of them even said to me, "Why are you spreading panic?" I replied: "I am not spreading panic; ... Everyone must act according to these rules". But you know, they didn't perceive it as a threat. They just perceive it as an additional burden or something unnecessary" (EGSP).

Participants described a range of activities related to preparing for COVID-19. This included measures to ensure effective response systems were in place, adjusting the physical layout and infrastructure, including risk stratification, pharmacist deployment in clinical settings, adjusting working hours, staff leave, testing team for COVID- 19 and using health students to help with services.

EGSP and TPD participants described a redistribution of the pharmacy team from other areas of the UBS. However, TPD reports not having received any training prior to its implementation; in his words: *"I was upset that I didn't have any training to deal with the changes in the way I work. Plus I was the only one at the clinic who was still working remotely from home. I felt alone."*

It is important to consider that, in parallel with changes in pharmaceutical practice, according to Moreira; Sousa; Nóbrega (2020) high levels of anxiety and stress among pharmacists are recently highlighted by the pharmaceutical regulator due to the increased workload, the threat of infection, patient aggression and the financial implications of the pandemic. Thus, as demand for pharmacy services increases during the pandemic, pharmacy staff are at risk of mental breakdown.

The three participants stated that they had their working hours adjusted, including a reduced number of days, but more hours or alternate working days. However,

ASS reports that he had his annual vacation cancelled; in his words: *"Not taking a vacation would only cause a lot of illnesses and things like that. So the days I got on maternity leave were good in terms of maintaining resilience."*

However, it is important to consider that adjustments to the hours of operation of the UBS pharmacy were allowed by the government, which allowed them to operate limited hours to minimize wear and tear on employees. However, the three participants agreed that in the context of PA and primary care, this caused problems in the provision of medication to patients.

In this regard, Martins and Reis (2020) report that pharmacists were assigned an essential service and should, whenever possible, remain open during the pandemic to meet the population's pharmaceutical care needs. His practice had to adapt significantly, but the pandemic also drew attention to the case of the long-awaited evolution of the professional role.

Although participants noted that the team's tests for COVID-19 were not available in the early stages of the pandemic, the situation was perceived to have improved over time. According to ASS, *"We didn't have any tests. So, nobody knew about the situation…… and it didn't allow us to really measure the risks and benefits of our interventions [preventive measures]." However, over time we started to receive these tests.*

Lack of testing was not the only obstacle reported by participants, as all three respondents agree that there was a shortage of medical supplies during the initial phase of the pandemic; and mentioned the loan of shares of health facilities in the municipality.

"We had a brief moment where acetaminophen was a problem because they used it a lot for corona patients [COVID-19] ... but they managed to distribute it from the main pharmacy ... I needed to call them every day to ask for it" EGSP

Importantly, participants described ordering drugs such as hydroxychloroquine for the first time and this led to procurement challenges. Rationing of drugs, as well as PPE and disinfectants, was implemented at all stages. In addition, AF participants described the high demand for repeat prescriptions and over-the-counter pain relievers, vitamins, particularly vitamin C and products that claim to boost the immune system. Temporary restrictions were implemented to resolve the situation.

EGSP and ASS participants described repackaging larger packages into smaller packages to ensure equitable supply. According to them, they were allowed to extend the supply of repeat prescriptions without the need for additional authorization from the prescriber. Therapeutic substitutions were often performed due to supply problems in all environments.

"People wanted the same brand and we ran away. When the pandemic started, people were buying 10 packs or 100 pills of acetaminophen per person. In some pharmacies in the city, each person could buy only 2 packs of medicines and people didn't understand why...Patients were shocked at first [about the therapeutic substitutions for prescription drugs], but later they were very cooperative".

Participants described the enormous impact of COVID-19 on routine clinical practice at UBS. In addition, they reported that they could no longer provide blood pressure, temperature, oxygen saturation and cholesterol measurements and had to counsel patients on the use of continuous medications, specifically, patients with comorbidities. Reductions and adjustments to routine activities, such as medication use reviews and medication reconciliations, were noted and many were conducted over the phone.

"I used to do home inspections or see patients at the UBS and they often brought their medication. I was a little pessimistic to begin with. I thought that was not how medication review was done. But actually, it's doing great over the phone. People can explain their symptoms very well over the phone, have their medications on their side, and are surprisingly open about sensitive issues." TPD

Study participants further noted that the cancellation of routine clinical services created difficulties in ensuring that patients received adequate monitoring and follow-up.

Remote forms of communication, including electronic messaging services (Whatsapp) were widely used by participants to communicate with patients and other healthcare teams. However, they described that online platforms were overloaded. Remote communications were considered to have caused problems in communicating with patients with low levels of health literacy, as well as elderly and disabled patients, those without access to online communication resources.

As reported by EGSP, *"many patients are elderly, have hearing problems, have vision problems, do not understand what you say, especially when you wear a mask and cannot see your lips. So I had to write what I wanted to say."* Still on the remote form of care, it is reported that they were less effective in providing recommendations to physicians and some needed intensive follow-up to ensure that their advice was accepted by physicians.TPD reports: *"I noticed that the acceptance rate of interventions decreased. I really had to follow up*

with the patients to make sure the interventions were accepted. This took more time."

A similar study by Fuzari (2021) suggests that pharmacist-led telemedicine services can improve clinical outcomes in patients with chronic diseases and effectively provide public health services such as vaccinations, smoking cessation, hypertension management and adherence and counseling medicated. As many participants in this study identified that there will be greater use of remote communications in the future, healthcare systems should consider investing in digital communications and telemedicine platforms in the context of clinical pharmacy services.

Regarding the work opportunities, the experience at the UBS under study shows that the role of the pharmacy was defended, as well as becoming a source of information for physicians. Two participants (ASS and TPD) reported providing information to physicians during the pandemic, researching and evaluating guidelines, particularly regarding treatments with experimental drugs, including hydroxychloroquine and ivermectin. Therefore, they described that the pandemic offered the opportunity to showcase their experience as pharmacists.

"Doctors see me as someone who provides information about medications and, of course, critically assesses the importance of scientific knowledge, [for example] what is known about hydroxychloroquine etc." (SSA) *"[...] although clinical pharmacists are not recognized enough, I think this period may end with better recognition for clinical pharmacists and pharmacists as drug specialists"* (TPD).

However, not everyone agreed that pharmacists were well recognized. The EGSP participant felt that she was left out of care and planning activities during the initial crisis phase. According to her, *"The first two weeks were very unsettling. I felt like I was in some sort of identity crisis. I felt that we [primary care pharmacists] were useless, we didn't need it anymore. Everyone was working 24 hours on the front line, who cares about my job? But it turned out to be different, at least for patients. We developed protocols to deliver care remotely and patients really appreciated that."*

All three participants reported feeling proud to serve their community and country in this time of need. They considered this a professional and ethical responsibility. In the words of ASS: *"I felt this as my professional and human responsibility. I think it was something I couldn't even negotiate, I felt it was my responsibility".*

Furthermore, all participants felt that providing care during the pandemic was challenging but rewarding. It was also mentioned that they felt they were able to develop new skills related to PA, primary care and health care. Other skills mentioned by participants include remote communication, time management, resilience and the ability to work under pressure.

It is evident that pharmacists have adapted their existing roles and implemented innovations to existing work practices in order to meet the challenges presented by COVID-19. Thus, it is clear that they faced the pandemic to the best of their abilities to ensure that Pharmaceutical Assistance services were uninterrupted, as much as possible, at a time of critical need.

V. CONCLUSION

This study of pharmacists' views and experience around prevention, preparation, and response to COVID-19 identified the many contributions of pharmacists to patient care and the education of other healthcare professionals and the public.

In a matter of weeks, the role of the pharmacist has evolved considerably. Although it was a very challenging and stressful period, PA services were recognized as frontline and essential. The need for crisis has led to the expansion of professional roles, responsibilities and significant adaptation to care models. In addition, pharmacists will play an important role in continuing to combat misinformation during the COVID-19 pandemic, including the development of reliable and credible pandemic-specific information resources for the general public.

In this sense, the study points out that the main areas of contribution of pharmaceutical care include direct clinical care for patients with COVID-19; collecting and evaluating evidence to inform patients and healthcare professionals; ensure the uninterrupted supply of medicines in the community through the effective procurement, planning, distribution and supply of medicines and making therapeutic substitutions when necessary; provision of clinical pharmacy services to high-risk populations; and the adoption of a new digital communication with healthcare professionals and patients.

Thus, the government and should control facilitators and address barriers to the provision of pharmaceutical care services, as reported in this study. Future research should include outcome assessments to examine the effectiveness of adapted and new services in the context of the pandemic, including remote PA services.

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Comparative Analysis of Covid-19 Cases in the World According to their Human Development Index (HDI)

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Abstract *— In 2019, China's Centers for Disease Control and Prevention reported a new coronavirus called SARS-CoV-2, responsible for respiratory infections and a series of pneumonia cases in Wuhan (China). Such an outbreak eventually turned into a pandemic. This study aims to comparatively analyze the cases of Covid-19 in the world according to their population base and human development index (HDI). Methodology: 189 countries were analyzed, verifying data such as HDI, population, number of deaths per Covid-19, the death rate per 1000 inhabitants, the death rate per 1000 cases, and the number of patients retrieved. Conclusion: Countries with the highest HDI recorded the highest number of deaths and cases. However, they had the highest number of recovered patients and the lowest death rates per 1000 cases.*

I. INTRODUCTION

In 2019 the entire world was faced with a new disease when China's Centers for Disease Control and Prevention reported a new coronavirus called SARS-CoV-2 and reported the first stage of an outbreak, which the World Health Organization called COVID-19(GUAN et al., 2020b; ZHU et al., 2020).

Coronaviruses are considered RNA viruses and cause respiratory infections, ranging from a simple cold to more severe illnesses such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS) (FEHR; PERLMAN, 2015).

This new coronavirus gives rise to a disease popularly called COVID-19, and it was the cause of a series of pneumonia cases in Wuhan (China). However, there are still many details to be clarified since we still don't have more accurate information on the mechanism of SARS-CoV-2.

However, it is known that the virus is highly transmissible and causes an acute respiratory syndrome that varies from mild cases – about 80% – to very severe cases with respiratory failure – between 5% and 10% of cases. Furthermore, its lethality varies mainly according to age and associated clinical conditions(MCINTOSH, 2021).

Since then, several institutions have been updating the numbers on the pathology practically in real-time. The website created by the Johns Hopkins University and by the World Health Organization are examples of this disclosure, releasing daily reports on the pandemic, on its evolution, and also describes the main changes that occurred related to the day before(CANDIDO et al., 2020; WORLD HEALTH ORGANIZATION – WHO, 2020).

A study by Maciel, Castro-Silva, Farias (2020) in Ceará demonstrated a direct and significant correlation between the human development index (HDI) and the incidence rates of COVID-19.

Specialists and scholars already describe that the impacts will be medical, epidemiological, and other aspects, such as social, economic, political, cultural, and historical (IPEA, 2020; MATTA et al., 2021).

The use of the HDI in measuring the performance of countries serves as a thermometer to assess the effectiveness of actions. This research intends to evaluate the influence of the HDI of different countries in confronting the Covid-19 pandemic, assess the numbers of cases and deaths. We will use the HDI and the policies to fight the pandemic, comparing the different countries in the world. Therefore, the study's general objective is to comparatively analyze the cases of Covid-19 in the world according to their population base and HDI. The specific objectives are to verify the relationship between the HDI and its applicability in fighting the pandemic in the world, raise country indexes of Covid-19 death and active case numbers, and correlate the HDI with the number of cases of deaths.

The study is justified due to the need for more information regarding the number of deaths and active cases confirmed globally. In this sense, carry out a comparative analysis between the HDI and the correlation between the indicators. But unfortunately, the current scenario is still uncertain, and we still do not know the magnitude of the consequences of this pandemic to our society.

II. THEORETICAL FOUNDATION

HUMAN DEVELOPMENT INDEX - HDI

In the early 1990s, the United Nations (UN) launched the Human Development Index (HDI), which aims to verify the level of development of a country by using performance indicators. This index has become the best-known calculation of human development(TOWERS; FERREIRA; DINI, 2003). With the HDI, social characteristics came to have a crucial value in the concept of the human development assessment. Based on this index, the discussion relevant to socio-economic conditions became more converged with quality of life and the necessary needs of society, opposing the old measures in which the individual's economic sphere stood out against the social aspects relevant to it(TOWERS; FERREIRA; DINI, 2003).

The HDI is based on the notion of capabilities, that is, everything that a person can accomplish or do. In this sense, human development would have, as its broader meaning, the expansion not only of wealth but of the potential of individuals to be responsible for more valuable and valued activities and processes(UNDP, 1998).

Since 2010, when the Human Development Report turned 20 years old, new methodologies have been incorporated to calculate the HDI. Currently, three pillars constitute the HDI: health, education, and income.First, a long and healthy life (health) is measured by life expectancy. Second, access to knowledge (education) is measured by the average years of adult education, which is the average number of years of schooling received over a lifetime by people aged 25 and over; and by the expected years of education for school-starting age children, which is the total number of years of schooling a school-starting age child can expect to receive if the prevailing age-specific enrollment rate patterns remain the same during the child's life. Last, the standard of living (income) is measured by the Gross National Income (GNI) per capita expressed in constant purchasing power (PPP), in dollars, with 2005 as the reference year (UNDP, 2018).

The United Nations Development Program (UNDP) is linked to the UN and aims to combat poverty globally. It is a multilateral program and currently exists in 170 countries and territories, which work together to solve challenges in development and sustainability.

WITH UNDP's methodological change, the Atkinson Formula was no longer used, and a formula based on logarithms was used instead. However, in both forms of calculation, there is consistency with the philosophical foundations of the HDI, which is precisely to reduce the importance of the GDP per capita indicator - of a strictly economic character - to the detriment of other variables in the process of analyzing the stages of well-being experienced by the populations across the planet.

The current formula calculates the Yield Indicator through exponential numbers, and Sudhir Anad and Amartya Sen developed it. According to the 1999 UNDP Report, this method has several advantages. First, it does not discount income as intensively as in the formula previously used. Second, it discounts all income, not just income above a certain level. Thirdly (with the new formula), developing countries are not unduly penalized.

Moreover, as revenue grows more in these countries, their increasing income will continue to be recognized as a potential means for further human development(MACHADO; PAMPLONA, 2008)

It is worth remembering that the other indicators that make up the HDI, the Educational Indicator and the Longevity Indicator, remained the same. The gender-adjusted HDI ended up suffering changes in the measure. Its construction depends on some data of the GDP per capita calculation method and the Income Indicator.

One of the main obstacles in this plan concerns that the UNDP calculates the HDI involving 187 countries worldwide. In this case, it is not enough to make a simple survey of the parity ratio of these currencies with the US dollar. That is because the purchasing power of the dollar in each country can also vary greatly. For this reason, the UNDP adopts a concept developed by the World Bank called the PPC$ dollar (Purchasing Power Parity Dollar). In this way, this "currency" - which does not exist or circulates in the real world - serves to match the exchange rates in current dollars in different countries, allowing the subsequent comparison of their respective actual values at the international level.

According to the World Bank, "When calculating GDP and GDP per capita in US dollars for specific operational purposes, the World Bank uses a synthetic exchange rate, called the Atlas Conversion Factor. The Atlas Conversion Factor aims to reduce the impact of exchange rate fluctuations in comparing national income across the country. Therefore, to arrive at the PPP$ dollar, it is necessary to use a conversion factor called the Conversion Atlas Factor.

In 2000, leaders from 189 member states of the United Nations and international organizations agreed to support a strategy for global development known as the "Millennium Development Goals." They pledged to meet a series of goals set out in the Millennium Declaration. Reducing poverty to half of the population living in extreme poverty, identified in 1990, is one of theestablished goals to be met until 2015.

This target was set initially concerning an international poverty line of approximately one US dollar (US$1.00) per person per day, in 1985 US prices, which were then converted to national currencies using the parity exchange rates of purchasing power. Poverty is a complex social and economic phenomenon whose dimensions and determinants are numerous. Still, it can be defined as a set of income deficiencies, and its reduction requires a combination of economic growth and a decline of social inequality. Unfortunately, the Latin America and Caribbean region registers the highest level of social inequality compared to any area in the world(ECLAC; IPEA; UNDP, 2003).

SARS-Cov-2 - COVID 19

In 2019, the entire world was faced with a new disease whenChina's Centers for Disease Control and Prevention reported a new coronavirus called SARS-CoV-2. They announcedthe first stage of an outbreak, which the World Organization called Health as COVID-19(GUAN et al., 2020b; ZHU et al., 2020).

Coronaviruses considered RNA viruses cause respiratory infections, ranging from a simple cold to more severe illnesses such as Respiratory Syndrome Middle East (MERS) and Severe Acute Respiratory Syndrome (SARS) (FEHR; PERLMAN, 2015). This pathology is exceptionally infectious, and its predominant clinical signs include dyspnea (when there is impairmentlower respiratory tract), myalgia, fatigue, fever, and dry cough. Severe conditions are described as challenging to treat metabolic acidosis, acute respiratory distress syndrome, bleeding and coagulation dysfunction, septic shock, multiple organ failure, and death(CHEN et al., 2020a; ZHONG et al., 2020). In addition, it is believed that death may be associated with acute myocardial injury and/or sepsis(CHEN et al., 2020b; LI et al., 2020). However, the presence of one or more symptoms is inherent in the interaction of the host and SARS-CoV-2. In addition, thepatient's immune response is determinant for the phenotype of the pathology and may predetermine the progression to more severe proportions of Covid-19, which can range from 15.7% to 17.6% of cases(DU et al., 2020; GUAN et al., 2020a; TIAN et al., 2020; WANG; DING, 2020).

III. METHODOLOGY

The search in the databases was performed using the terminologies registered in the Health Sciences Descriptors created by the Virtual Health Library developed from the Medical Subject Headings of the US

National Library of Medicine, which allows the use of common terminology in Portuguese, English, and Spanish. The keywords used in Portuguese for the search in the databases were: As a tool to support the decision in the selection and prioritization of articles, they were considered a set of criteria deemed essential to represent the state of the art of the subject of research. In addition, this method has the following characteristics: (i) rigorous logic allows the acceptance of the method as a decision support tool; (ii) simple to be understood and applied with results that are easy to interpret.

The COVID-19 data survey, related to deaths, number of recovered patients, and the number of active cases, refer to the date of September 4, 2021. Such data were removed from the Johns Hopkins University and the World Health Organization websites, which disseminates COVID data in different countries worldwide.

Current Human Development Index (HDI) analyzes were obtained, provided through United Nations analyzes and reports. The basic methodology adopted in the construction of the HDI takes place in three specific stages. The first is to choose the indicators used and define how they will be divided between the dimensions. The HDI is based on four indicators, grouped into three dimensions(UNDP, 2020). The second step is to transform the various indicators into indexes whose values vary between zero and one so that higher values indicate better living conditions. Obtaining, from an indicator, an index with these characteristics requires: (i) choosing the worst and the best possible value of the indicator (these values can represent both the theoretical limits for the indicator and the variation range in which it is expected that this must fall for all practical purposes); and, (ii) based on the value observed for the indicator and the limits established for it, obtain the index through the formula.

Index = (observed value for the indicator - worst value) / (best value - worst value)

In this way, this expression guarantees that the index always remains between zero and one, at least as long as the value observed by the indicator remains within the established limits. Thus, the more the observed value approaches the value delimited, the better the index will tend towards the value one (better situation). In the opposite case, when the observed value approaches the worst deal, the index will tend to zero (worst scenario). As for the HDI categories, we can list four descriptions: low HDI when the index is below 0.500; mean HDI when the index is between (0.500 and 0.799); high HDI when the index is between (0.800 and 0.899); Very high HDI when the index is equal to or above 0.900(UNDP, 2020). O

Some other information base was chosen due to the analysis multifactorial analysis of this index, which includes the study of three dimensions and their respective parameters: health (life expectancy at birth); knowledge (adult literacy rate, combined primary, secondary and tertiary enrollment rate) and standard of living (Gross Domestic Product). Details on the calculation of the Human Development Index can be obtained from the Human Development Reports website.

IV. DATA ANALYSIS

First, the rate of deaths by COVID-19 per 1000 inhabitants was calculated using the following calculation: "number of deaths times 1000 divided by the country's total population". Afterward, the rate of deaths by cases of COVID-19 was performed, and the calculation was made: "the number of deaths times 1000 divided by the number of cases obtained in the country by COVID-19". And finally, the analysis of the number of cases per 1000 inhabitants was made through the calculation: "number of cases times a thousand divided by the number of inhabitants."

The term "death rate" is used to analyze the impact of a disease on the entire population of a specific region. In other words, it can be defined as Mortality rate = the number of people who die from a particular cause x 1000/total number of people in the population.

Data are presented as means. Data normality was assessed using the Shapiro Wilk test. To determine the association between continuous variables according to the HDI classification, the Kruskal-Wallis test was used (due to the non-parametric condition). The level of significance was set at less than 0.05. Data were analyzed using Stata software version 12.

V. RESULTS AND DISCUSSION

The HDI is classified as low, medium, high, and very high, ranging from below 0.550, from 0.550 to 0.699, from 0.700 to 0.799, and above 0.800. Ranges from 0.957 to 0.394 represent the HDI of Norway and Niger, first and last in the world ranking.

The ten countries that registered the highest numbers of cases globally were the United States, India, Brazil, Russia, United Kingdom, France, Turkey, Argentina, Iran, and Colombia.

When we compare the numbers of cases for the first and tenth, we see a difference of almost ten times, since the US registered 40,708,457 and Colombia 4,914,881 cases. Still, the number of deaths was quite different since the US registered 664,941 and Colombia 125,158, even with nine times fewer cases than the US, reported a quarter

of its casualties. It seems that there is an influence of the Human Development Index (HDI) in the figures presented since the US HDI is 0.926 and is in the seventeenth place. Colombia is in the eighty-third with 0.767.

In this sense, when we compare the two largest countries in the Americas, the USA and Brazil, we find different numbers. The first registered almost twice as many cases as Brazil, 40,708,457, against 20,856,060. Still, the number of deaths in the US was only 82,188, a difference that seems to be related to the HDI, as the first has a value of 0.926. It is in the seventeenth position in the world, as previously mentioned, and Brazil 0.765 in the eighty-fourth position.

As described in table 1, countries with the highest HDI recorded the highest numbers of cases, the highest mortality rates per 1000 population, and the highest case rates per 1000 population. Such results can be explained by the fact that they are populations that live in urban centers with higher population densities (TORKIAN et al., 2020; LIU et al., 2020) and because they have more organized health systems, providing adequate notification of cases and deaths (SHAHBAZI & KHAZAEI, 2020). Early diagnoses and better structuring of the health system, on the other hand, made it possible to record the lowest mortality rates per 1000 cases and the most significant number of people recovered (SHAHBAZI & KHAZAEI, 2020). Another factor contributing to these results was population-level immunization that occurred quickly in countries with these characteristics (SALLES et al., 2021).

Table 1 - Mortality rate per 1000 inhabitants, mortality rate per 1000 cases and case rate per 1000 inhabitants, number of cases, number of deaths, number of recovered, number of active cases and population, stratified by low, medium HDI, tall and very tall.

Table 1

	HDI				
	Low	Medium	High	Very high	P
Variables	upto 0.549	0.550-0.699	0.700-0.7999	≥ 0.800	
Mortality rate/1000 inhab	0.05	0.25	0.97	1.22	0.0001
mortality rate/1000 cases	26.87	24.57	24.47	14.43	0.0225
Case rate/1000 inhab	2.60	13.78	45.2	84.27	0.0001
Numberof cases	47,770	1,167,315	1,103,258	1,795,554	0.0001
numberofdeaths	1,061	16,870	34,393	31,602	0.0001
Numberofretrieved	38,686	1,118,312	968,281	1,495,462	0.0001
Numberofactive cases	6,468	32,133	94,319	206,075	0.0040
Population	2.80e+07	6.35e+07	5.57e+07	2.33e+07	0.1383

Values are averages; Kruskal-Wallis Test * for p≤0.05

In the Americas, when we compare the two largest countries (Brazil and the United States), we find that although the second has registered more than double the number of cases, 40,708,457, against 19,820,202, the number of deaths was similar, 664,941 and 582,753 in Brazil, demonstrating that the HDI seems to be determinant in the most effective health treatment of the population since the HDI of these countries are different, Brazil is 0.763 occupying the 84th and the United States 0.926, occupying the 17th position in the world.

VI. FINAL CONSIDERATIONS

While there is a need for further studies on the influence of the HDI on health care at the population level, our study found that although countries with a very high HDI recorded the highest number of cases and deaths, they

also recorded the highest number of recovered individualsand the lowest death rate per 1000 cases, demonstrating that the HDI appears to be a determinant for effective care in health care.

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Antifungal Susceptibility Pattern against Dermatophytic Strains Isolated from Humans in Anambra State, Nigeria

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***Keywords*— Antifungal drugs, Dermatophytic strains, Profile, Susceptibility**

***Abstract*—** *Dermatophytosis are fungal infection that involve only superficial keratinized tissue of the body, skin, hair and nails. Out of the 1000 cultured samples on Sabroud dextrose agar, 320(32%) isolates of dermatophytes were isolated. Susceptibility testing was performed using sterilized discs (6mm) prepared from whatman No. 1 filter paper, impregnated with different concentrations (25mg, 50mg, 100mg and 200mg) of terbinafine, itraconazole, ketoconazole, fluconazole and griseofulvin dissolved in 2% dimethylsuphuroxide (DMSO).These dermatophytes tested were susceptible to the five antifungal drugs used. The MIC of the quality control strains was within established ranges. However no resistance was recorded among the isolates. The isolates were less susceptible to griseofulvin and fluconazole with MICs ranging from 0.1 – 4.00 and 0.007 – 0.500ug/ml respectively. The MIC range for them respectively is between 0.06 – 0.125ug/ml for griseofulvin and 4.0 – 16.0ug/ml for fluconazole. Most dermatophytes 320(32%) were susceptible to terbinafine, since the MIC range was between 4.0 – 16.0 ug/ml. The study showed that there is no abuse of antifungal drugs in this area whose samples were used for the study.*

I. INTRODUCTION

Dermatophytes are the fungal pathogens of human and animals infecting the keratinized tissues of the body namely skin, hair, nails. Reactions to a dermatophyte infection may range from mild to severe as a consequence of the host's reactions to the metabolic products of the fungus, the virulence of the infecting strain or species, the anatomic location of the infection, and local environmental factors. (1). Dermatophyte infections are common disorders worldwide, and dermatophytes represent the prevailing type of fungi that cause infection of the skin and nails (2). These infections lead to a variety of clinical manifestations including *Tineacapitis*, *Tineapedis*, *Tineacorporis*, *Tineacruris*, and Majocchi's granuloma. These are typically superficial, involving the epidermis.

Dermatophytosis routinely affect individuals who are otherwise healthy, but people with compromised immune systems are particularly susceptible. Bizarre presentations and failure to respond to treatment should alert care providers to the possibility of an underlying immunologic problem (3).

In the last 50 years numerous drugs have been introduced for the treatment of superficial infections. The choice of

treatment is determined by the site and extent of the infection, the species involved as well as the efficacy, safety profile and kinetics of the drugs available. For localized non-extensive lesions caused by dermatophytes, topical therapies with an imidazole, allylamines, tolnaftate, morpholine derivates is generally used.

According to the World Health Organization (WHO) survey on the incidence of dermatophytic infection, about 20% of the people worldwide present with cutaneous infections (4) and affect people of all ages (5).

With very rare to no exception, oral antifungal therapy is needed to eradicate dermatophytoses. Griseofulvin remains a very effective treatment for many cases of *Tinea* infections caused by both *Trichophyton spp* and *Microsporum spp*, provided an adequate daily dose is administered and an appropriate duration of therapy completed which is commensurated with what is needed in each individual case. Unlike the newer oral antifungal agents, which include the allylamine agent, terbinafine, and the triconazoles, fluconazole and itraconazole, griseofulvin does not persist in cutaneous tissue for a prolonged time period after discontinuation, often necessitating a longer duration of therapy in many cases in order to achieve complete cure, Importantly, although use of oral griseofulvin in children was initially plagued by exaggerated fears of major side effects, such as hepatotoxicity and haematological disturbances, such side effects have proven to be very rare in both adults and children

Griseofulvin, terbinafine, fluconazole, and itraconazole, appear in the literature, including in approved product labelling, and may serve as a guide to the clinician. Importantly, PDA approval status in pediatric patients for *Tinea* infections with available oral antifungal agents does not necessarily encompass all clinical situations that the clinician may encounter in clinical practice. The risk of hepatocellular injury or haematological reactions with these agents is low in Overall, oral antifungal therapy has been safe and well tolerated in children with a variety of superficial and systemic fungal infections, including infants with dermatophytosis and other mycotic infections in some analyses and case reports. As with any other therapy, especially with a systemic agent, patient monitoring to assess both efficacy and safety is vital to the success of treatment and allows for adjustments in therapy if needed based on clinical response and/or suspicion of adverse reactions.

The decision to perform baseline and repeat serum transaminase testing during treatment of *Tinea* infections with fluconazole or itraconazole in children and infants is ultimately left to the decision of the clinician along with the patient (or parent legal guardian when applicable) on a case-by-case basis after discussion of the benefits versus risks of oral antifungal therapy. Additionally, in the presence of underlying major medical disorders of concern, the clinician may elect to monitor more closely. Therefore the purpose of the present work was to carry out invitro activities of antifungal drugs tested against dermatophytic strains isolated from Anambra State, Nigeria.

II. MATERIALS AND METHODS

2.1 STUDY POPULATION AND STUDY DESIGN

The study design is randomized cohort selected schools were randomly chosen to represent the L.G.As investigated. The study population was primary school pupils and staff members. All were examined and screened for the presence of lesions. Only pupils and staff members who had lesions were further examined and samples collected from the observable dermatophytic lesions. From the population, age group of 1 to 20 were 820 and age group of 21 and above were 180 . then 186 were male and 134 were female.

2.2 ANTIFUNGAL AGENTS TESTED

Antifungal agents used in this study included five (5) antifungal agents namely itraconazole (ITR) ketoconazole (KET) (Jansen), fluconazole (FLU) (Pfizer), terbinafine (TER) (Novertis) and griseofulvin (GRI) (Schering plough).

Fluconazole and ketoconazole were dissolved in sterile distilled water while the rest were dissolved in 100% dimethylsulpuroxide (DMSO) (Sigma-Aldrich). They were subsequently prepared as stock solution and stored at 25 ^{0}C temperature.

2.3 Collection of scalp scrapping

The scalp area with lesion were swabbed with 70% ethanol to remove surface contaminants. The scalp scrapping was taken from the border areas of lesions with the help of sterile scapel and placed between two clean microscopic slides in clean envelopes and transported to the laboratory. Moist exudates present on the lesions were also collected and examined. This was collected in clean envelopes and taken to the laboratory for examination.The lesions were scrapped with a sterile blunt scapel as well as the stubs of broken hairs were pulled with tweezers.

2.4 Collection of nail samples

Scrappings of infected nails or clippings of nail were collected by cutting nails that have been cleaned with 70%

ethanol. The scrapings were taken from the proximal to the distal end of the nail (6). The samples collected were labelled with the patients identification number, Age, Sex, Date of collection, Code of patient and location. Seventy (70%) ethanol, sterile uricol (Himedia) sterile scalpel/tweezers, L – shaped needle, Bunsen burner, cover slip, culture plates, glass slide, sterile razor blades, epilator forceps.

2.5 DIRECT MICROSCOPY

A potassium hydroxide mount was prepared and few drops of 10% potassium hydroxide was placed on a clean glass slide. The specimen was placed in the solution and allowed to stand for 30 minutes. A gentle heat was applied through a bunsen flame to facilitate softening and clearing of the keratin found in specimen.

2.6 CULTURE

Petri dishes containing dermatophyte test medium (Jinhua Noke Biotechnology Co., Ltd) were inoculated with scalp scraping and hair samples collected from infected pupils. This medium is a selective and chromogenic medium that permits the growth of dermatophytes which impacts reddish colouration on the medium. Plates were incubated at room temperature of 25 – 27 ^{0}C for up to 10 days during which the plates were observed for growth. Each fungal growth was sub-cultured on SDA to obtain a pure culture which was then stored in agar slants for further studies.

IDENTIFICATION: Colonial morphology on dermatophyte test medium was used for preliminary identification of the dermatophytes. Pure fungal colonies were also subjected to lactophenol blue staining for microscopy observation of their specialized hyphae and the morphology of their macronidia, micro conidia and chlamydospores.

2.7 SUSCEPTIBILITY PROFILE OF DERMATOPHYTES

2.7.1 STANDARDIZATION OF DERMATOPHYTES

Isolates were inoculated onto SDA plates and incubated at 25 ^{0}C for 7 – 10 days to obtain young actively growing cultures consisting of mycelia and conidia. A mycelial disc, 5 mm in diameter, cut from the periphery of the 7 – 10 days old cultures, was aseptically inoculated into tubes containing Sabouraud dextrose broth. The tubes were incubated at 25^{0}C for 48 – 72 hours. After incubation, the tubes were placed on a vortexing machine and vortexed for about 15 – 20 minutes to properly disperse the cells in the broth. The concentration of organisms in the tubes was standardized by adjusting to a concentration of about 10^4 CFU/ml, from 10^8 CFU/ml already prepared by Macfarland standard. Dimethylsulphoxide used as control in time kill kinetics, do not have any dermatophytic organism in it.

2.8 DETERMINATION OF ANTI DERMATOPHYTE ACTIVITY

Sterilized discs (6 mm) prepared from Whatman No 1 filter paper were impregnated with different concentrations (25 mg, 50 mg, 100 mg, 200 mg) of anti-fungal agent dissolved in 2% dimethylsuphuroxide (DMSO) and sterile distilled water. (7).

The discs of different concentrations of antifungals were placed on SDA plates seeded with 10^4 CFU/ml dilutions of inoculum preparation. The plates were prepared in duplicates, incubated at room temperatures for 7 days and average diameter zone of inhibition recorded. Discs impregnated with 2% DMSO and 100 ul/disc of clotrimazole were included as negative and positive controls respectively.

2.8.1 Minimum Inhibitory Concentration (MIC) and Minimum Fungicidal Concentration (MFC)

MIC: Two hundred milligrams/millilitre of the DMSO are serially diluted in sterile water. Different tubes containing different concentrations (25 mg/ml, 50 mg/ml, 100 mg/ml and 200 mg/ml) of the antifungals were inoculated with 0.1ml of 10^{-4} dilution of the test dermatophytes and incubated at room temperature for 7 days. These were done in duplicate and broth medium containing no antifungal was used as control.

MIC was recorded as the tube with the lowest concentration of antifungal that failed to show any visible macroscopic growth.

MFC: Loopful from tubes of MIC and the preceding tubes were inoculated on sterile SDA plates without drug supplements. The plates prepared in duplicates, were incubated for 7 days at room temperature and observed for growth. The lowest concentration of the tube dilutions that showed no visible growth on SDA plates was considered as the MFC as described by *(*7).

DATA ANALYSIS

SPSS version 21 was used for the statistical analysis of the data generated. Bar chart, tables, ANOVA, Chi – square and student t test were used in the representation of the data generated.

III. RESULTS

Out of the total of 1000 cultured samples on SDA, 320(32%) were dermatophytes. Out of this, 120(12%) isolates were *Trichophyton tonsurans*, 26(2.6%) *Trichophyton violaceum*, 18(1.8%) *Trichophyton verrucosum*, 73(7.3%) *Trichophyton rubrum*, 13(1.3%)

Trichophyton mentagrophytes, 6(0.6%) *Epidermophyton floccosum*, 56(5.6%) *Microsporum audounii* and 12(1.2%) *Microsporum canis*. *T. tonsurans* is the most prevalent in the Local Government Areas, with percentage of (37.5%).

Susceptibility pattern of dermatophytes against various antifungal agents and their MIC (ug/ml) are as shown on Table 1. The in vitro susceptibilities of 320 isolates of dermatophytes to ketoconazole, fluconazole, itraconazole, terbinafine and griseofulvin are summarized in Table 1. All the 320 isolates of dermatophytes tested were susceptible to the five antifungal drugs used in the study. The MIC 90 microgram per ml are shown, the data are presented as MIC ranges and were appropriate as the drug concentrations required to inhibit 90% of the isolate of each species (MIC 90). The MIC of all the quality control strains used was within established range.

Majority of the isolates had luxirant growth in five days but the result reflect readings recorded at 25^0C room temp. The various dermatophytic isolates were less susceptible to griseofulvin and fluconazole with MICs ranging from 0.01 – 4.00 and 0.007 – 0.500 ug/ml. The MIC 90 range for them respectively is between 0.03 – 0.125 ug/ml for griseofulvin and 0.06 – 0.125 ug/ml for fluconazole. Terbinafine was the most effective drug against all isolates of dermatophytes since MIC 90 range was between 4.0 to 16.0 ug/ml.

Fig 1 shows the susceptibility pattern of dermatophytic isolates against different concentration of the antifungal drugs.

All the 320 isolates of dermatophytes tested were susceptible to the five antifungal agents used. The isolates were less susceptible to griseofulvin and fluconazole. The order of in vitro activity is therefore terbinafine > itraconazole > ketoconazole > griseofulvin > fluconazole.

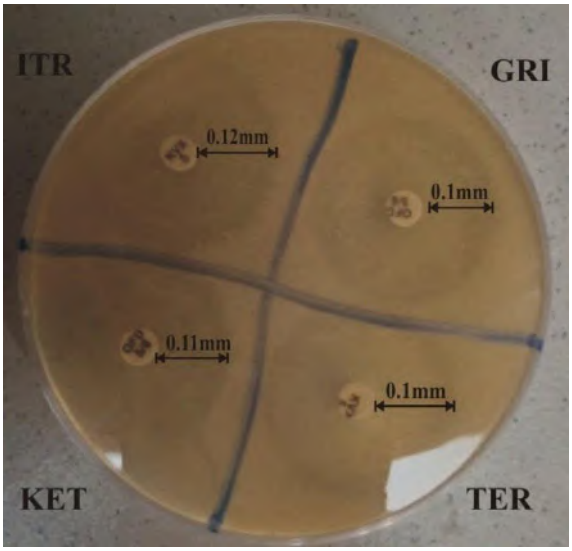
Table 1: Minimum inhibitory concentration (ug/ml) of the various antifungal drugs on dermatophytic isolate.

			MIC (ug/ml)	
Species (n^2)	**Antifungal drugs**	**Range (mm)**	**MIC**	**MIC 90**
T. tonsurans (120)	GRI	0.06 – 0.5000	0.01	0.03
	TER	0.25 – 16.00	1.00	4.00
	FLU	0.007 – 0.125	0.07	0.125
	KET	0.125 – 1.00	0.125	0.25
	ITR	0.50 – 16.00	2.00	8.0
T. violaceum (36)	GRI	0.01 – 1.00	0.01	–
	TER	1.00 – 8.00	1.00	–
	FLU	0.007 – 0.125	0.01	–
	KET	0.03 – 0.25	0.25	–
	ITR	0.25 – 8.00	0.50	–
T. verrucosum (18)	GRI	0.125 – 1.00	0.125	–
	TER	4.00 – 16.00	4.00	–
	FLU	0.007 – 0.125	0.007	–
	KET	1.00 – 16.00	2.00	–
	ITR	0.50 – 4.00	4.00	–
T. rubrum (60)	GRI	0.03 – 1.00	0.03	–
	TER	1.00 – 8.00	2.00	–

	FLU	0.03 – 0.25	0.007	–
	KET	0.125 – 4.00	0.125	–
	ITR	0.50 – 4.00	4.00	–
T. mentagrophytes (14)	GRI	0.01 – 4.00	0.01	–
	TER	0.06 – 64.00	2.00	–
	FLU	0.007 – 0.500	0.07	–
	KET	0.06 – 4.00	0.05	–
	ITR	0.125 – 4.00	0.50	–
M. audounii (54)	GRI	0.01 -0.125	–	–
	TER	0.50 – 2.00	–	–
	FLU	0.01 – 0.02	–	–
	KET	0.01 – 0.50	–	–
	ITR	0.25 – 1.00	–	–
M. canis (10)	GRI	0.03 – 0.125	0.03	0.125
	TER	8.00 – 32.00	8.00	16.0
	FLU	0.01 – 0.25	0.01	0.06
	KET	1.00 – 16.00	1.00	2.00
	ITR	2.00 – 16.00	2.00	8.00
E. floccosum (8)	GRI	0.01 – 0.50	–	–
	TER	0.50 – 2.00	–	–
	FLU	0.01 – 0.125	–	–
	KET	0.01 – 1.00	–	–
	ITR	1.00 – 2.00	–	–

NOTE: n^2 = (320 number of isolates tested); B± MIC for 50% of the isolates tested

KEY: GRI = Griseofulvin TER = Terbinafine FLU = Fluconazole KET = Ketoconazole ITR = Itraconazole



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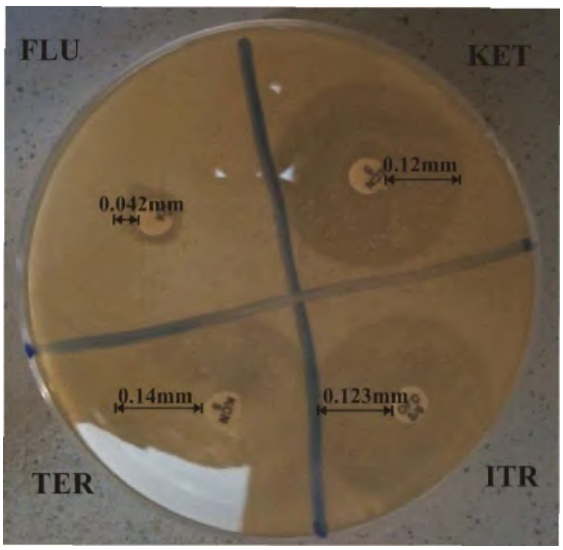

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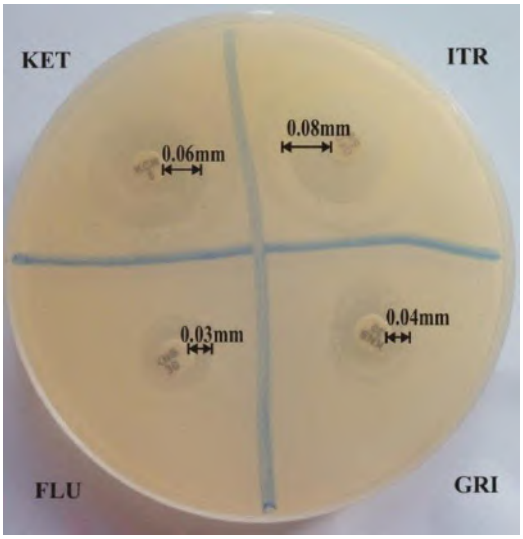

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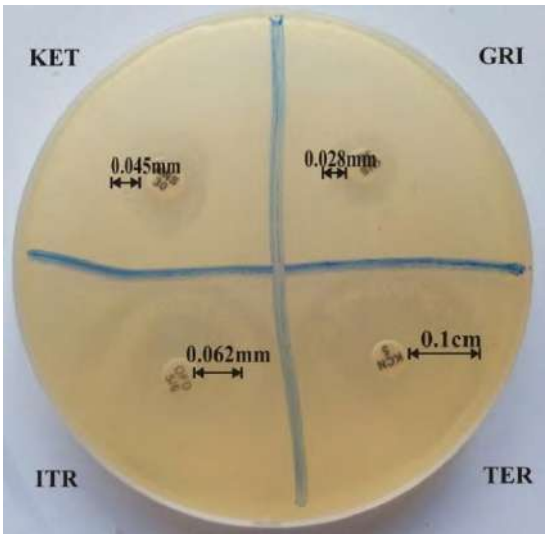

d.

KEY: ITR – Itraconazole TER – Terbinafine GRI – Griseofulvin KET – Ketoconzaole FLU – Fluconazole

Zone of inhibition

Plate 1: Zone of inhibition exhibited by various antifungal agent the dermatophytic isolates

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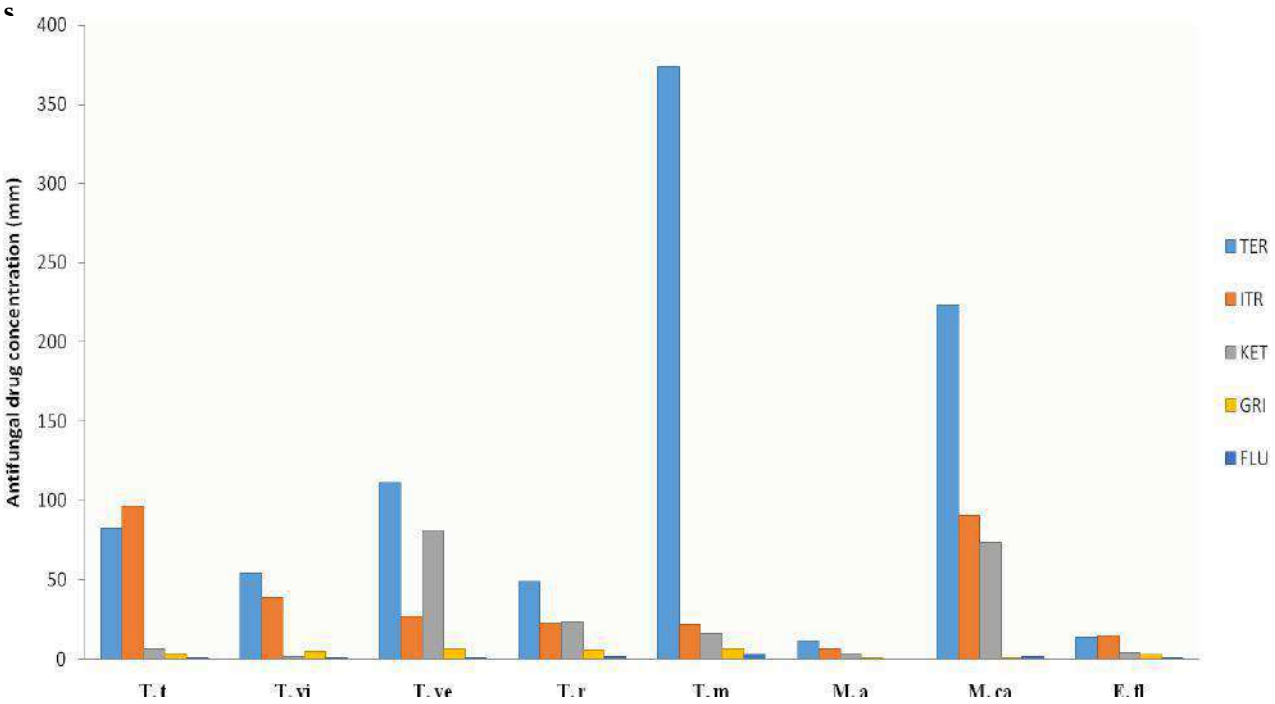

KEY

Dermatophyte species: T. t = *T. tonsurans,* T. vi = *T. violaceum,* T. ve = *T. verrucossum,* T. r = *T. rubrum* T. m= *T. mentragrophytes,* M. a = *M. audounii,* M. ca = *M. canis,* E. fl = *E. floccosum*

Drugs: TER = Terbinafine**,** ITR = Itraconazole**,** KET = Ketoconazole, GRI = Griseofulvin, FLU = Fluconazole

Fig.1: Susceptibility pattern of dermatophytic isolates against antifungal drugs tested

IV. DISCUSSION

The susceptibility pattern of the dermatophyic isolates in relation to antifungals used showed that Terbinafine was the most effective drug followed by Itraconazole. This also agrees with the work of Nweze (8)

Antimicrobial resistance monitoring is useful in tracking and detection of resistance trends by microorganisms, it also gives clues to emerging new resistance. This serves among other things, in assessing interventional efforts and empirical treatments recommendations. Previous authors like (9)., (8)., (10) and(11) have performed in vitro susceptibility tests on various strains of dermatophytes. Therefore, this is an in-vitro susceptibility profile of dermatophytes obtained in the Local Government Areas where the study was conducted revealed that there was no major difference in the MIC by incubating at 30 ^{0}C or 35 ^{0}C. Information available in the literature from other authors indicated that four days of incubation were sufficient to observe noticeable growth in the control wells. We therefore recorded our MIC values after four days of incubation. In the study of (12) tested 508 strains belonging to 24 species of dermatophytes against conventional (Itraconazole and Fluconazole) and some newer antifungal agents like Vericonazole and UR – 9825, with similar results. This seems to support the fact that incubating for four or seven days does not have a significant effect on the MIC readings.

Nevertheless, the result on terbinafine which was the most active agent for example agrees with the observation from previous authors (13) and (5). These antifungal agents used in the susceptibility testing were effective on the dermatophytic isolates. This antimycotic showed an excellent in-vitro potency and broad-spectrum activity against all the tested species. This suggested that terbinafine can be used to treat a majority of dermatophytic infections especially those showing high MIC values on the azoles, such as fluconazole. Although the newer antifungals were not included in the study, such as posaconaloe, voriconazole, and literatures had shown their promising antifungal activities. In Nigeria these antifungals are relatively new and are not readily available, affordable and not widely used as the ones tested during this study.

It will be of interest to state that all isolates used in this study were obtained from school children, teachers and other staff members in all the schools sampled. Interestingly, there was no record of resistance in this study even though some agents recorded high MIC values than others. From the data, Ketoconazole appeared to be the next choice in terms of in vitro activity after terbinafine and itraconazole.

V. CONCLUSION

Tinea capitis is still a problem of childhood, particularly among those living in unhygienic crowded conditions and mostly in riverine areas. This showed that *T. tonsurans, T. violaceum, T. verrucosum, T. rubrum, T. mentagrophytes, M. audounii, M. canis* and *E. floccosum* are dermatophytres found in public school pupils in the Local Government Area of Anambra State, Nigeria in which *T. tonsurans* predominates.

This showed that there is no abuse of antifungal drugs in this area which further affirmed non affordability of these drugs by the individuals whose samples were used for the study.

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Methodology for inventory risk analysis and management using excel and visual basic modeling

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Keywords*— *risk analysis, risk management, VBA, programming language.

Abstract *— Visual Basic for Application (VBA) programming, when used in an Excel programming environment, is an important tool in determining inventory classification risks, as well as an excellent option in view of the current situation of scarcity of classification optimization assessment. inventory risks. This work aims to contribute to the development of programming for an application in VBA - Excel, with the ability to classify inventory risks, capable of delivering data and assertive responses, according to the concepts established within the organization. To achieve this objective, a field research was carried out with small and medium-sized companies in the city of Manaus, Amazonas. The research is classified as experimental, allowing the achievement of qualitative type results. The use of the proposed tools will be available to academic circles and the result of the study will be used to improve the quality of information and data speed, whenever necessary, for management decision-making. It is also expected that this research will contribute to foster discussion about the proposed theme and serve as a technical-theoretical framework for practical application for users and programmers in Solver and VBA tools.*

I. INTRODUCTION

Many products lose their functionality or lose market value over time. Examples include fresh products, blood products, packaged foods, pharmaceuticals, technology or fashion products. The rational configuration of inventory risk can reduce the costs of business losses, lessen the risks of taking time-consuming actions and improve the rates of a reduction in expenses or cost (saving), in addition to determining the success of logistics management. In view of the current situation of scarcity of inventory risk classification optimization assessment, an opportunity was identified to analyze possible practices to accelerate and optimize this process.

The theoretical framework of the work was divided into three sessions where inventory management, its importance, needs, types and problems were addressed. Then it was discussed about inventory management, its meaning, theories, categories and main techniques and finally, the application of IT in Supply Chain Management, its role, goals, MRP system and use of Excel/VBA Spreadsheets. After the literature review, the Visual Basic for Application (VBA) programming language was used to develop a tool to determine the various risks of inventory classification, and cluster analysis and the fuzzy evaluation method were applied to establish the model and the inventory optimization evaluation algorithm.

It is believed that the topic, despite being very important for the business, still has many opportunities for the companies' inventory system. Regardless of the type of

business, there is a great need for the classification of inventories, which is one of the most complex activities within companies, to be carried out in a faster and more practical way, in order to avoid the risk of inventory loss. The relevance for such activity is to propose a clear and well-defined answer, through related criteria, in order to provide an efficient return for decision-making, according to the strategy that best suits.

The general objective of this research is to contribute to the development of programming for an application in VBA - Excel, with the ability to classify inventory risks, able to deliver data and assertive responses, giving reaction time for taking action within the business. . As specific objectives: identify the parameters for analysis and inventory risk management; model the input data for inventory risk analysis and management; classify inventory risks for assertive answers and develop the application in VBA – Excel for classifying inventory risks.

II. LITERATURE REVISION

2.1 Inventory management and its objectives

The term inventory refers to the goods or materials used by a company for the purposes of production and sale. It also includes items, which are used as supporting materials to facilitate production.

According to Lambert; Stock; Vantine (2010, p. 77) “There are three basic types of inventory: raw materials, work in progress and finished goods. Raw materials “are the items purchased for use in the production of the finished product”. The work-in-progress "consists of all items currently in production." Finished products "consist of items that have already been produced but not yet sold."

Inventory is one of the important items of current assets, which allows the proper functioning of the production and sale process of a company. Inventory management is the aspect of current asset management, which is concerned with maintaining the ideal investment in inventory and applying an effective control system in order to minimize the total cost of inventory (LINDER, 2012, p. 81).

An effective inventory management system is the cornerstone of companies. With a strategic plan in place that streamlines the inventory oversight and management process, including real-time data on inventory conditions and levels, companies can realize inventory management benefits.

Simply put, according to Novaes (2011, p. 107), “an inventory management system oversees all stock and stock items of a company”.

Through a robust inventory management system, all inventory items can be tracked and managed throughout their lifetime, from delivery to warehouse to customer's shopping bag. Most inventory management systems have some similar elements. First, they have a way to identify each item, usually via a barcode or RFID. After each item (BALLOU, 2011, p. 98).

An inventory management system helps keep businesses more organized. Without tracking and managing inventory, it's hard to know what's needed, when, and in what quantity.

Silva (2015, p. 12) mentions that “With a quality inventory management system, you have detailed records of all company assets”. You can see all the moving parts in one place, easily see the products that are moving and those that are selling slowly. Having all of this information and resources in one place allows you to make informed decisions about your business needs.

The investment in inventory must not be excessive or inadequate. It must be ideal. Maintaining the optimal level of stock is the main objective of stock management. Excessive investments in inventory result in more fund tying costs, reducing profitability, inventories can be misused, lost, damaged and retaining costs in terms of ample space and others. At the same time, insufficient investment in stock creates problems of lack of stock, interruption in production and sales operation (LINDER, 2012, p. 82).

Therefore, the company may lose customers as they switch to competitors. The finance manager, as he is involved in managing stocks, should always try not to over- or under-invest in stock.

Inventory control refers to the efficient control of goods stored in warehouses. Maintaining an adequate level of stock is very essential for a business flow.

For Moura (2010, p. 53) “The stock acts as a bridge between customer orders and production. They are the reservoir of goods kept in anticipation of sales”. Therefore, it needs to be managed and controlled properly.

Inventory represents a key economic factor in network design that forces inventory consolidation in a small number of locations. Over the years, there has been substantial research on controlling inventory levels for individual product items, but relatively little on estimating inventory levels when there is more than one product item at a time. The practical concerns of network design require that many items be collected across product families and treated as an aggregated group. What is needed is to be able to estimate stock levels as demand is assigned to facilities (SEVERO, 2012, p. 97).

Proper anticipation of product demand is necessary to maintain the correct level of stock. Properly estimated demand helps companies in terms of inventory cost, providing the customer on time and maintaining the production schedule.

Fleury (2015, p. 74) mentions that the basic objective of inventory management is "to minimize the amount of working capital blocked in inventories; and, at the same time, provide a continuous flow of materials to meet production requirements"; and provide timely supplies of goods to meet customer demands.

Novaes (2011, p. 70) points out that the administration must maintain stocks of:

1. Raw materials and parts
2. Semi-finished goods
3. Finished products

Management must balance the benefits of holding stocks with the costs associated with holding stocks, such as - storage space costs, insurance costs, risk of damage and deterioration in stock holdings, etc.

2.2 Inventory control

Inventory control refers to a planned method of purchasing and storing materials at the lowest possible cost, without affecting the production and distribution schedule. Inventory control, therefore, can be classified as a scientific method, capable of determining what, when and how much to buy to have in stock for a certain period (SCHONSLEBEN, 2000).

According to Schonsleben (2000), inventory control refers to the process by which the investment in material and parts transported in stock is regulated within predetermined limits defined in accordance with the inventory policy established by the management. Thus, inventory control activities include: determination of inventory limits to be carried out, determination of inventory policies, establishment of investment standards and its regulation, according to individual and collective requirements, and monitoring, to examine the work of the policy of inventory and, effecting changes, as and when necessary.

It should be evident from the above analysis that materials control is the operational process, while inventory control is the management process and the latter is the first step to be followed by the former. Inventory control therefore forms the basis of material control, without which the entire operation of inventory maintenance can be ineffective or aimless to some extent. On the other hand, stock control precedes storage, which predetermines the scope of stocks and investments (SALEEMI, 2007).

Ramanathan (2006) proposed an approach, called weighted linear optimization, to aggregate the performance of an inventory item, in terms of different criteria, to a single synthetic score, using a weighted additive function. He proposed an extended version of such a weighted linear optimization for multi-criteria inventory classification. These quotes directly explore and support the problems observed in the case study.

The main purpose of an inventory control is:

• Minimize downtime caused by stock shortages and non-availability of stocks as required;

• Keep capital investment in inventories low, avoiding carrying cost losses and obsolescence. Achieving these goals will result in more return on capital, which is materially the main goal of an organization, whether commercial or industrial.

Return on Capital is the relationship between Profit and Capital Investment. Under normal circumstances, the profit margin depends on external factors such as competition over which management has little control. Since the capital turnover rate is maximum when capital investment is minimal, management can exercise control over competitive market trends to some extent (SALEEMI, 2007).

2.3 Types of Costs Involved in Inventory Control

Mclaney (2003) emphasizes that all companies normally seek to balance the costs and risks of keeping inventory levels zero or even low in relation to the parameters established for each organization. Thus, such costs, which until then were aggregated, would be reduced. One of the types of costs involved in inventory control is the order cost. This is the sum of the fixed costs that are incurred each time an item is ordered. These costs are not associated with the quantity ordered, but with each activity required to process the order.

The great challenge of stock management is to reconcile, in an integrated manner, the goals of the departments involved, optimizing this investment, without harming the company's operations. Still, according to Ballou (2006), there are three categories of associated costs. These are acquisition costs, maintenance costs and the costs of out-of-stocks. Acquisition costs generally include the price of the products, the costs of processing orders by the purchasing department, and especially the transportation costs, when these fees are not part of the purchase of the products. Maintenance costs comprise those deriving from the storage of stocks during a certain period. Among them are the cost of space, which are costs

related to the volume occupied by inventories. Capital costs are also included in maintenance costs as they result from the cost of money fixed in stock. There are also the costs of storage services and the costs of storage risks.

2.4 Order point, replenishment time and safety stock

For Pozo (2010), it is the inputs found in the stock that ensure the production process so that continuity problems do not occur, while the arrival of the previously made purchase batch is expected. In order to find the minimum stock needed for the continuous operation of companies and to meet customer demand, it is essential to determine the time taken to replenish stocks.

According to Dias (2010), replacement time is the time spent from verifying that the stock needs to be replaced until the material actually arrives in the company's warehouse. This time can be divided into three parts:

• Order issuance: It is the time it takes from the issuance of the purchase order until the purchase order reaches the supplier;

• Order preparation: It is the time it takes from the supplier to manufacture the products, separate the products, issue billing until they are ready to be transported;

• Transport: It is the time it takes from the supplier's departure until the company receives the ordered materials.

In order for the company to maintain the balance between reducing costs and minimizing uncertainty, it is essential to determine a level of stock called safety stock or minimum stock. According to Dias (2010), the minimum or safety stock may be the minimum amount needed to cover any delays in demand, thus ensuring the continuity of the flow of production processes.

According to Pozo (2010), the main purpose of safety stocks is to try not to harm the production process, much less to cause inconvenience to customers due to lack of supply, which occasionally can lead to delays in the delivery of products to the market. Safety stock is intended to address the impact of uncertainties such as delays and claims in freight transport, unexpected increase in demand, and denial of defective purchase lots.

2.5 Inventory management

Efficient inventory management within companies has the most important objective of determining a more streamlined flow of materials and products, which guarantees good customer service, without any waste and surplus stocks throughout the entire chain. The main objective and purpose of an Inventory information system is to collect and keep up to date all data from within the company, for decision making covering the operational level.

According to Dias (2010), companies are growing and standing out, especially in the supply chain, offering the possibility of reducing unit costs for moving products between companies. For Antônio (2009), inventory management is of paramount importance for the company to avoid possible deviations and ensure the availability of stocks to serve the end customer. According to Francischini (2004), inventories usually contain a description of the product as well as the existing quantity and location. Accuracy in inventory management is currently important and should be placed as a priority for supervisors, managers and directors of any company that seeks to achieve the desired operational efficiency objective.

Inventory control and maintenance is a vital problem experienced by almost every sector of the economy. This topic is very important, as all organizations deal with inventories on a daily basis. Neglecting the importance of inventory in any organization can lead to the closure of the company, especially if the factors of production are not well managed in order to meet the needs or desires of customers, the company tends to move towards a stop. The stumbling block of inventory is having enough items available when desired by customers. Item inventory must be reasonable, which means it should not be too much or too little, and the company must be in a position to meet customer demand in terms of quantity and quality.

According to Dobbler (1996), the main objective of inventory management and control is to provide services to customers at a minimum cost. Managing inventory has become a special issue when selling globally. Inventory management is of great importance especially for managers who must decide how much (if any) they have to insure and how to manage the rest of the logistics system more creatively in order to ensure that customer service does not suffer as a result. of lower stock levels. This is why inventory management requires special attention or support from all levels of management in the company in order to meet customer satisfaction.

III. MATERIALS AND METHODS

This chapter's main objective is to present the research method that will be used in this work, the reasons that make clear the implementation of the inventory risk classification system. More specifically, with food products, where the motivations and difficulties that were encountered during the entire process of implementing the system will be identified, in addition to raising the main benefits achieved with the use of this tool.

For such an investigation, which can be considered as contemporary, premised on the answer to the research questions: "What are the potential benefits for the inventory with the implementation of the risk classification system?".

In order to answer this question, the case study methodology will be used in this project. This method will allow us a deeper analysis of the problem, which allows us a better understanding of the inventory classification process (MIGUEL, 2007).

The problem to be solved in the present study is the lack of speed in the classification of inventory risks, in relation to stock management of perishable products, when the demand is sensitive to the product's expiration date.

Due to several factors that can contribute to the formation of these inventories, such as demand and sales, a schedule will be created to contribute and support the user, in a clear and objective manner.

For the development of the research, a methodology was developed using VBA Excel as the main tool, this application was chosen because it is a tool that can be used in Microsoft Excel, where it has access to most users, this way, the user has more options for controlling and editing spreadsheets. Basically, VBA acts as a programming language at the service of the user, allowing the creation of macros and the automation of various processes within spreadsheets and tables developed in Excel.

During the field research visits were carried out at the sites, for observation and dialogue with the people involved in the process, this visit had a foundation and direction in order to obtain non-formal information, the foundation was guided according to a composed research script for ten questions to be observed by the researcher, nine of which are multiple choice and one is a dissertation. The target population determined for this research was approximately 48 small and medium-sized businesses, located in the neighborhood of Tarumã, West Zone of the City of Manaus, AM. The selected sample consisted of 12 businesses, representing 25% of the target population surveyed.

IV. RESULTS AND DISCUSSION

4.1 Field research

According to the population and sample defined for this research, the answers to the questions were acquired through the application of a research questionnaire and tabulated and presented, with the use of graphs and tables, in order to better elucidate the issues observed.

This analysis also contemplated the results of the development processes of a programming for inventory risk classification, using Visual Basic Applications (VBA). This schedule consisted of three steps:

• Elaboration;

• Modeling;

• Compilation.

To analyze the issues related to the size of the stock of the companies evaluated and the use of inventory control tools, the observations reported in questions 01 and 02 were grouped, as shown in Table 01.

• Question 01: What is the approximate size of the stock?

• Question 02: Does the establishment use any tool for inventory control?

Table 1 - Size of stocks and stock control tool is used.

Reference	Use tool	Don't use tools	Total	%
Up to 1,000 items	2	5	7	58,3 %
Between 1,000 and 5,000 items	5	-	5	41,7 %
	7	5	12	

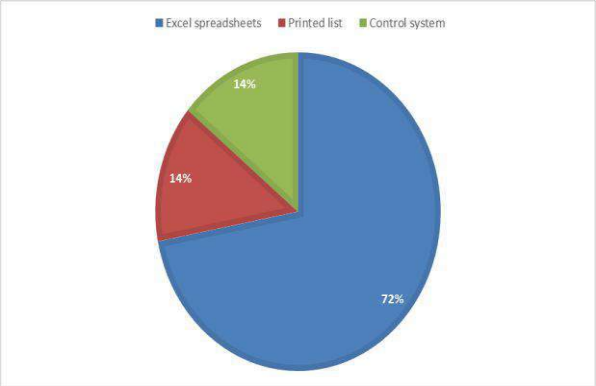
Source: Authors, (2021).

According to Table 1, seven (58.3%) of the companies visited have up to 1,000 (one thousand) items in their stocks. Of this total, only two use some control tool and most (five companies) do not use this tool. With regard to companies that have an average of between 1,000 (one thousand) and 5,000 (five thousand) items, all use some control tool.

• Question 03: If YES in the previous question (If you use a control tool). Which one?

As seen previously in Table 1, only seven companies visited use some inventory control tool. In this sense, Graph 1 shows that of these seven companies, 72% use Excel spreadsheets to control their stocks, 14% use printed lists and only 14% (1 company) use a control system.

Graph 1 - Inventory control tools used by respondents.

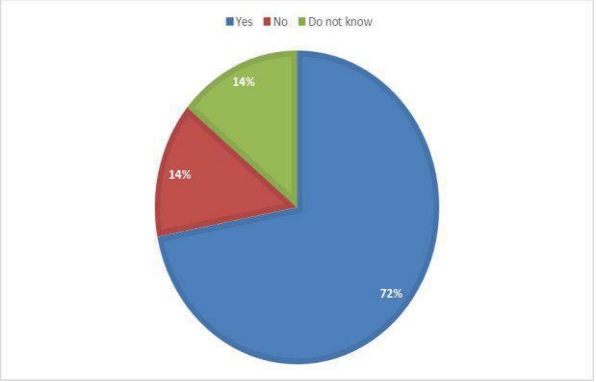


Source: Authors, (2021).

Question 04: Does the control tool used today meet all stock needs?

As for the efficiency of the tools used, the reports of those responsible for the establishments who reported using some tool (seven establishments) were considered. Graph 02 shows that for 72% of companies the tools used meet their needs. 14% reported "No" and 14% did not know or did not report.

Graph 2 - If the tools used by respondents meet their needs.

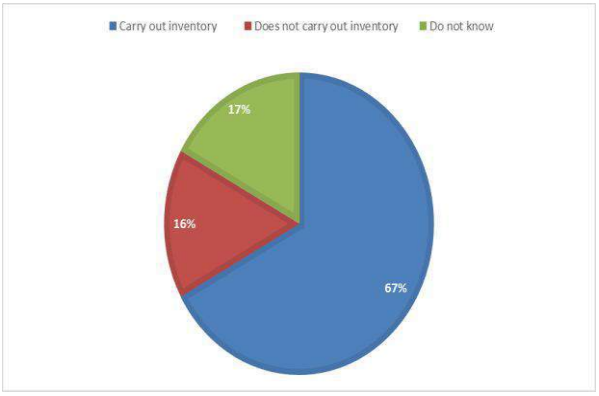


Source: Authors, (2021).

Question 05: Carrying out inventories (item counts) in stock:

As shown in Graph 3, 67% of establishments carry out inventories in their stocks. A minority (16%) do not carry out inventories and 17% did not present any relative data. It is noteworthy that in this question only the realization or not of the inventories was addressed, as to their frequency, accuracy or effectiveness, it was dealt with in questions 06 and 07 below.

Graph 3 - Companies that carry out inventories in their stocks.

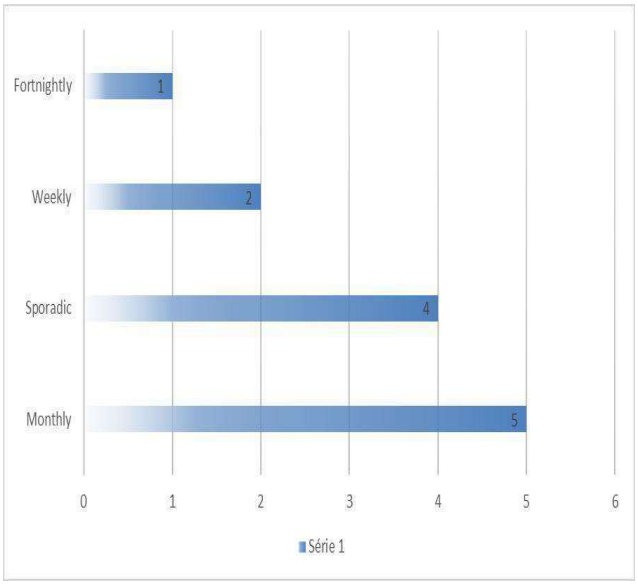


Source: Authors, (2021).

Question 06: If YES in the previous question. What frequency?

Regarding the periodicity of carrying out inventories, most establishments carried out monthly. Second, sporadic practice, followed by weekly and finally fortnightly.

Graph 4 - Frequency of inventory realization by establishments.



Source: Authors, (2021).

The modeling, for data observation, was done through the VBA Excel programming environment, where the interface was performed between the provided environments, containing data on stock balance, entry date and expiration date of the products correlated with the

variables analysis of the schedule, resulting in response to the health of the analyzed stock.

Data compilation was carried out using the programming designed to obtain the inventory classification, which is presented by a computer application using Excel resources in the VBA programming environment, where it was intended, in fact, to show the versatility of using this program in making a decision about the scenario of how the stock is at the time of analysis.

The observation and classification of inventories are carried out in such a way as to meet the health of the business' stock, taking into account the variables that we will deal with in this case study.

For the case study, the inventory was classified into three main classifications:

• No Risk – Where it was shown that for inventory, there was no risk of inventory loss, when input and output variables were analyzed, according to demand and consumption, in view of the expiration date of the products.

• Medium Risk - Where it was shown that for stock, there was a risk of inventory loss of up to fifty percent, when the input and output variables were analyzed, according to demand and consumption, due to the expiration date of the products.

• High Risk - Where it was shown that for the stock, there was a risk of inventory loss in one hundred percent, when the input and output variables were analyzed, according to demand and consumption, due to the expiration date of the products.

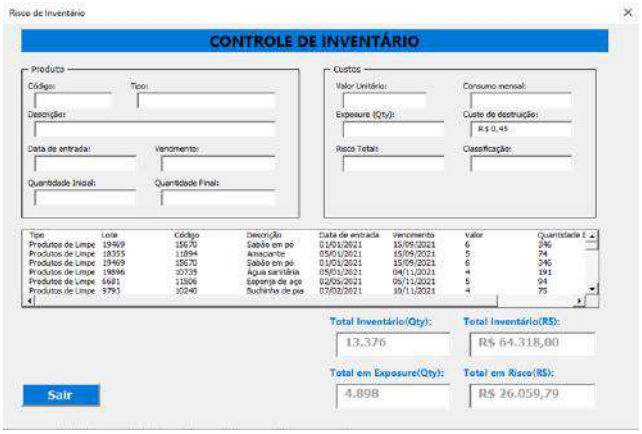


Fig.1: Inventory Health Summary.

Source: Authors, (2021).

When we approach the topic of Stocks, it is essential to pay attention to the Control factor. In this aspect, several authors such as: Owler (1985); Pozo (2010); Ballou (2006); Saleemi (2007), Brent and Travis (2008); Mclaney (2003), among others, confirm the importance of Control for an effective balance between costs and risks.

According to Dobbler (1996), the main objective of inventory management and control is to provide services to customers at a minimum cost. The financial objective is the ability of funds to make management demands of how much is needed to invest in inventory so that the money has not been put into inventory, leaving other areas without working capital.

Under the objective of asset protection, inventory represents money. Therefore, this objective gives the stock controller the obligation to ensure that stocks are protected against all possible dangers, including theft, waste and misappropriation of inventory, therefore, there must be adequate inventory and stock control.

In this sense, the other questions in the questionnaire sought to address the Inventory Control used by respondents, with regard to the tools used and the practice of inventory. The questions from 02 to 04 were aimed at investigating the interviewees' inventory management, regarding the use of control tools:

Question 02: Use of any tool to control inventory?

Question 03: If YES in the previous question. Which one?

Question 04: Does the control tool used today meet all stock needs?

Simchi-Levi et al. (2004) informs us that the use of technology in inventory control is a crucial enabler that ensures efficiency in the process. Therefore, the evolution of Information Technology (IT) has been and will continue to act as the main driving force for the development of SCM. In this sense, it appears that there are today on the market several tools for stock control, suitable for different types of companies and with a wide range of costs and profiles.

The main importance of an inventory management system is to collect and keep up to date all data from within the company, for decision making, covering the operational level. It is up to the entrepreneur to make an investment plan, according to the particular needs of the company. The lack of standards, on the other hand, contributes to software being soon developed to mediate between different systems and different standards and, eventually, the concept of supply chain standards can be established in the basic systems that make up the infrastructure (SIMCHI-LEVI et al., 2004).

It is also noteworthy that the acquisition of an inventory control tool is part of a mix of investments necessary for its good maintenance. In this aspect, Dias

(2010) states that investments in stock are necessary as they work as a lubricant for production and sales service. Insufficient stock compromises the pace of production and limits sales.

The questions from 05 to 08 were aimed at evaluating the practice of inventory (counting items) of stocks:

Question 05: Carrying out inventories (item counts) in stock?

Question 06: If YES in the previous question. What frequency?

Question 07: Do the results of inventories usually diverge from the actual stock?

Question 08: If YES in the previous question. At what percentage?

Render (2003) teaches us that an inventory is any stored resources that are used to satisfy a current or future need. The inventories, therefore, usually contain the description of the product as well as the existing quantity and the place where it is found. Accuracy in inventory management is important today and should be placed as a priority for supervisors, managers and directors of any company that seeks to achieve the desired operational efficiency objective.

Inventory management is of paramount importance for the company, to avoid possible deviations and ensure the availability of stocks to serve the final customer (ANTÔNIO, 2009). Saleemi (2007) alerts us to the fact that inventory control is a planned method of purchasing and storing materials, at the lowest possible cost, without affecting the production and distribution schedule and that they incur costs for the care of the stored material. and are subject to damage and obsolescence.

In this way, stocks of raw materials provide a stable source of inputs needed for production. Large inventory requires less replenishment and can reduce ordering costs due to economies of scale. In-process stocks reduce the impacts of variability in production rates in a plant and protect against process failures.

Questions 9 to 10 sought to address the use of the Excel Solver tool with respondents, as well as possible improvements in terms of inventory control:

Question 09: Knowledge or have you ever heard of Excel Solver?

Question 10: What could be improved in inventory control?

For Simchi-Levi et al. (2004), the supply chain management is complex and distinct in each company and they may be concerned with the magnitude of the return on investment, or very detailed information that does not make sense to the customer, or a certain investment in IT is too much great.

Thus, the large number of resources in computational areas, which are available today in the market to be a support point for decision making, demonstrate the need to apply resources in micro and small businesses. For Cezarino et al. (2008) this is mainly applied in relation to the cost item. To serve this purpose, there are several tools available on the market, for example, in solving problems related to clean production, which can be treated with Solver, which is a tool that is available in Excel and whose main objective is to find a optimal answer to the problems that are encountered.

In this aspect, Solver proves to be quite efficient, as it is composed of a set of programs (tool for hypothetical analysis) and allows the change of values in cells, in which it finds a value through a formula in a system within the spreadsheet, characterized also as a target cell.

V. CONCLUSION

This research aimed to contribute to the development of a methodology for inventory risk analysis, a programming for an application in VBA - Excel, with the ability to classify inventory risks and, for this, it was elaborated from a survey bibliographic and case study, carried out with small and medium businesses in the city of Manaus-AM.

The data presented in the research, in terms of technical-theoretical framework and field research results, allowed an analysis of the scenario experienced by some companies (field research sample) regarding the control and management of their stocks and inventory practices . In this aspect, in relation to the pre-defined specific objectives, it is possible to highlight:

A methodology for inventory risk classification was developed, according to the variables established within the inventory concepts, which met the theorization proposed by the authors and contemplated the variables established within the inventory process, which included the following parameters: Average consumption monthly; Minimum stock; Replenishment Time or Order Point (issuance, preparation and transport).

Then, the parameters for analysis and management of these risks were identified, a modeling was carried out to observe the data, using the VBA Excel programming environment, whose interface is performed using the provided environments, and which included data on: balance in inventory; date of entry and expiration of the products. These data were correlated with the

programming analysis variables, which guarantees results in terms of response to the health of the stock.

Finally, it is concluded that, although it has great economic and operational importance, inventory management is a minimized subject in most of the interviewed companies and that investments in terms of control tools are reduced, causing problems with stock accuracy and control, which can have negative consequences for the company in many situations.

This work is suggested, given its technical-theoretical importance, but of great practical application, to educational and research institutions, in order to contribute to the theoretical framework promoted and to researchers and technicians who use the Solver and VBA tool, from way they can use this reference, as a guide and study material in their projects involving the technical applications of these tools in inventory management.

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Inclusion of Disabled Students at the Federal University of Maranhão in Times of the Covid-19 Pandemic

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Keywords- ***Higher education, Disabled students, Emergency remote learning, inclusion.***

Abstract*—The current global outlook, created by the coronavirus pandemic, has brought an adverse situation for education in most countries. This exceptionality, consequently, also imposed new challenges to students with disabilities. Thus, the present study sought to identify the institutional actions developed by the Federal University of Maranhão (UFMA) in order to guarantee the inclusion of the target audience of Special Education in the context of the Emergency Remote Education (ERE) adopted during the COVID-19 pandemic. Data were collected through a bibliographic survey, document analysis, and institutional actions published in the news on the UFMA Portal from March 2020 to July 2021. The findings of this study signal that, despite hundreds of acts developed in favor of non-presence education, few contained actions aimed at the inclusion of students with disabilities.*

I. INTRODUCTION

The pandemic of Corona Virus Disease 2019 (Covid-19) has installed a health crisis and an unprecedented scenario all over the planet. Isolation and quarantine measures were necessary in several countries in order to reduce the number of infected and dead people. As a consequence of these actions, teaching activities were initially suspended at all levels of education. In this context, authorities and education professionals were faced with the need to find a solution to minimize the damage to the 2020 school year, using Emergency Remote Learning, a common alternative term used by distance education researchers and professionals to establish a clear contrast to what many of us know as high-quality distance education (Hodges et al., 2020).

In Brazil, Ordinance nº. 343 of March 17, 2020, of the Ministry of Education [MEC] (2020a), will "Authorize, on an exceptional basis, the replacement of classroom subjects in progress by classes that use media and information and communication technologies [...]" (p. 39). With the increase in the amount of contaminated people and the worsening of the situation caused by the coronavirus, the initial suspension of 30 school days, approved by the normative diploma previously mentioned, was extended until December 31, 2020, according to Ordinance nº. 544 of June 16, 2020 (Ministry of Education [MEC], 2020b). Moreover, the apparent stability in the number of cases and deaths initiated a dispute between the spheres of public power about the return or not of classes in person in the year 2021. Thus, in December 2020, some ordinances issued by the MEC attempted to force the Higher Education Institutions to return to face-to-face activities. Firstly, Ordinance nº. 1.030 would revoke Ordinance nº. 544, providing for the return to classes on January 1st, 2021 (Ministry of Education [MEC], 2020c), however, it was unsuccessful. Soon thereafter, Ordinance nº. 1,308 was published, seeking to amend the aforementioned, suggesting the resumption only on March 1, 2021 (Ministry of Education [MEC], 2020d). The impasse created by the aforementioned documents was resolved as of the CNE/CP Opinion n° 19/2020 of the MEC and the approval of the CNE/CP Resolution n°2, of December 10, 2020, determining:

> Art. 31 In the scope of federal, state, district and municipal education systems, as well as in the Education Departments and in public, private, community and confessional school institutions, **the non-face-to-face pedagogical activities addressed in this Resolution may be used on an exceptional basis for the completion of the** workload of pedagogical activities, in compliance with the measures for facing the Covid-19 pandemic established in biosafety protocols (National Education Council, 2020e, p. 52, our emphasis).

Therefore, it was established that the current context would be the main point of analysis for the return or not of face-to-face classes in the 2021 academic year. However, non-face-to-face teaching would continue to be understood as being of exceptional nature. Given this panorama, developing classes remotely has presented itself as the greatest challenge for students and teachers at all levels. In Higher Education it has not been different. Institutions have built strategies and resources aimed at the maintenance of teaching activities for all their students. In this sense, this research presents as central question: what actions have been developed by the Federal University of Maranhão aiming to ensure the inclusion of students with disabilities during the period of emergency remote teaching?

In order to answer the research problem, it was outlined as a general objective of this research: to identify the institutional actions of UFMA that ensure the inclusion of students with disabilities during the period of emergency remote education.

For the development of this research, of qualitative approach, it was developed a bibliographic and documental type research, because it "makes use of materials that have not yet received analytical treatment or that can still be reworked according to the research objects" (Gil, 2010, p. 30). After the delimitation of the general objective of the work, it began the bibliographic survey and data collection in the news section of the UFMA Portal, in the period from March 16, 2020 to July 20, 2021, with the descriptors: Inclusion; Accessibility; Disability/ Disabled; Pandemic/Covid-19. The objective of this search was to identify the news about university actions regarding the pandemic, organizing them into categories to identify and highlight which ones dealt with actions directly related to students with disabilities. Thus, the following categories of documentary analysis were established: institutional documents; courses; webinars; videos and news of institutional actions aimed at students with disabilities.

II. INCLUSIVE INSTITUTIONAL ACTIONS AT UFMA

The documentary analysis presented here is the result of data survey, from March 16, 2020 to July 20, 2021, in the UFMA Portal. This research allowed listing several actions developed by the institution in the context of emergency remote education. The initial search was based on the descriptor "Pandemic", finding a total of 729 materials, containing: institutional documents approved for the organization of the university in the pandemic period; actions for non-presence education promoted by the site "EaD for you"; and news in general about initiatives aimed at students with disabilities.

It was discovered in the "News" section that numerous institutional documents were approved during this period, as can be seen in Table 1, organized chronologically:

Table. 1: UFMA's institutional documents referring to the actions for the period of the Covid-19 Pandemic, disclosed in the "News" section

Nº	Document	Date of publication	Contemplates
1	Ordinance GR nº. 189/2020-MR	March 16, 2020	No
2	Ordinance GR nº. 190/2020-MR	March 16, 2020	No
3	Resolution nº. 1.978-Consepe	March 18, 2020	No
4	Resolution nº. 1,980-Consepe	April 2, 2020	No
5	Resolution nº 1.981-Consepe	09 April 2020	No
6	Resolution nº 1.982-Consepe	09 April 2020	No
7	Ordinance nº 241-MR	April 9, 2020.	No
8	Resolution nº 1.983-Consepe	April 15, 2020	No
9	Resolution nº 1.984-Consepe	April 15, 2020	No
10	Resolution nº 1.998-Consepe	May 15, 2020	No
11	Resolution nº. 1.999-Consepe	May 18, 2020	Art. 1, VI
12	Resolution nº. 2078-Consepe	July 17, 2020	Art. 7, §§1 and 2

13	Normative Instruction nº. 04-Proen	August 04, 2020	No
14	Resolution nº. 2.081-Consepe	August 10, 2020	No
15	Resolution nº 232-Consad	August 18, 2020	No
16	Normative Instruction 05/2020 - Proen	August 18, 2020	No
17	Ordinance GR nº472/2020-MR	August 19, 2020	Topic 1, letter h
18	Resolution nº. 2.083-Consepe	August 24, 2020	No
19	Resolution nº. 2.176-Consepe	March 22, 2021	No
20	Resolution nº 2.185-Consepe	March 22, 2021	Art. 5, §§1 and 2

Among the related documents, only four mentioned, in some excerpt, students with disabilities. However, these only deal with the referral of care for these students to the Directorate of Accessibility (DACES) of UFMA. Only after Resolution No. 2.078 - Consepe, of July 17, 2020, it is specified which public with disabilities will be served by DACES, as well as describes, more clearly, what would be the support offered to these students (Universidade Federal do Maranhão [UFMA], 2020). With the approval of Resolution nº. 2185 - Consepe, of March 22, 2021, the wording of the previous document is repeated, i.e., no further specifications or actions directed to such group are drawn up, as evidenced in Article 5º:

> The undergraduate course coordination may request, if necessary, the support of the Directorate of Accessibility for students with disabilities, autistic spectrum disorder and high abilities who enroll in any of the curricular components offered in the academic period.
>
> In case of a student with **visual impairment** enrolled in a curricular component, the teacher must send, 10 (ten) days in advance, to the e-mail address: braille@ufma.br, material to be adapted by the Accessibility Board.
>
> In case of **deaf students** enrolled in the curricular component, the teacher must send, 15 (fifteen) days in advance, to the email: daces.proen@ufma.br, material for adaptation by the Directorate of Accessibility (Federal University of Maranhão [UFMA], 2021, p. 4, our emphasis).

What is noted is the documentation of an action focused only on the mention of who this student is and who is responsible for his care. Therefore, measures, strategies and adjustments aimed at the care of these students are not planned or even officially presented by UFMA. From this perspective, Böck et al. (2020) emphasize that:

> Although several advances can be identified regarding the participation of people with disabilities in different social spheres, **it can still be said that these people remain invisible when it comes to the development and implementation of public policies and other deliberations and decisions about the lives of these subjects. This is also a constant in the spaces of knowledge production, such as universities** (p. 134, our emphasis).

As can be seen, the number of documents approved by UFMA does not guarantee the visibility and inclusion of students with disabilities. It is observed that there was not even the participation of students with disabilities in the discussions, preparation and deliberations promoted about *online* education for this public in that institution. Moreover, the website "EaD for You" was created in April 2020 by the current Directorate of Technologies in Education (DTE), in order to support the distance learning activities of the university. According to Cavalcante (2020), "The purpose of the site is to offer information in the area of Technology in Education to the faculty and technicians of UFMA, through news, courses, training, webinars, among other educational initiatives" (para. 1). Thus, over the past few months, the team responsible for the site planned, created and made available a series of actions designed for the development of remote teaching in the institution.

The aforementioned DTE productions are described in the table below. The courses offered by the "EaD for You" are conducted through the VLE website, in partnership with the agreement between the Open University of Brazil (OUB) and the Unified Health System (UHS) and UFMA, "aiming to offer self-instructional courses conducted without the presence of a tutor, focused on the use of educational tools and technologies" (Potter, 2020, para. 1). Another resource developed by the DTE were the short videos, referring to varied themes and produced by experts in the area. Each section of the "Knowledge Drops" has three videos, available on the website and *YouTube*, as shown in Table 2.

Table 2: List of Courses, Training and videos developed by the Directorate of Technologies in Education, published on the website "EaD for You

Nº	Courses	Contemplates
1	Creation of learning situations for DE	No
2	Online tutoring	No
3	Sources of educational resource information	No
4	Tools and teaching resources for video lesson production (module I)	No
5	Tools and teaching resources for video lesson production (Module II)	No
6	Planning lessons for EaD	No
7	Selection of digital media for DE	No
8	Copyright and digital educational resources	No
9	Introduction to Distance Education	No
10	Introduction to intellectual property, copyright, software and personality rights	No
11	Impact and visibility of educational resources	No
12	Application of the basic concepts of intellectual property, copyright, software and personality rights	No
Nº	**Training**	**Contemplates**
1	Creation of remote disciplines: subsidies	No
2	Preparing interactive remote classes	No
3	*Booker* Site	No
4	Your voice in remote classes: tips and care	No
5	Google Gmail, Calendar, and Drive	No
6	Google Forms	No
7	Active Methodologies	No
8	SIGAA	No
9	*Google Meet* and Google *Classroom*	No
10	Development of educational resources	No
Nº	**Knowledge Drops**	**Contemplates**
1	Copyright and personality rights	No
2	Pedagogical presence in distance education	No
3	Notions on how to record your video lesson	No
4	How to prepare an EaD lesson plan	No
5	What to consider when planning remote classes	No
6	Instructional *Design*	No
7	Gamification in education	No
8	Mediatization of content for remote learning	No
9	Researching educational materials for the online classroom	No
10	Professional attitude and best practices in online meetings	No
11	Behavior and good practice in the online classroom	No
12	Remote Learning and Distance Education	No
13	Learning situations in DE	No
14	Preparation for remote teaching	No
15	How can technologies be used for study and research?	No

Despite the variety of courses offered, these are intended only for the teaching staff and administrative technician of the institution, offering introductory and basic knowledge about topics, content, characteristics and resources related to educational technologies. According to the objectives outlined for each course in the article entitled "*Registration open for self-instructional courses on* the *platform SITE AVA"*, published on the UFMA Portal, on January 15, 2021, there is no mention of the training needs to ensure the inclusion and accessibility of students with disabilities at UFMA. The training and videos produced are open to the public through the website and the *YouTube* video platform. However, in the same way as the courses, these productions are not focused and/or contemplate, in their approach, the inclusion of students with disabilities during the period of remote education.

What can be noticed is that "[...] education at the time of COVID-19 starts to understand technology as a space for struggle, transformation, but also for inequalities" (Barreto & Rocha, 2020, p. 2). That is why, to the extent that training spaces and resources are thought and created to ensure the viability of *online education* without contemplating the diversity; the needs and rights of people with disabilities, the exclusion process becomes more evident, expanding, consequently, the social and educational inequalities to other terms. "The quarantine makes social injustices, exclusion, human frailty and the suffering of the most vulnerable sectors of society more visible" (Silva et al., 2020, p. 130).

The DTE also offered, between May 2020 and July 2021, 57 webinars on various topics focused on the use of educational tools and technologies in the context of distance education. As known, during the pandemic period, videoconferences became common in the educational space, mainly because they are a resource that reduces geographical distances and can be used in real time by all participants through digital platforms. In this scenario, then, webinars appear - expression derived from the English word "*webinar*" - defined as "an online seminar in video, recorded or live, usually allowing the interaction of the audience via chat. [...] It is the same as a live, that is, live broadcast in which we have only one presenter [...]" (Mantilha & Boff, 2020, p. 3). The Table 3, below, presents all the webinars held until July 2021.

Table. 3: List of Webinars developed by the Directorate of Technologies in Education, disseminated in "EaD for You", between mid-2020 and July 2021.

Nº	Webinars	Cont.
1	UFMA's Computational Ecosystem: recent advances and achievements already available to the academic community	No
2	Information design for DE: contributions and perspectives	No
3	How to design learning situations for DE?	No
4	How to prepare a lesson plan in DE?	No
5	Notions of how to record your video lesson using resources available at home	No
6	Sources of information for building Educational Resources for ODL	No
7	Basic concepts of copyright for the production of educational resources for distance learning	No
8	Preparing digital content using the Google Platform for Education	No
9	Increased impact and visibility of the educational resources produced	No
10	*SaiteBooker*: tool to build *e-books* easily, quickly, free and easily accessible in e-pub format	No
11	Serious Games and Gamification: report of experience and tools	No
12	Creating online classes through *Microsoft Teams*	No
13	Online assessment methodologies and strategies for face-to-face or remote learning	No
14	Planning, Higher Education and *Online* Scenarios: meaningful learning in 2020	No
15	*Moodle* x Google *Classroom* x *Microsoft Teams* and SIGAA: digital platforms to support remote learning at UFMA compared	No
16	Pedagogical Presence in Distance Education	No
17	Active Methodologies and Educational Technologies	No
18	The role of Instructional *Design* in Distance Education	No
19	SIGAA as a virtual environment for remote classes at UFMA	No
20	Technologies for remote monitoring of research projects	No
21	IBM *Academic Initiative*	No
22	Strategies and resources for digital transformation of education: challenges and opportunities	No
23	Transposition of face-to-face discipline to the remote model	No
24	Gamification in education	No
25	Remote teaching and distance education: differences and limitations	No
26	Professional attitude and best practices in online meetings	No
27	Building Interactive Remote Classrooms	No
28	EaD Portal's Potential for You: Learn to work remotely autonomously	No
29	Potential of *Google Forms* and *Google*	No

	Drive for Remote Learning	
30	Mediatization of content for remote teaching: how to communicate better to teach better	No
31	What to consider when planning remote classes?	No
32	Bringing people together in remote learning: use of tools and technologies oriented to participation and engagement	No
33	The use of institutional e-mail by teachers, students, administrative staff and sectors of UFMA: advantages of use, legal and information security	No
34	Formative and Summative Assessment in the Remote Model: which tools and strategies to adopt?	No
35	**Students with Disabilities and Remote Learning: suggestions for accessibility**	**Yes**
36	Libraries and information services for online learning	No
37	Mental health dialogues in pandemic situations	No
38	Remote Verification of Learning: the *Game Quiz* App	No
39	Google Meet classes: resources and potential	No
40	Planning and Management of Postgraduate Courses Lato Sensu	No
41	Preparing for Remote Learning: details, tools and methodologies for a successful experience	No
42	The use of SIGAA by students: a tool for academic development	No
43	The perspectives of the use of *Google Classroom* and *Google Meet* by the student body	No
44	How can technologies be used for study and research?	No
45	Behavior and good practices in the online classroom	No
46	Suicide: Are we going to talk openly about it?	No
47	Student Assistance at UFMA: programs, advances and recent achievements for students	No
48	Learn how to digitally sign documents for free and with legal validity	No
49	LGPD: concepts and compliance process	No
50	*Microsoft Teams* for Educators and Students (Basic Level)	No
51	*Microsoft Teams* for Educators and Students (Intermediate Level)	No
52	AVA UFMA: the new virtual environment for distance learning at UFMA	No
53	*Microsoft Teams* for Educators and Students (Advanced Level)	No
54	COVID-19 and the *Burnout* Syndrome in health professionals	No
55	Demystifying the registration of computer programs at the National Institute	No
56	The bereavement process in childhood in times of COVID-19	No
57	Using the Electronic Information System in practice	No

Among the webinars produced, only one directly addressed the conditions and special needs of students with disabilities enrolled in courses in Higher Education, under the title "*Students with Disabilities and Remote Learning: suggestions for accessibility*", presented on August 14, 2020 by Professor Maria Nilza Oliveira Quixaba, director of DACES. In the context of this discussion about the invisibility of these students, authors such as Silva et al:

> The target audience of Special Education is, again, invisible in public policies, decrees and decisions created by Pandemic [...]. However, the political-educational discourse considers that everyone is in the same conditions. **The reality imposes itself and shows us that people with disabilities are not yet in a situation of equal access to different technological, social and cultural possibilities** (p. 132, our emphasis).

The validity of the initiative should be exalted, however, the democratic profile and the potential to explore this type of resource/space, could and should be used for wide dissemination and promotion of more training, debates and clarifications about the difficulties, barriers, vulnerabilities and how to promote the inclusion of this public during remote education. From this point of view, then, it becomes essential to highlight the importance and the role of lectures and institutional web

conferences to ensure information and training on the right to inclusion of students with disabilities and their respective strategies. In view of this, it is also highlighted the role of the news referring to the target audience of Special Education since the beginning of the coronavirus crisis. Cardoso et al. (2020) consider that:

> The COVID-19 pandemic has restricted communication/information channels to virtual media in virtually every aspect of the Brazilian citizen's life. **Education, communication and information have always been undeniably interconnected, however, the coronavirus pandemic has made the relationship between these rights one of extreme dependence (**p. 39, our emphasis).

In the UFMA Portal, hundreds of news were released since the year 2020, however, only those listed in Table 4 refer to the student with disabilities in the context of pandemic Covid-19.

Table. 4: News calls about institutional actions directed to students with disabilities, in the context of Covid-19 pandemic

Nº	**Webinars**	**Cont.**
1	DCom TV: UFMA in the fight against Covid-19.	08 and 14 April 2020 May 25, 2020
2	Launch of the "EaD for You" website.	April 28, 2020
3	Launch of the research "Psychosocial Demands in view of the Educational Accessibility of Students with Disabilities in the Context of Pandemic Covid-19 in the Campus São Luís - MA".	June 08, 2020
4	Dissemination of the webinar "Students with Disabilities and Remote Learning: suggestions for accessibility".	August 11, 2020
5	Dissemination of the Virtual Welcome of the Course of Pedagogy - Imperatriz Campus "Formative Experiences in Inclusive Education: Interlocutions and Pedagogical Praxis".	September 11, 2020
6	Information on Notices of Aid for Digital Inclusion specifically for people with disabilities.	September 15, 2020
7	Interview on the activities of the Directorate of Accessibility in the pandemic.	October 05, 2020
8	Research with people with disabilities verifies the accessibility of UFMA technologies.	October 27, 2020
9	Inclusive Debate Cycle will focus on accessibility and inclusion of students with de science in remote education.	March 03, 2021
10	Lecture "Assistive Technology for Visually Impaired Students" will take place on April 27 via *Google Meet.*	April 9, 2021
11	Pre-registration for those approved in Sisu in the first semester of 2021 begin on Monday, 19, exclusively online way.	April 19, 2021
12	Registration open for the third edition of the Cycle of Inclusive Debates promoted by the Board of Accessibility of UFMA, which will take place on 28 this month.	June 17, 2021
13	Accessibility Board promoted, online and with Libras interpreters, the III Cycle of Inclusive Debates focused on Higher Education.	July 1, 2021

As previously mentioned, 729 articles were found in the "News" section of the UFMA Portal about the pandemic, of which only the 13 previously listed were intended for activities and actions aimed at serving students with disabilities. Therefore, the scarcity of materials denotes, in reality, the small amount of diligences promoted by UFMA, in view of the specific educational needs already existing of these students and those that emerged in the last year. What is desired is the guarantee and respect for the rights of these students, because, as Carvalho (2016) states:

> The right to equal opportunities, which we emphatically defend, does not mean an equal way of educating everyone, but **giving everyone what they need according to their interests and individual characteristics. The watchword is equity, which means educating according to individual differences,** without any manifestation of difficulties becoming an impediment to learning (p. 37, our emphasis).

It is expected that equality and equity are the foundations of movements towards Inclusive Special

Education in times of pandemic, since including the person with disabilities, whether in society itself or in certain spheres, such as education, is a dynamic and constantly building process that has become more complex in the Covid-19 scenario. Education professionals, caregivers, families and people with disabilities find themselves facing an exceptional situation in relation to inclusion in times of physical distance and interaction and interactivity through *online*. However, it is hoped that this now unsettling reality will be used to transform discriminatory situations into inclusive ones, not just act as a reinforcement to the numerous exclusionary mechanisms already in place.

III. CONCLUSION

The global pandemic of Covid-19 brought unprecedented challenges for authorities around the world. In education, it promoted an exceptional scenario, in which the only solution was to try to maintain the 2020 and 2021 school years with emergency remote education. However, for people with disabilities the context of non-presence education proved even more challenging.

In view of the achievement of the proposed objective of identifying the institutional actions of UFMA that ensure the inclusion of students with disabilities during the period of emergency remote education, it was concluded that, despite the numerous and varied actions developed and the documents published in the pandemic context of Covid-19, the referred institution contemplated little the Special Education students.

It was noticed, from the analysis of documents, the absence of curricular adjustments and inclusive teaching strategies; shortage of training activities and guidelines on assistive technologies and specific teaching-pedagogical procedures for students with disabilities and their teachers, that is, few were the institutional actions favorable to the teaching-learning process of the target audience of Special/ Inclusive Education, during the period of emergency remote teaching.

The importance of combating the invisibility of these students is reinforced, often camouflaged by ideological discourses, but revealed by exclusionary practices, segregating actions and the silencing of these people in discussions and deliberations on issues, apparently general, but with harmful impacts on already marginalized groups.

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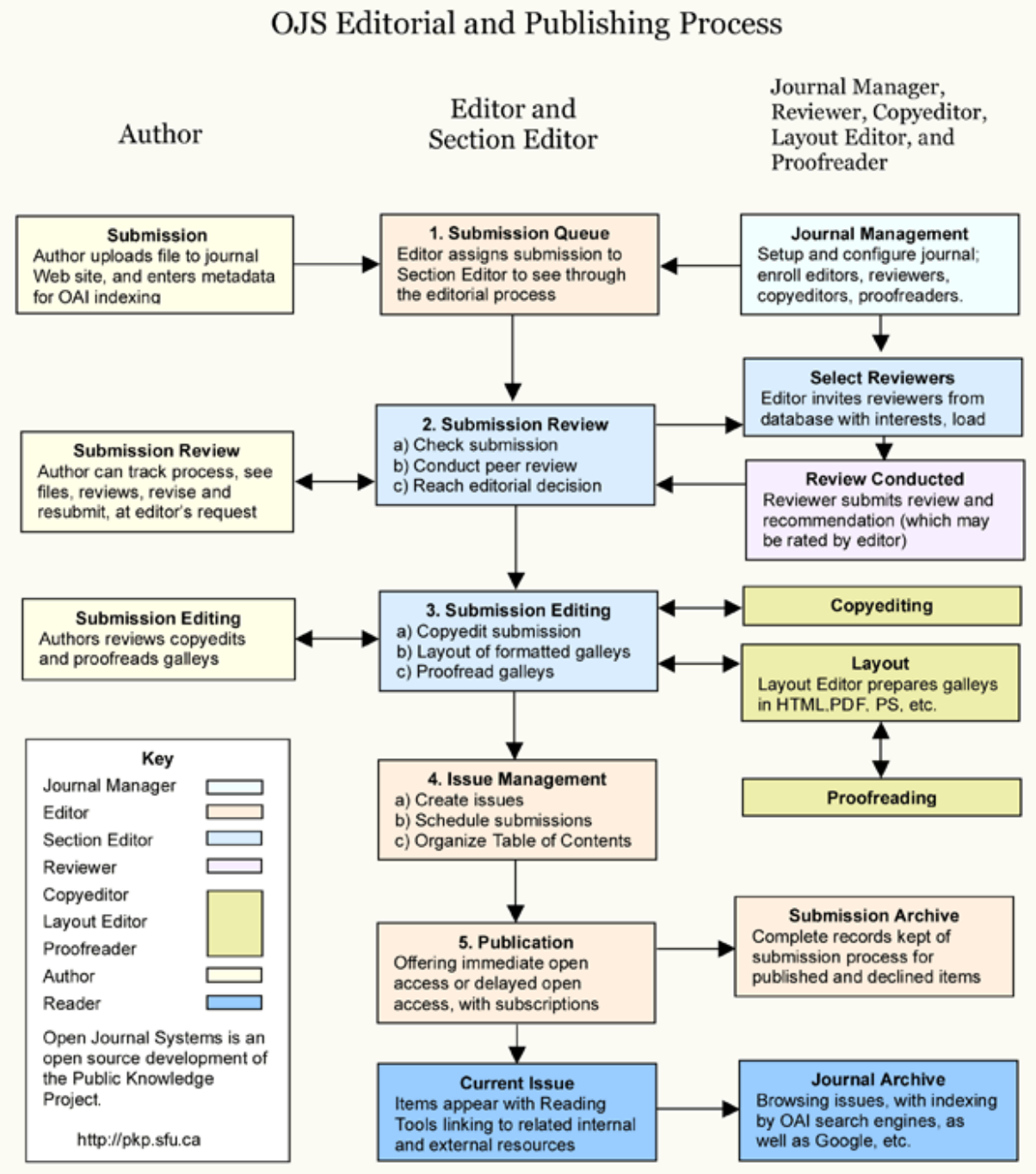

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